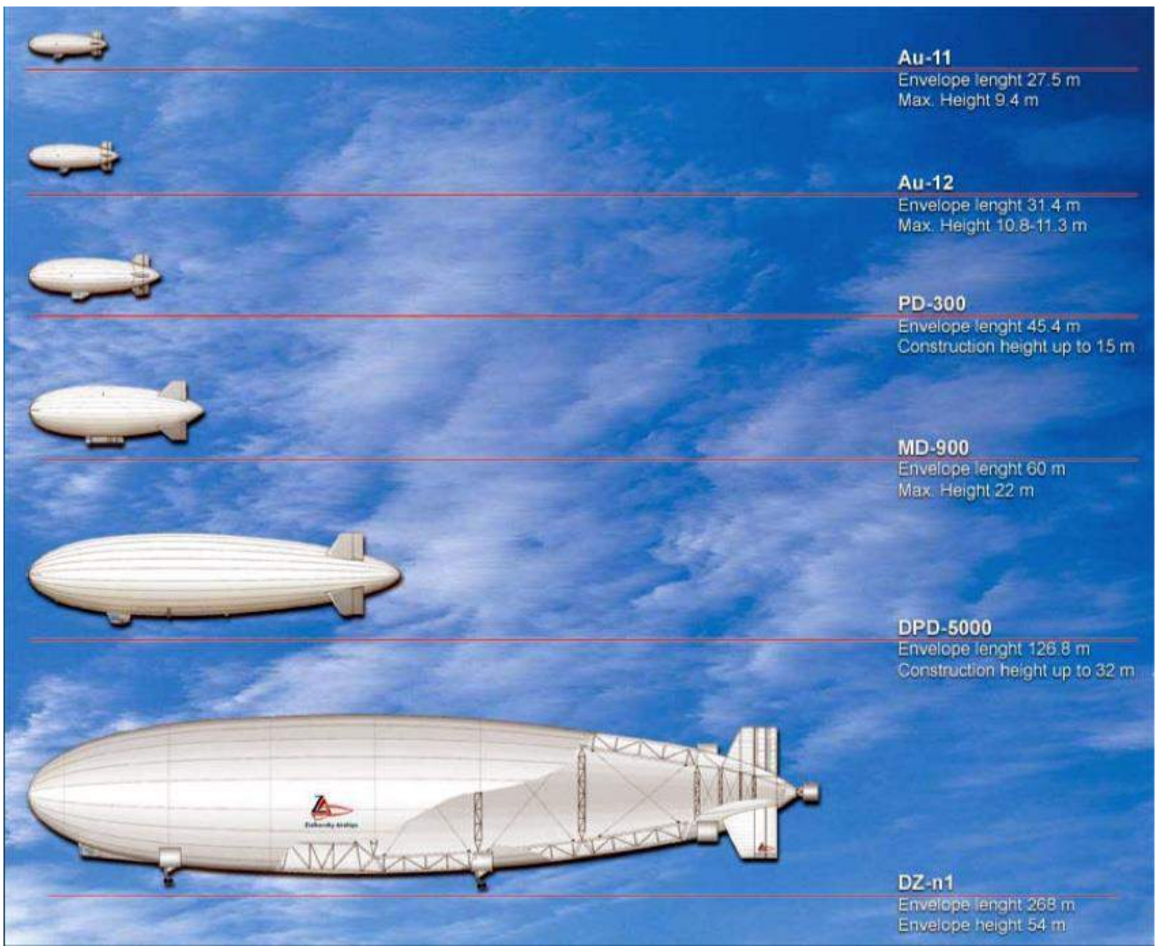
# Augur RosAeroSystems (RAS) airships

Peter Lobner, updated 11 February 2022

## 1. Introduction

Established in 1991 in Moscow, Augur RosAeroSystems (RAS) was a Russian manufacturer of airships and tethered aerostats.  The RAS lineup of airships circa 2002 is shown in the following chart.  The small, non-rigid Au-11 and Au-12 blimps were built in limited quantities.  None of the other larger airships were built.




*RAS airship lineup, circa 2002.  Source: RAS*

The most recent RAS airship product line includes the two-person Au-12 and 10-person Au-30 blimps.  Both have fabric-film envelopes and manage their lift and internal pressure like other blimps with variable air ballonets and ballast.

In the early 2000s, RAS started developing the ATLANT ("aerostatic flying transport vehicle of a new type") hybrid, variable buoyancy cargo airship, primarily for applications in the harsh environment of the Arctic. RAS also was developing other advanced unmanned airship designs for long-duration surveillance roles.

In 2018, the Israeli firm Atlas LTA Advanced Technology, Ltd. acquired RosAeroSystems, its product lines and intellectual property. Atlas moved the corporate headquarters to Yavne, Israel, and maintained subsidiaries in Russia and US.

Atlas has stated that its business goals include enhancing the ATLANT variable buoyancy airship technology and commercializing ATLANT heavy lift airships. In addition, Atlas is developing its own product lines of smaller electric-powered airships and specialized airships and aerostats for other missions. The Atlas website is here: https://atlas-lta.com.

The RosAeroSystems website is still online at the following link: http://rosaerosystems.com The website supports the current Au-12 and Au-30 product line.

This article provides a historical overview of RAS and the following airships and concept designs prior to the 2018 acquisition by Atlas.

- DZ-N1 heavy lift rigid zeppelin
- MD-900 and DPD-5000 / DZ-10 semi-rigid airships
- MA-55 and PD-200 non-rigid airship
- Au-11, Au-12, Au-30 and ATLANT-6 non-rigid airships
- ATLANT 30 and 100 rigid, variable buoyancy airships
- High Altitude Airship (HAA) Berkut
- Long-duration surveillance airship SOKOL
- Au-29, Au-31, Au-35 and Au-37 thermal airships

Atlas LTA Advanced Technology, Ltd. airships are addressed in a separate article.

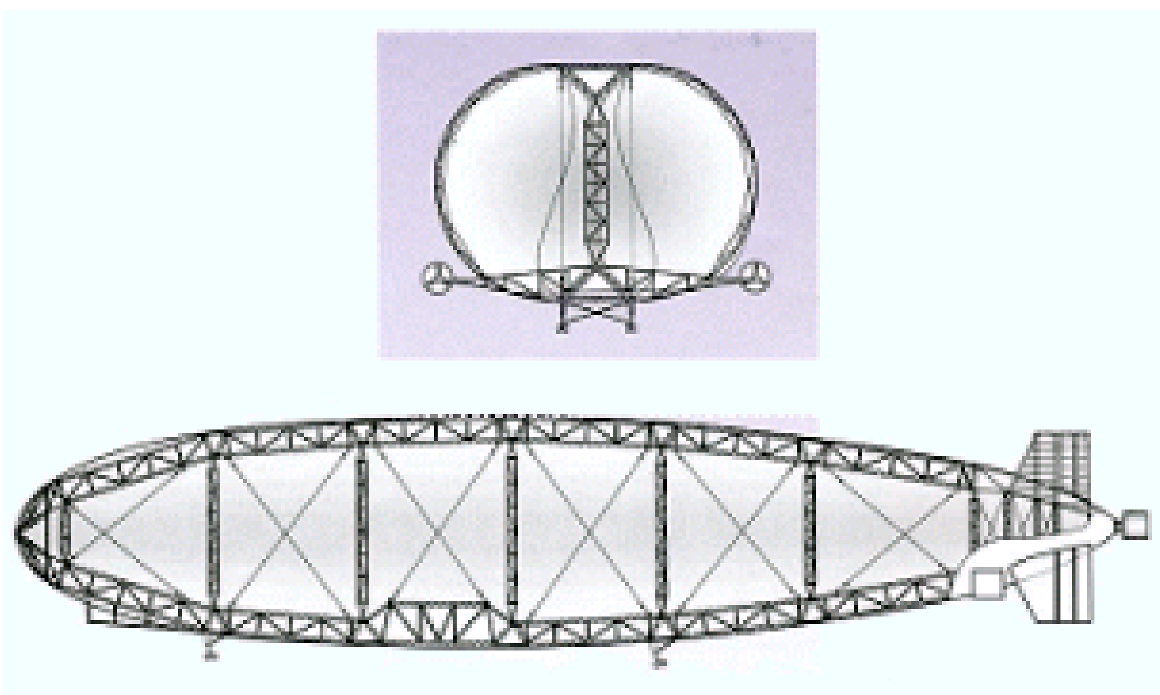
## 2. RosAeroSystems DZ-N1, circa 2001 - 2009

In 2001, RosAeroSystems initiated work on a very large, heavy-lift, rigid cargo zeppelin designated DZ-N1 (dirigible number one), which was designed primarily to support industrial activity in the Russian Arctic by mining and oil and gas exploration companies. The DZ-N1 was named for Russian rocketry and airship pioneer Konstantin Tsiolkovsky (Ziolkovsky). One of his significant inventions was the hybrid thermal airship with an all-metal envelope. He proposed to use engine exhaust for heating the lifting gas. This concept was used in the early 1990s in the Russian Thermoplane hybrid thermal airship and the later hybrid thermal airship designs by Locomosky and Aerosmena.

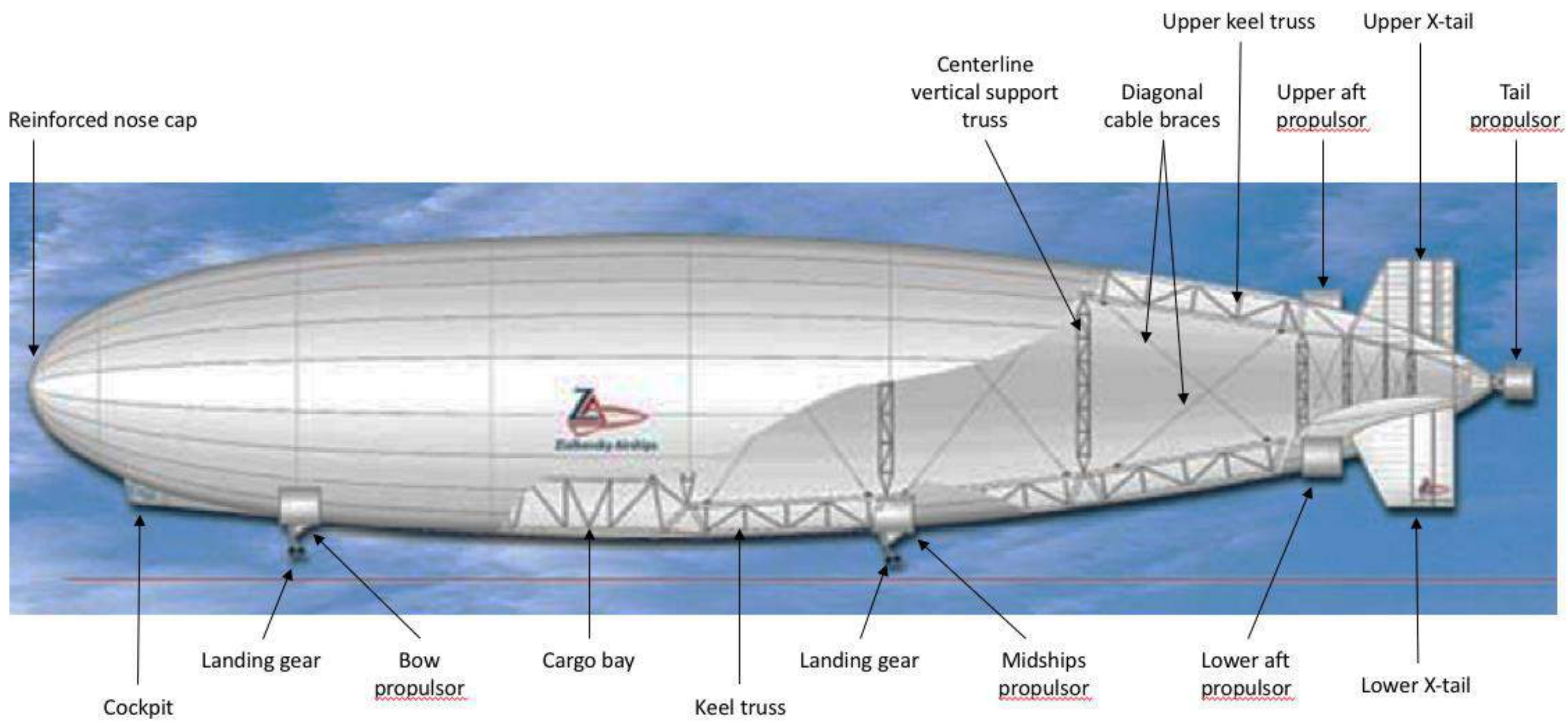
*Rendering of DZ-N1 flying in the Arctic.*
*Source: https://metagran.ru/default_048.html*

## General characteristics of the DZ-N1

| Parameter | DZ-N1 |
|---|---|
| Type | Rigid, all-metal hull, semi-monocoque, vertical frames and composite panels form the envelope |
| Length | 268 m (880 ft) |
| Width, overall | 64 m (210 ft) |
| Height, overall | 64 m (210 ft) |
| Envelope volume | 400,000 $m^3$ (14.1 million $ft^3$) in 16 lifting gas cells |
| Payload | 180 metric tons (198 tons) |
| Cargo compartment dimensions | 40 L x 12 H meters (131.2 L x 39.4 H ft) |
| Propulsion and control | Nine diesel engines driving ducted propellers:<br>• 6 x along the lower flanks (bow, midship and aft), supported by transverse trusses<br>• 2 x above the aft ducted propellers<br>• 1 x at the tail |
| Speed, max | 170 kph (111 mph) |
| Speed, cruise | 120 kph (74.6 mph) |
| Range | Up to 15,000 km / 9,300 miles |



*DZ-N1 rigid structural design, transverse view (above) and profile view (below). Source: RAS*

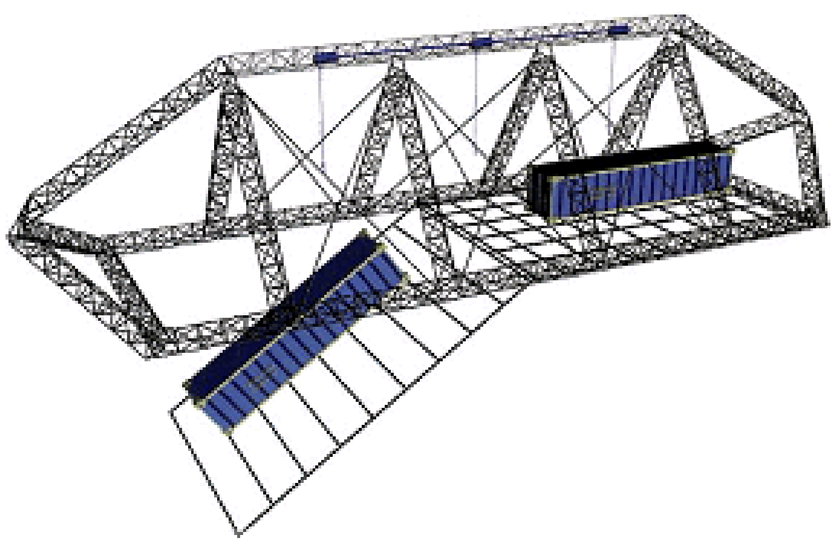



*DZ-N1 profile view cut-away diagram. Source: RAS*

Buoyancy control is accomplished by heating / cooling the helium lifting gas. For operation in the Arctic, heating the helium is the more important issue. Heating is accomplished with compact plasma generators located in each of the 16 gasbags in the giant airship, with each plasma generator capable of delivering 25 kilowatts of heating. A little blower pushes cold helium through each plasma generator.

*Arc plasma generator. Note the size relative to the ball point pen in the foreground. Source: RAS*

The cargo compartment is integrated with the airship's rigid frame. The compartment is 40 meters long and 12 meters high (131.2 x 39.4 ft) and is designed to handle low-density cargo. Cargo also can be carried externally as a sling load suspended on tethers.



*The DZ-N1 cargo compartment.*
*Source: [https://metagran.ru/default_048.html](https://metagran.ru/default_048.html)*

In October 2002, RAS CEO Gennady Verba reported on the performance of this helium heating system at the Airships in the Arctic Symposium in Winnipeg, Canada:

> "What benefits we can get from just heating the helium by 50° C? If we have an airship with a 500,000 cubic meter volume, 400,000 cubic meters are helium. If we heat it by 50° C, we gain 71 tonnes of additional lift. Of course, we heat the helium on the ground using available sources of electricity. During the flight we use a smaller generator of 340 kilowatts power, just to compensate for losses of heat. What is very important in Arctic is that we use this heating for anti-icing."
>
> "How about the efficiency of this system? We have two tonnes of generators and 3.35 tonnes of additional fuel needed for this generator to work. This is a total of 5.35 tonnes and we gain 71 tonnes of lift. The thermal dynamic method and the aerodynamic method are combined during the take-off. We have mostly thermal dynamic method initially and during the flight we slowly transfer to the aerodynamic method (aerodynamic lift from the hull)."
>
> "This long range (15,000 km / 9,300 miles) is available only because of plasmatron technology."

A February 2009 article by Morning International Freight Co. Ltd. reported that RAS still planned to produce the DZ-N1. However, no date was given for starting construction.

The DZ-N1 was never built.

*Striking image of a large Russian zeppelin the scale of the DZ-N1.*

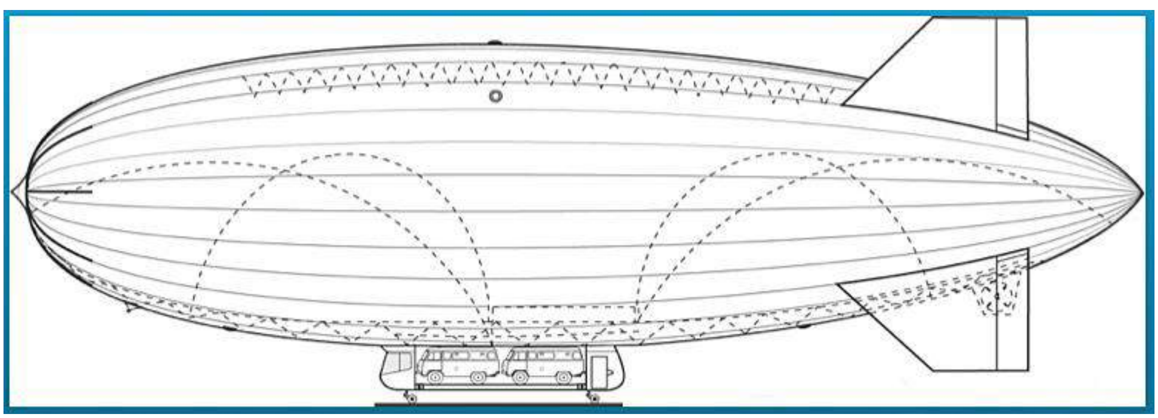
*Source: M D Dubroff, "Zeppelins: A Noble History…"*

### 3. RosAeroSystems MD-900 and DPD-5000 / DZ-10 airships, circa 2001 - 2009

The MD-900 was a concept for a semi-rigid, multi-purpose airship that RAS considered to be the smallest possible cargo airship for use in the Arctic. Basic characteristics of the MD-900 were:

- Type: Semi-rigid
- Length: 60 m (196 ft)
- Height: 22 m (72 ft)
- Cargo capacity: 3 metric tons (3.3 tons, 6,614 lb)
- Range: 4,828 km (3,000 miles)

The MD-900 was proposed as a replacement for the aging Mil Mi-8 medium lift, twin-turbine helicopter, which first flew in 1961. On the MD-900 modular airship, the central part of the gondola was a removable module that could come in several different, interchangeable configurations, such as a cargo module, a portable power plant module, a tourist module, or some other module customized to the needs of the customer. As shown in the following diagram, the cargo module could accommodate two small cars.



*MD-900 circa 2002. Source: RAS*

*MD-900 circa 2002.  Source: RAS*

The larger DPD-5000 was a concept for a long-range surveillance airship, with a cargo version designated DZ-10.  Basic airship characteristics were:

- Type:  Semi-rigid
- Length:  126.8 m (416 ft)
- Height:  32 m (105 ft)
- Cargo capacity:  25 metric tons (27.5 tons, 55,116 lb)

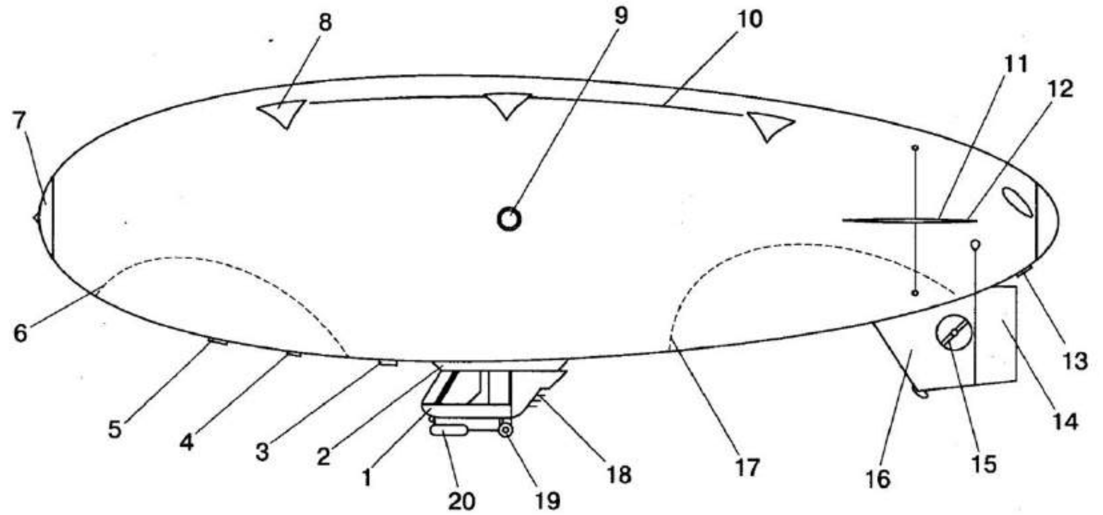
Neither the MD-900 nor the DPD-5000 / DZ-10 were built.

**4. Augur MA-55 and PD-300 blimp concepts**

**<u>MA-55</u>**

In 1997, the Russian firm Augur Aeronautic Center in Moscow developed the MA-55 as a modern, motorized, single-seat, small blimp. Russian author Yu.S. Boyko (2001) described potential applications for this small airship:

“Simplicity of design, excellent visibility for the pilot, and widespread use of commercial products in design and equipment contribute to the use of this device for patrolling and monitoring urban areas, roads, forest areas, performing advertising flights, video and television filming from the air, training aeronautic pilots, and working out the technology of using (larger) airships.”




Legend
1 - gondola; 2 – reinforced fairing with the envelope; 3 - gas filling sleeve: 4 - air sleeve: 5 - air valve; 6 - nose ballonet; 7 – nose reinforcement; 8 – envelope access port; 9 - gas valve; 10 – internal catenary belt; 11 — horizontal stabilizer; 12 - elevator; 13 - gas appendix; 14 - rudder; 15 - steering electric motor; 16 - vertical stabilizer; 17 - aft ballonet; 18 – thrust deflecting louvers in the propeller slipstream; 19 – single strut landing wheel; 20 – float

*Motorized balloon MA-55. Source: Boyko (2001)*

The single-seat gondola is supported by an internal catenary suspension system that distributes loads into the top of the gas envelope. A piston engine is installed behind the pilot, driving a two-bladed pusher propeller in an annular channel with thrust deflecting louvers in the propeller slipstream to provide up/down thrust vector control. A reversible electric-powered propeller in the vertical stabilizer provides lateral thrust and good maneuverability in low speed flight and in hover mode. In forward flight, a T-tail (no upper fin), with a conventional rudder and elevators, provided aerodynamic control.

The MA-55 was designed to operate on land, snow or ice, and on water. A single-strut landing gear and landing skis are installed under the gondola, which can be supplied with floats for landing on water. A ground crew of 4 to 6 people was required. For field repairs, six triangular access ports were available along the top of the envelope.

The cost of the MA-55 was estimated at $185,000, circa 2000.

While no MA-55 blimps were built, this airship is important as the predecessor of the somewhat larger Au-11 single seat blimp.

**General characteristics of the Augur MA-55**

| Parameter | Augur MA-55 |
|---|---|
| Length | 25 m (82.0 ft) |
| Diameter, max | 6.44 m (21.1 ft) |
| Envelope volume | 550 $m^3$ (19,423 $ft^3$) |
| Envelope material | Two-layer diagonally-duplicated rubberized fabric on a mylar base with an aluminized coating (terylene) |
| Ballonet volume | 40 $m^3$ (1.413 $ft^3$), fore and aft ballonets |
| Weight, empty | 400 kg ( 882lb) |
| Payload | 50 kg (110 lb) |
| Crew | Single seat |
| Propulsion and control | • 1 x VAZ-1111 piston engine rated @ 21 kW (28.2 shp), mounted behind the pilot, driving a shrouded, two-bladed pusher propeller with thrust deflecting louvers in the propeller slipstream to provide up/down thrust vector control<br>• 1 x reversible electric motor rated @ 2.5 kW (3.4 shp) installed in the lower vertical stabilizer provides lateral (left / right) thrust vector control at low speed and hover. |
| Dynamic lift, max | 50 kg (110 lb), from thrust deflectors |
| Speed, max | 85 kph (52.8 mph) |
| Speed, cruise | 60 kph ( 37.3 mph) |
| Altitude | 800 m (2,625 ft) operating, 1,500 m (4,921 ft) max |
| Range | 600 km (373 miles) at cruise speed |

## PD-300

PD-300 multi-purpose, non-rigid airship was designed for long-duration flights, including flights at low altitude and a low speed. Possible applications for this airship included: visual control and patrolling, de-mining operations in coastal waters, agricultural spraying operations, photo and video filming, rescue operations, advertising and propaganda campaigns, executive transportation and tourism.

The PD-300 had an overall length of 45.4 m (149 ft) and an overall height of 15 m (49.2 m).  Visually, it resembles a significant scale-up of the MA-55, with the addition of a larger gondola and an upper fin. The PD-300 retained the MA-55-style thrust vectoring via deflectors in the shrouded propeller slipstreams and the small, fixed, lateral control propeller in a duct in the lower fin. This latter feature is not found in the later Au-11, -12 or -30 blimps.

The PD-300 blimp was not built.


*Desktop model of the PD-300 in RosAeroSystems colors.*

*Source: USSR-Russian Aviation & Space Collectibles, [http://www.ussr-airspace.com/](http://www.ussr-airspace.com/)*

## 5. RosAeroSystems blimps: Au-11, Au-12, Au-30 and Atlant-6 concepts

### Au-11 Stork

A single Au-11 was built in 2001 and was the first manned airship produced by RosAeroSystems. It is a small, single seat blimp measuring 27.65 m (90.7 ft) long, with a gas envelope volume of 669 $m^3$ (23,626 $ft^3$), with two (fore and aft) air ballonets and a cruciform tail.

*Au-11. Source: https://vdv-dmitrov.ru/*

The enclosed gondola has an Austrian-made Rotax 582 engine rated at 48.5 kW (65 shp) installed behind the pilot. The engine drives a single pusher propeller in a ducted housing with controllable horizontal deflectors in the propeller slipstream to vector thrust up and down for improved maneuverability during takeoff and landing. The Au-11 has a maximum speed of 80 kph (49.7 mph).

The Au-11 could carry a maximum load of 160 kg (353 lb), including the pilot and fuel.  Maximum altitude is 1,500 m (4,921 ft), maximum range is 300 km (186 miles).


*The Au-11 single-seat gondola, showing the ducted propeller installation and the horizontal thrust deflectors in the propeller slipstream in the "down" position.*
*Source: RUSLET Velká encyklopedie*

The Au-11 blimp can be employed in a variety of roles, such as air advertisement, air surveillance, aid services, police and environmental protection.  It can operate at low altitude and low speed and is capable of hovering.

On 10 February 2005, the Au-11 established an FAI world speed record of 50.03 kph.  The Au-11 participated in the 2005 MAKS air show in Moscow.

The lone Au-11 was later transferred to the Ukrainian testing institute NII Aerouprugij Sistem. It is believed to still be in Ukraine in 2021.

## **Au-12M**

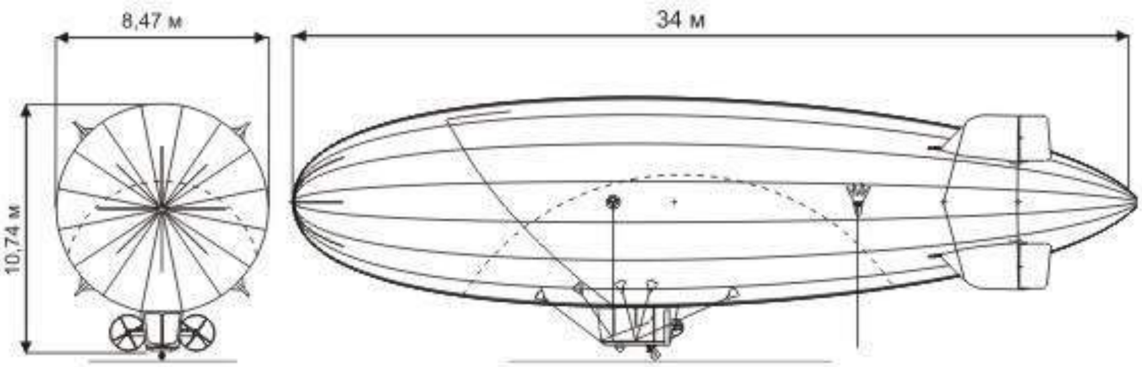
The gas envelope for the French Voliris V900 airship was the first Russian Au-12 blimp gas envelope manufactured in 2002 in Moscow by CJSC Augur Aeronautical Center (later Augur RosAeroSystems). This envelope was produced within the framework of a joint Russian-French project named "Voliris-900," which was commissioned by the French National Aeroclub. The first Au-12 gas envelope for the Voliris V900 was 31 meters (102 feet) long, with a volume of 996 cubic meters (35,173 cubic feet) and a cruciform tail. The later production Au-12M gas envelopes were somewhat larger and had an X-tail.

The production Au-12M was introduced in September 2004 with a gas envelope that measured 34 meter (111.5 ft) long, with a volume of 1,250 $m^3$ (44,100 $ft^3$). The Au-12M propulsion system consists of a single petrol Rotax 912 engine rated at 74.6 kW (100 hp) driving two shrouded propellers mounted on a rotating beam that adjusts the pitch angle of the propellers relative to the airship's centerline. This provides thrust vector control in the range from +75° (up) to -45° (down). RosAeroSystems claims that the "Au-12 is the only airship in the world of this size equipped with a thrust vectoring system providing exceptional controllability at low velocities."

The Au-12M airship carries a pilot and a payload of up to 130 kg (286 lb), which may include a passenger. It typically is used for airship pilot training, gas / oil pipeline and electrical transmission line monitoring, road and urban area surveillance on behalf of police and emergency services, rescue operations, aerial photography, and advertising.

OSKBES MAI is subcontracted to manufacture the gondolas, nacelles, fly-by-wire power plant controls and empennages for these airships. The OSKBES MAI webpage for the Au-12M is here: http://www.oskbes.ru/au30-e.html

The Au-12M became the first Russian airship awarded a Type Certificate and the first Russian airship sold to international customers.




*Au-12 two-view diagram.  Source: RAS*

*Au-12M airship on the ground.  Note the “up” position of the thrust vectoring propulsors supported from the gondola.*
*Source: OSKBES MAI*

*Au-12M in flight. Source, both photos:  RAS*

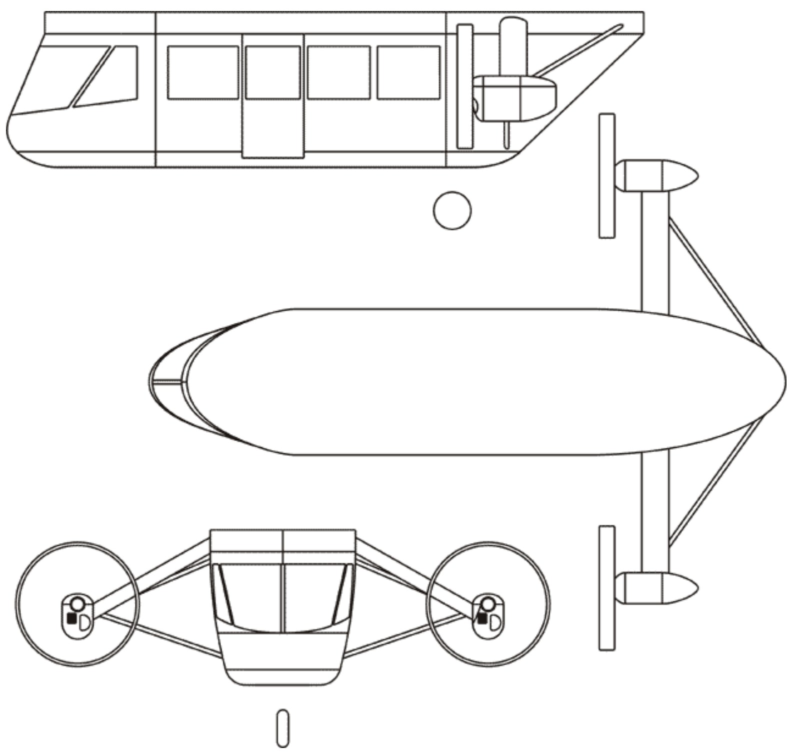
**Au-30**

The Au-30 multi-purpose airship was introduced in 2006.  It is considerably larger than the Au-12, with an envelope having twice the volume, giving it a higher payload capacity of 1,500 kg (3,306 lb) or eight passengers with a crew of two.

The Au-30 is designed for long flights, including low altitude and low speed missions. The airship is well suited for applications such as visual patrolling, gas / oil pipeline and electrical transmission line monitoring, naval anti-mine operations, crop spraying, photo and video filming, search & rescue operations, tourism and advertising.

OSKBES MAI is subcontracted to manufacture the gondolas, nacelles, fly-by-wire power plant controls and empennages for these airships.  The gondola can accommodate up to seven passengers. It is fastened to the envelope by means of a rigid attachment that is supported by catenary belts to distribute the weight of the gondola into the upper surface of the envelope. The OSKBES MAI webpage for the Au-30 is here: http://www.oskbes.ru/au30-e.html

*Au-30 airship at the Kirzhach airfield. Source: OSKBES MAI*



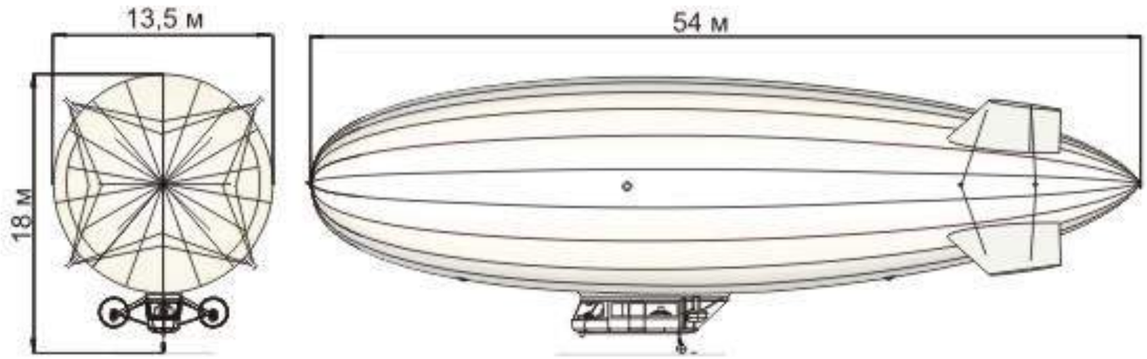
*Au-30 gondola three-view diagram. Source: OSKBES MAI*

*Au-30. Source: Aerosystemes.com*

The propulsion system consists of two piston engines in individual nacelles, each driving a single ducted propeller attached to the gondola with three struts.

The engine control system manages differential-thrust, thrust reverse and thrust vectoring, to provide very high maneuverability at low speeds.

*Sources: OSKBES MAI (above) Aerosystemes.com (below)*




*Au-30 two-view diagram. Source: RAS*

**General characteristics of the Au-30**

| Parameter | Au-30 |
|---|---|
| Length | 54 m (177 ft) |
| Diameter | 13.5 m (44.3 ft) |
| Height overall | 17.5 m (57.4 ft) |
| Envelope volume | 5,250 $m^3$ (185,400 $ft^3$) |
| Air ballonet volume | 1,266 $m^3$ (45,415 $ft^3$) |
| Max. takeoff weight | 4,850 kg (10,692 lb) |
| Payload weight | 1,500 kg (3,306 lb) |
| Propulsion | 2 x piston engines rated @ 126.8 kW (170 shp), each driving a thrust vectoring ducted propeller |
| Speed (cruise) | 40 to 80 kph (25 to 50 mph) |
| Speed (max) | 110 kph (68 mph) |
| Altitude (working) | up to 1,500 m (up to 4,921 ft) |
| Altitude (max) | 2,500 m (8,202 ft) |
| Range (at cruise speed) | 1,600 km (994 miles) |
| Range (max. ferry) | 3,000 km (1,864 miles) |
| Flight endurance (at cruising speed) | 24 hours |
| Flight endurance (at max. speed) | 5 hours |
| Flight crew | 1 or 2 |
| Ground crew | 4 to 6 |

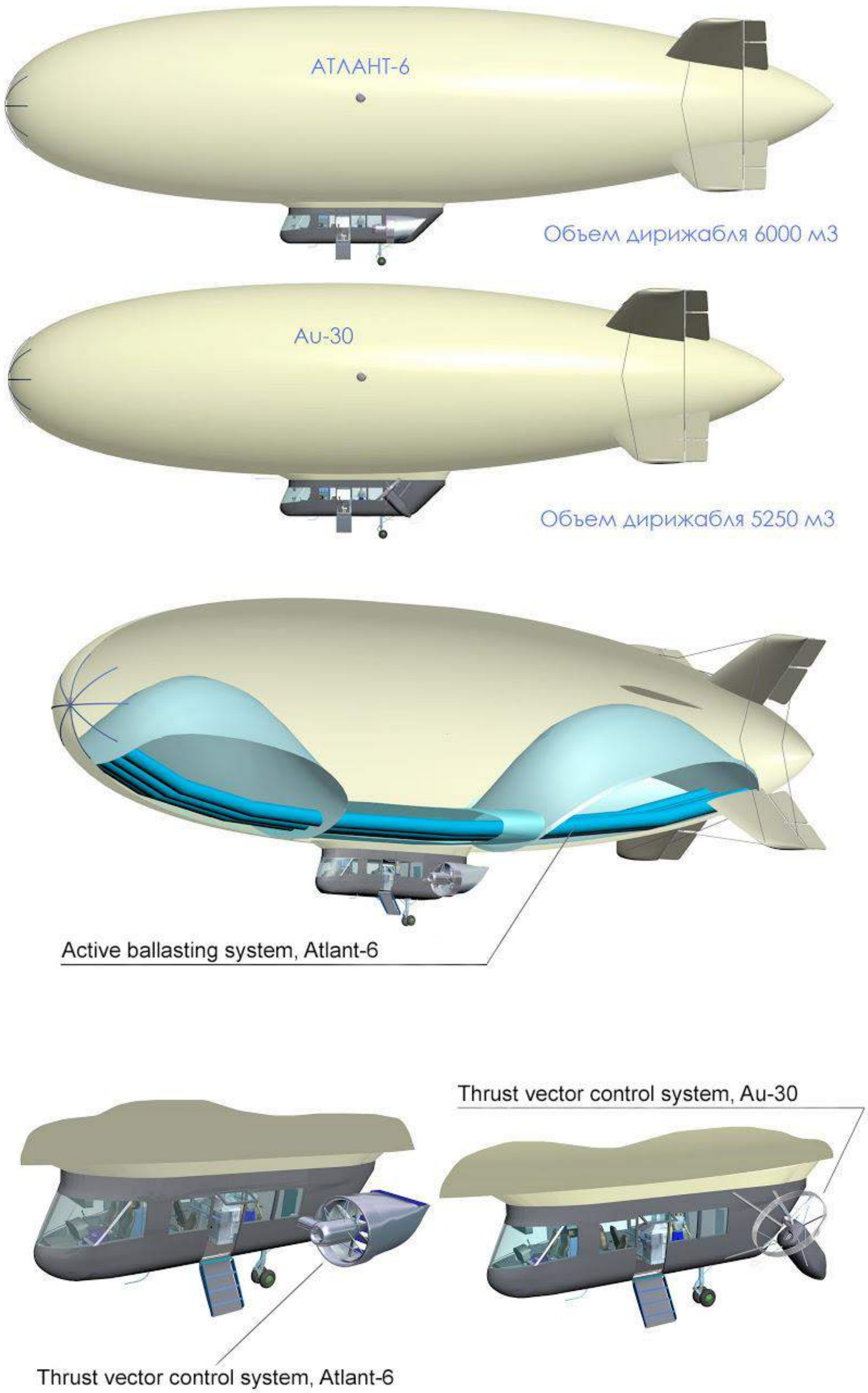
An Au-30 was acquired in 2008 by a French group to undertake the Jean-Louis Etienne North Pole expedition. Unfortunately, this airship suffered damage in France during preparation for the mission, and was not flown in the Arctic.

*Au-30 in Atlant colors. Source: RAS via The Siberian Times (30Jun2015)*

## Atlant-6 concept for a modernized Au-30

The Atlant-6 was a 2009 concept to demonstrate technologies for a modernized version of the Au-30. The Atlant-6 was slightly larger than the Au-30 (envelope volume of 6,000 $m^3$ vs. 5,250 $m^3$), incorporated a more powerful thrust vectoring system and added an active ballasting system (a variable buoyancy control system).

The active ballasting system added a series of long longitudinal tubes along the bottom the envelope, running from nose to tail and passing through the air ballonets. This ballasting system is believed to be similar to the “Control of Static Heaviness” (COSH) system demonstrated in July 2008 by the US firm Aeros on their modified Aeros 40D Sky Dragon non-rigid airship. Buoyancy is reduced by pumping some helium from the main lift gas cells into the smaller, higher-pressure storage tubes. Buoyancy is increased by venting some helium from the storage tubes back into the main lift gas cells.




*Feature comparison of Atlant-6 concept and Au-30.*
*Source: Stanislaw Fuodoroff, LiveJournal, LiveJournal, 1 Dec 2009:*
*https://st-fuodoroff.livejournal.com/215034.html*

## 6. RosAeroSystems ATLANT variable buoyancy airships

RAS started developing their ATLANT variable buoyancy airships in the early 2000s. This section describes the ATLANT variable buoyancy airships in 2018, before Atlas LTA Advanced Technology, Ltd. acquired RAS. At that time, RAS described their ATLANT airships as follows:

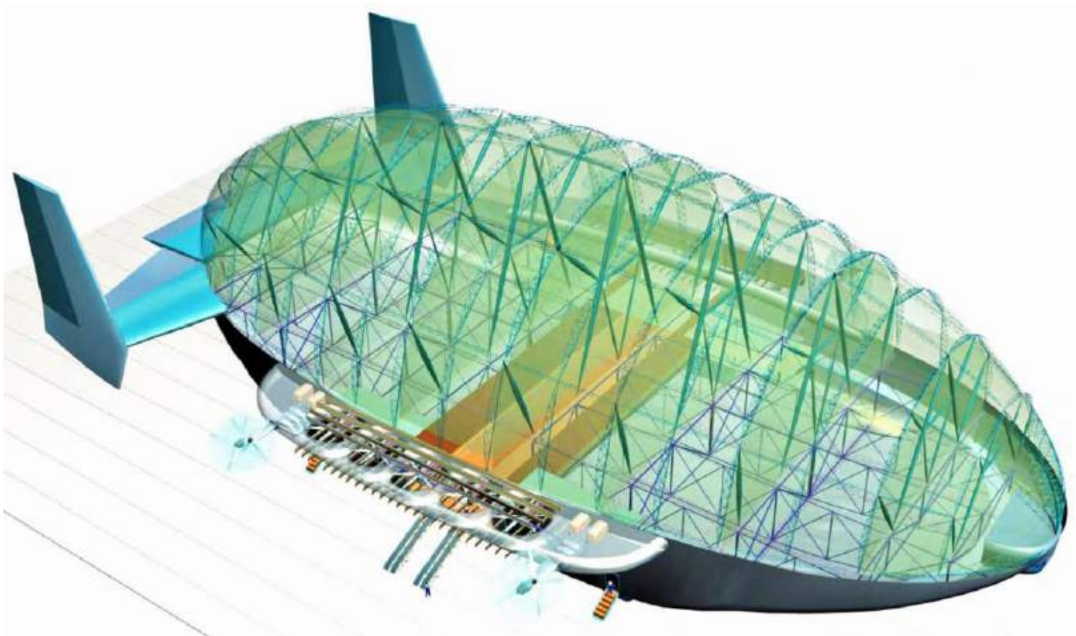
> "We develop the size spectrum of ATLANT aircraft with the lifting capacity of 15, 60 and 170 tons and flight range from 1,500 to 5,000 km. According to preliminary estimation the transportation costs will be in the range of 7 to 25 rubles per (metric) ton-km (which is about 16 to 56 cents per short ton-mile). ATLANT aircraft can be used for medium and short range distribution logistic to connect existing transport hubs with the remote regions, as well as for long-haul transportation with the possibility of door-to-door transportation including unprepared sites and water surface."

Prior to its acquisition by Atlas, RAS had presented a plan for developing a new factory capable constructing two to ten ATLANT airships per year. The funding requirement for the factory was estimated at $157 million. Following acquisition of RAS in 2018, Atlas is making all decisions on future manufacturing of the ATLANT.

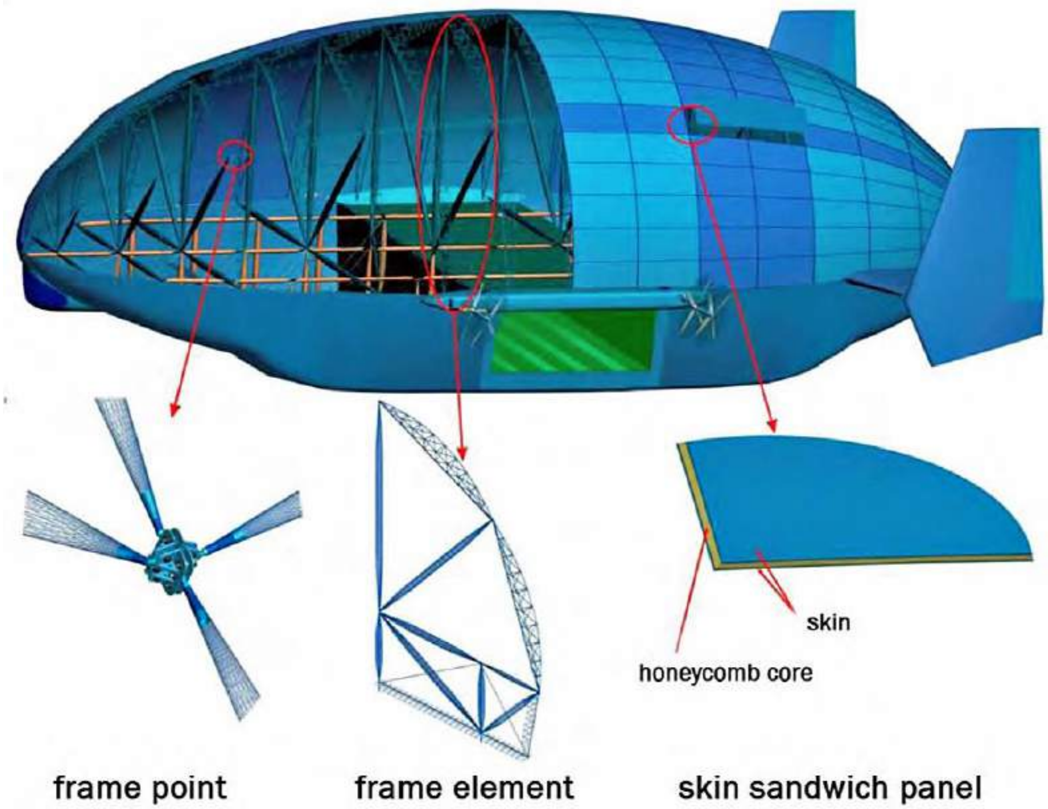
### <u>General features of the ATLANT variable buoyancy airships</u>

A. **Rigid structure:** Rigid, lightweight, composite airframe with a hard, composite, three-ply exterior aeroshell, which provides several operational benefits.

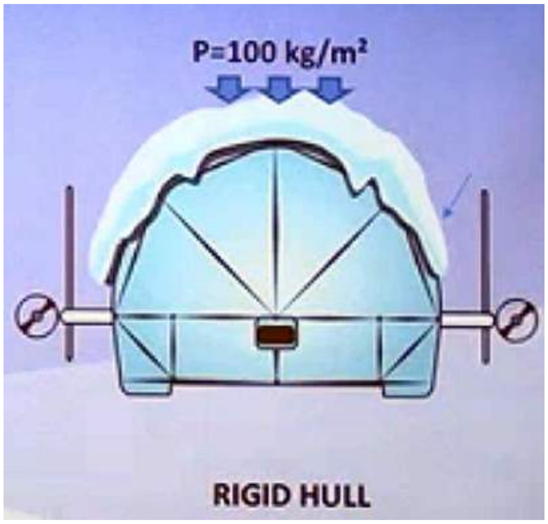
    - The hull and small aero surfaces provide aerodynamic lift in forward flight.
    - Airship width and profile provide stability on the ground in side gusts up to 20 meters/second (72 kph, 45 mph).
    - Low structure loads in flight and on the ground.
    - The rigid hull is designed to handle snow loads up to 100 kg/square meter (20.5 pounds/square foot).
    - The rigid aeroshell permits "hangarless" operation, with the airship secured outdoors, even in Arctic conditions.



*ATLANT rigid airframe structures. Source: RAS*

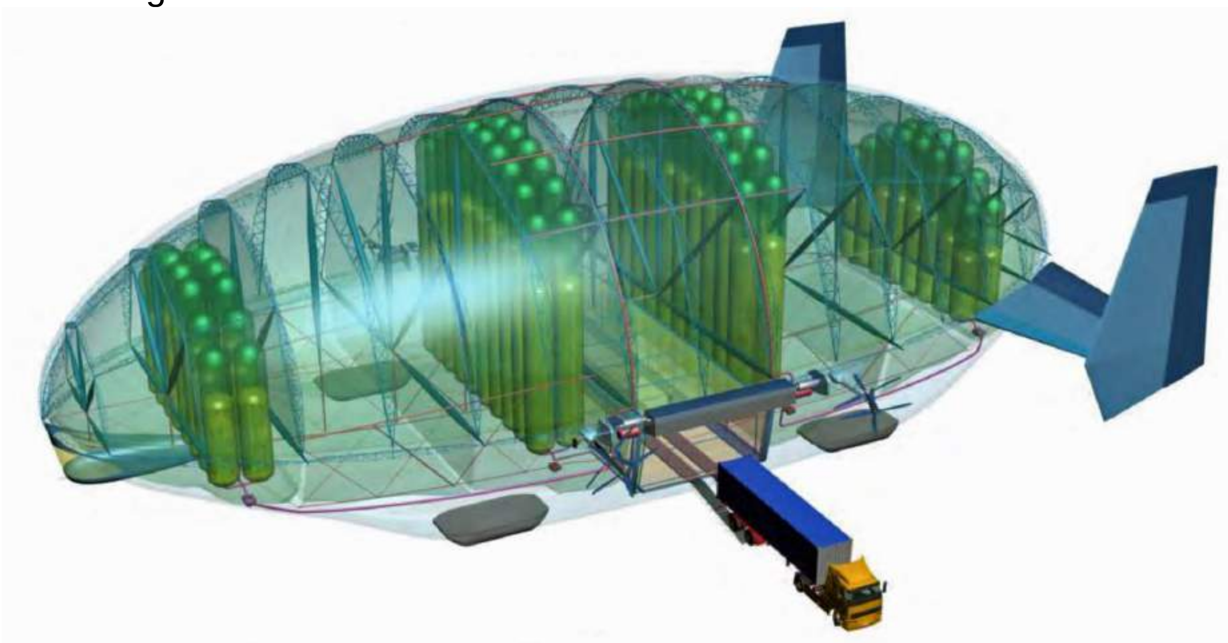



*ATLANT rigid airframe and shell structures. Source: RAS*



*Hull snow load capacity.  Source: RAS*

B. **Variable buoyancy control:** Aerostatic buoyancy is controlled by a variable buoyancy control system that enables load exchanges to be conducted without exchanging external ballast at the pickup or delivery site as cargo is moved on or off the airship. The Active Ballasting System (ABS) is the variable buoyancy control system employed on ATLANT airships to manage airship buoyancy in flight and on the ground. ABS has two different modes of operation: air ballast control and helium lift gas control.


*ATLANT showing the locations of the vertical gas storage tanks (green) used by the ABS.  Source: RAS*

**Air ballast control:**

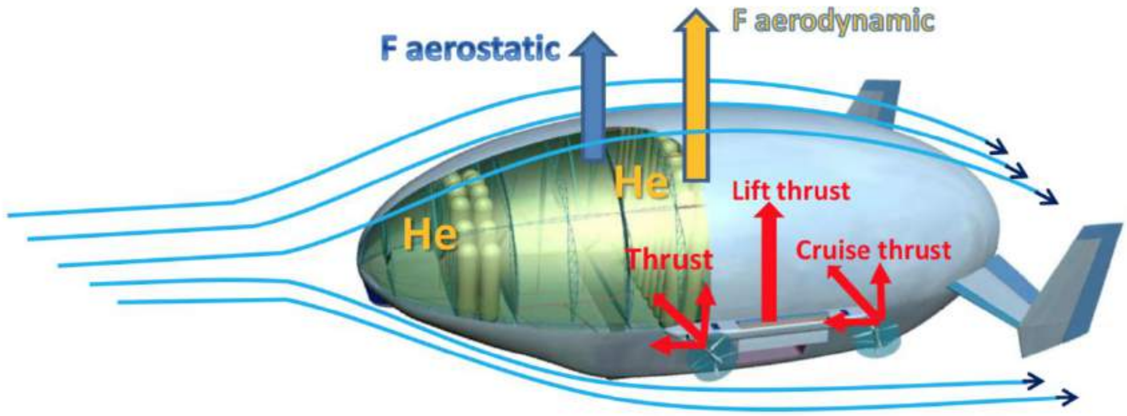
- On the ground, ABS uses ambient air to establish the needed ballast conditions as loads are removed or added to the airship. The density of air is about eight times the density of helium. To increase ballast, the ABS pumps ambient air into pressurized air storage tanks aboard the airship, adding about 10 metric tons of ballast in 30 minutes.
- To decrease ballast for takeoff, the pressurized air storage tanks vent some or all of their contents to the atmosphere.
- In flight at an altitude less than 2 km (6,500 ft), the ABS will use air to manage the buoyancy of the airship, pressurizing the storage tanks further to add ballast or venting the tanks to the atmosphere as needed to reduce ballast.

**Helium lift gas control:**

- In flight at an altitude greater than 2 km (6,500 ft), ABS will reduce buoyancy by pumping some of the helium in the lifting gas cells into pressurized helium storage tanks, thereby reducing the volume of helium in the lifting gas cells. To increase buoyancy, ABS will release pressurized helium back into the lifting gas cells. No helium is lost during this cycle.
- This part of the ABS is not used on the ground.

Prior to Atlas acquiring RAS in 2018, RAS had built ground test rigs to validate the variable buoyancy control system and the propulsive lift system that are key elements of the ATLANT design.

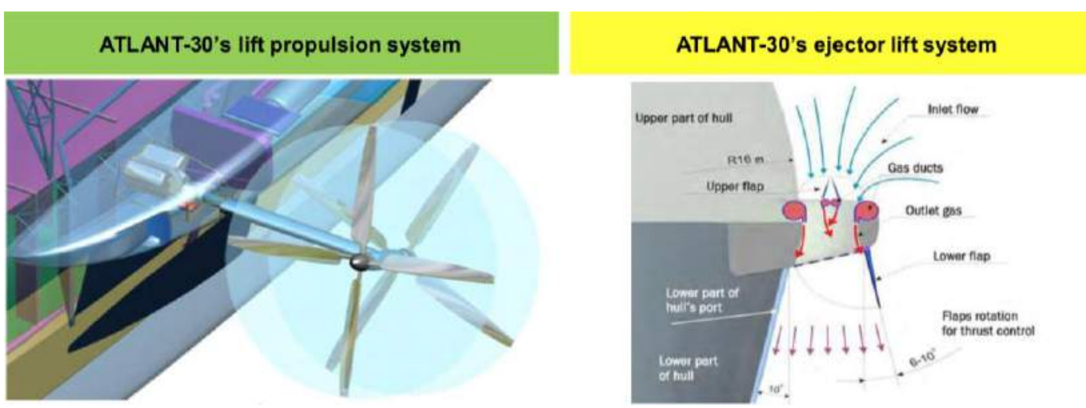
C. **Hybrid airship designed for vertical takeoff and landing (VTOL) and hovering**: The total lift generated by the ATLANT is the aggregate of aerostatic lift from helium, aerodynamic lift from the hull and small aerosurfaces, and propulsive lift from the vectoring main propulsors and the fixed air ejector lift system along the flanks of the airship. The vectoring main propulsors are aligned to deliver forward thrust in cruise flight.




*Source: RAS*

During VTOL operations, including hovering, total lift is the sum of aerostatic lift and propulsive lift. There is no aerodynamic lift during VTOL operations.

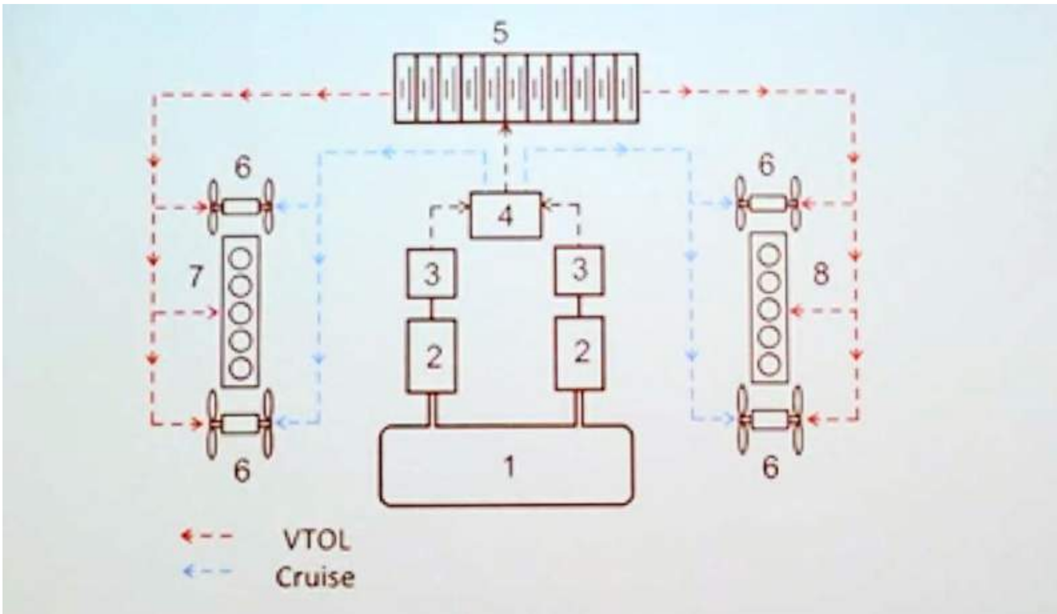
The ATLANT can takeoff and land vertically from a small landing space to deliver or pickup loads on the ground. With precise geo-positioning during hover, the ATLANT also can operate as a flying crane and pickup or deliver suspended cargo while hovering above the destination




*Electric-powered vectoring main engines for cruise and VTOL flight supplemented by the ejector-lift system during hovering and VTOL operations.*
*Source: RAS*

**D. Hybrid electric power system:**

- Meets the power demands of cruise and VTOL flight.
- 3 x more power is needed for VTOL than for cruise flight.
- Batteries supplement the generators to meet short-term high power demand




**Hybrid system architecture: 1. Fuel. 2.Turboshaft engine. 3.Generator. 4.Power distribution unit. 5. Battery pack. 6. Main engine. 7,8. VTOL engines.**

*Source: RAS*

**E. Air cushion landing system (ACLS)**

- ACLS provides mobility on the ground, ice and water.
- For stability when parked on the ground, the ACLS fans operate in reverse and take a suction on the ground to hold the airship steady in high winds.

**F. All-weather, year-round operation without traditional airship ground support equipment**

- ACLS provides airship mobility after landing, enabling the airship to taxi by itself to a parking site.
- Airship aerodynamic design and ACLS provide cross-wind stability, reducing the need to secure the airship immediately after landing.
- No mooring mast is required. If needed, an onboard anchor can be deployed. On the ground, this is an “autonomous tie-

down device" (a ground penetrating spike).  Other anchors can be used after landing on ice or water.
  - Designed for "hangarless" operation, with the airship secured outdoors.
  - Able to operate in Arctic conditions, with outside temperatures of -40 degrees Celsius (-40 degrees F).
  - Able to fly in icing conditions.

**Conducting a load exchange on the ground**

ATLANT airships primarily make their load exchanges after the airship has made a vertical landing.  An ATLANT 30 requires a landing site of about 160 m (525 feet) in diameter.  After landing, the ATLANT will be ballasted to be heavier-than-air.

Using its ACLS and the main propulsors, the airship can maneuver on the ground, ice or water to a designated loading / unloading site.

The Active Ballasting System (ABS) manages the airship's aerostatic buoyancy during the load exchange, with air ballast being loaded as needed to compensate for the weight of cargo being removed. Loading and unloading the internal cargo bay takes place through large doors on the side of the airship.  Some long, slender cargo items (i.e., wind turbine bladed) can be carried in external trays under the airship.  When cargo operations have been completed, the airship may remain parked or readied for takeoff.  The ABS adjusts the aerostatic buoyancy as required.

**Conducting an airborne load exchange (Flying Crane)**

The ATLANT can carry an oversized cargo item as an external suspended sling load, and can pick up and deliver the load while hovering over the destination.

Precise geo-positioning over the pick up / delivery site in variable wind conditions is required for a load transfer from a hover.  While the ABS can compensate for some or all of the airship's gain or loss of mass during the load exchange, significant time is required for the ballast adjustment to be made, especially for large loads.  Propulsive lift will be adjusted as needed to provide the required total lift.  During such a delivery, even with precise geo-positioning over the destination, the variable wind direction may require the hovering airship to change its heading slightly to point into the wind.

*Rendering of an ATLANT hovering and delivering an over-sized item to an off-shore site.  Source: RAS*

The ATLANT designers recognized this issue and developed a rotating external load handling system that maintains the precise alignment of a load, even if the airship has to change heading because of the wind.  This feature is shown in the following graphic, in which a long wind turbine blade being lowered to the ground. The longest wind turbine blade currently in production is the GE Haliade-X intended for off-shore wind turbine installations. This one-piece blade is 107 meter (351 ft) long. A two degree change in airship heading could sweep the long end of the blade more than three meters (10 feet), which could be hazardous to people and structures on the ground.

*Rendering of an ATLANT airship with a rotating external load handling system. Source: RAS*

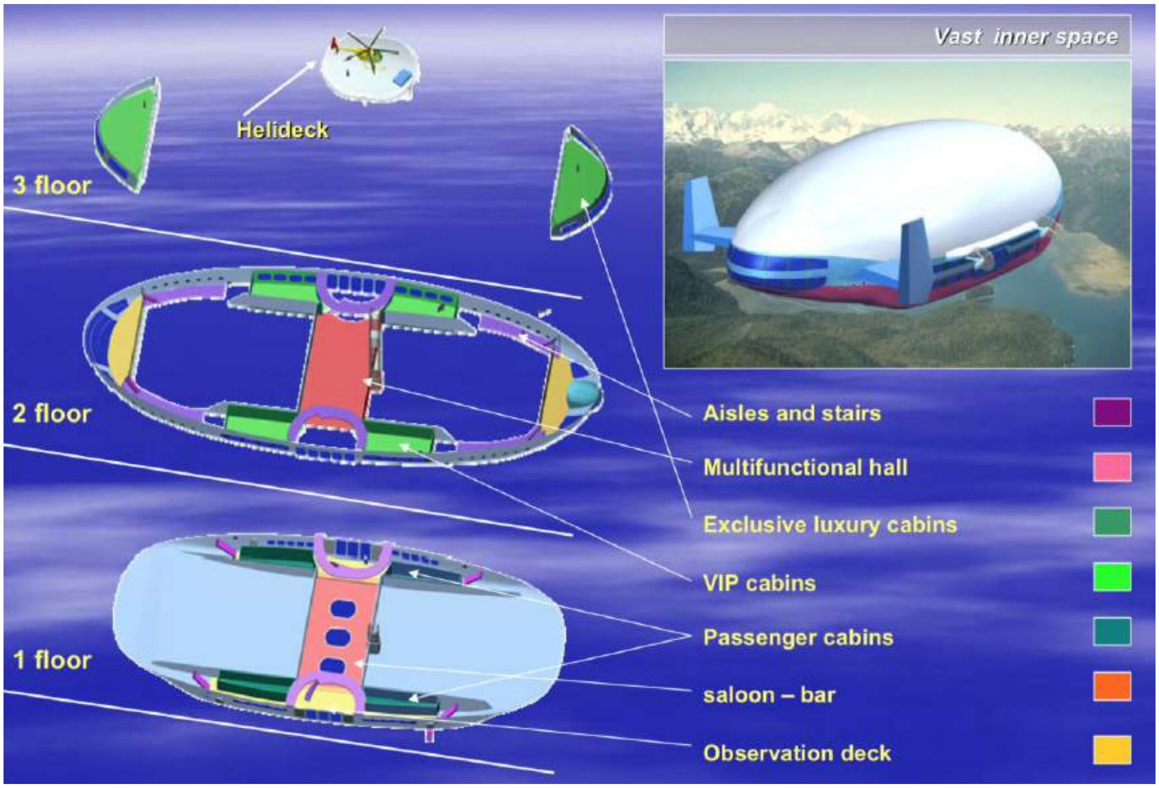
At the March 2019 cargo airship conference in Toronto, Canada, RAS / Atlas CEO Gennady Verba described the air turbulence encountered on an offshore platform during the relatively simple task of retrieving a small, tethered aerostat. Such air turbulence during a heavy load exchange at an offshore platform would be quite hazardous and may require aborting the exchange.

It seems that fine weather may be required for a successful hovering load exchange with some loads.

## The ATLANT family of variable buoyancy airships

There are two models of the ATLANT variable buoyancy airship, the ATLANT-30 and the ATLANT-100. Both can be configured for passenger, cargo or mixed operation.

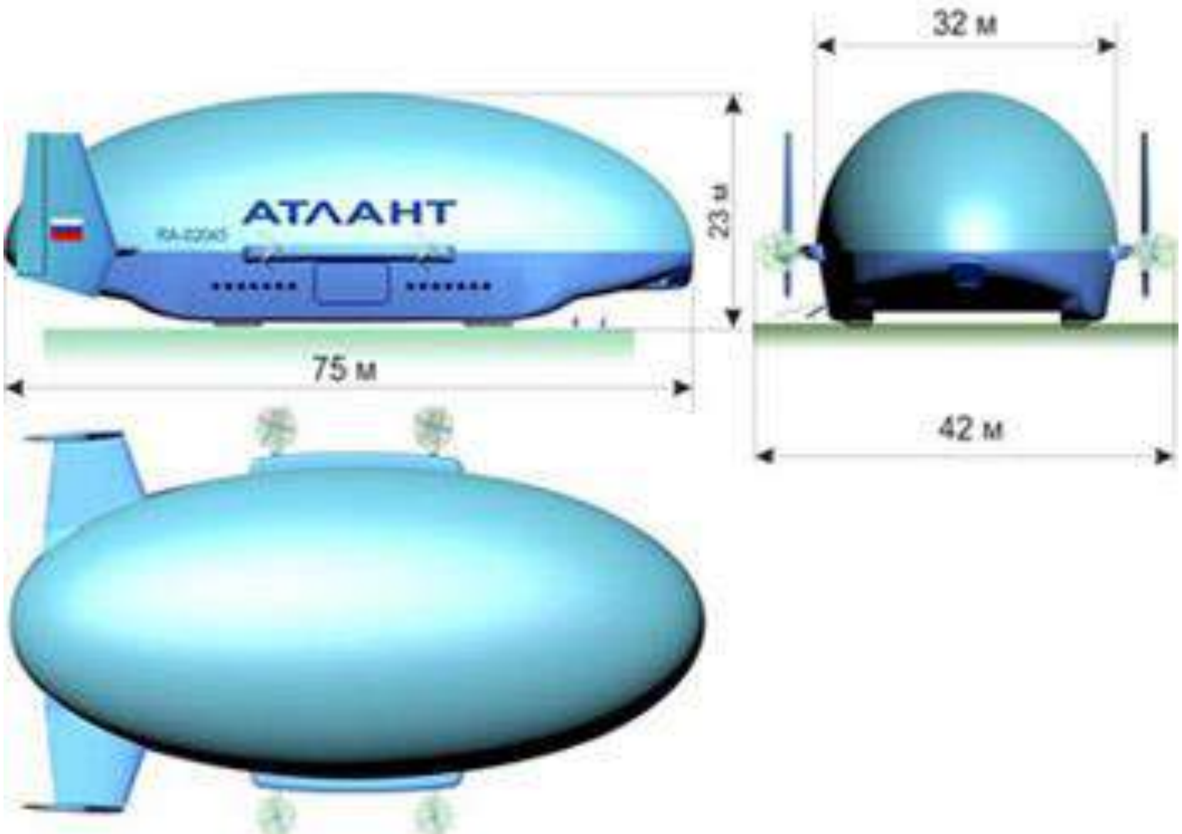
*ATLANT-100 (left) and -30 (right). Source: RAS (2009)*




*An example of the spacious passenger accommodations that could be configured. Note the helideck on the top of the airship's rigid hull. Source: RAS (2009)*

## The ATLANT 30 airship

The ATLANT 30 airship is the smaller member of the ATLANT family. It can be configured to transport cargo and/or passengers for civilian or military applications and could be used for tourism or as a VIP air yacht.




*ATLANT 30 three-view drawing. Source: RAS*

### General characteristics of the ATLANT 30

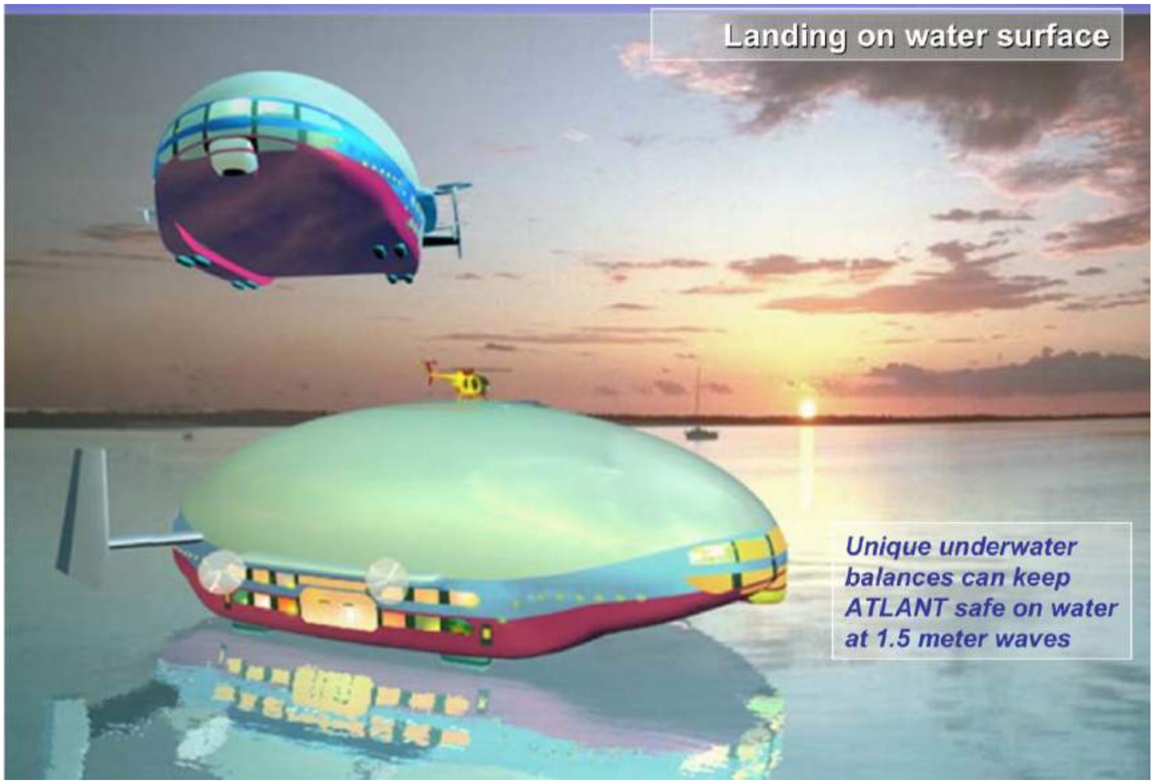
| Parameter | ATLANT 30 |
|---|---|
| Length | 75 m (246 ft) |
| Width, envelope | 32 m (105 ft) |
| Width, overall | 42 m (138 ft) |
| Envelope volume | 30,000 $m^3$ (about 1,059,000 $ft^3$) |
| Payload | 16 metric tons (16,000 kg; 35,274 lb) |
| Accommodations | 3 crew and up to 80 passengers |
| Speed, cruise | 90 - 140 kph (56 - 87 mph) |
| Range at full load | 2,000 km (1,243 miles) |

As a cargo carrier, the ATLANT 30 is well suited for transferring cargo from a regional logistic center (i.e., port, airfield, railway station) directly to a remote consumer location.

RosAeroSystems claimed that the purchase price of an ATLANT 30 airship will be 30% less than Russia's Mil Mi-26 heavy transport helicopter, which is capable of handling a cargo of 13 metric ton (13,000 kg; 29,000 lb) and has a purchase price of $20 to $25 million.

In 2009, RAS expected to have the ATLANT 30 developed by 2014. No ATLANT 30 airship was completed and rolled-out before RAS was acquired by Atlas in 2018.

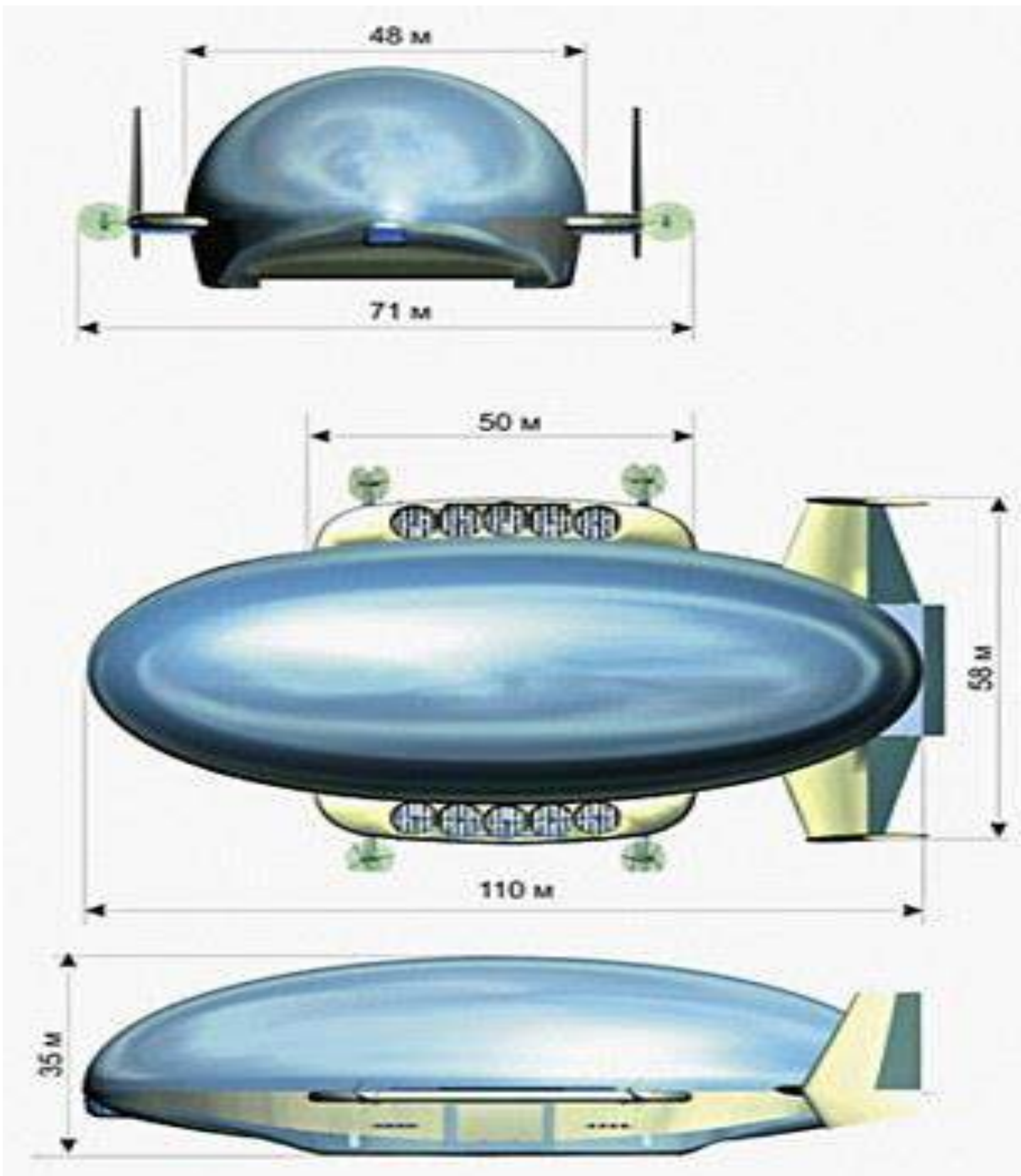
*ATLANT 30 concept shown in flight. Source, both graphics: RAS*




*ATLANT-30 landing on water (above) and operating in the Arctic (below). Source: both graphics: RAS (2009)*

## **The ATLANT 100 airship**

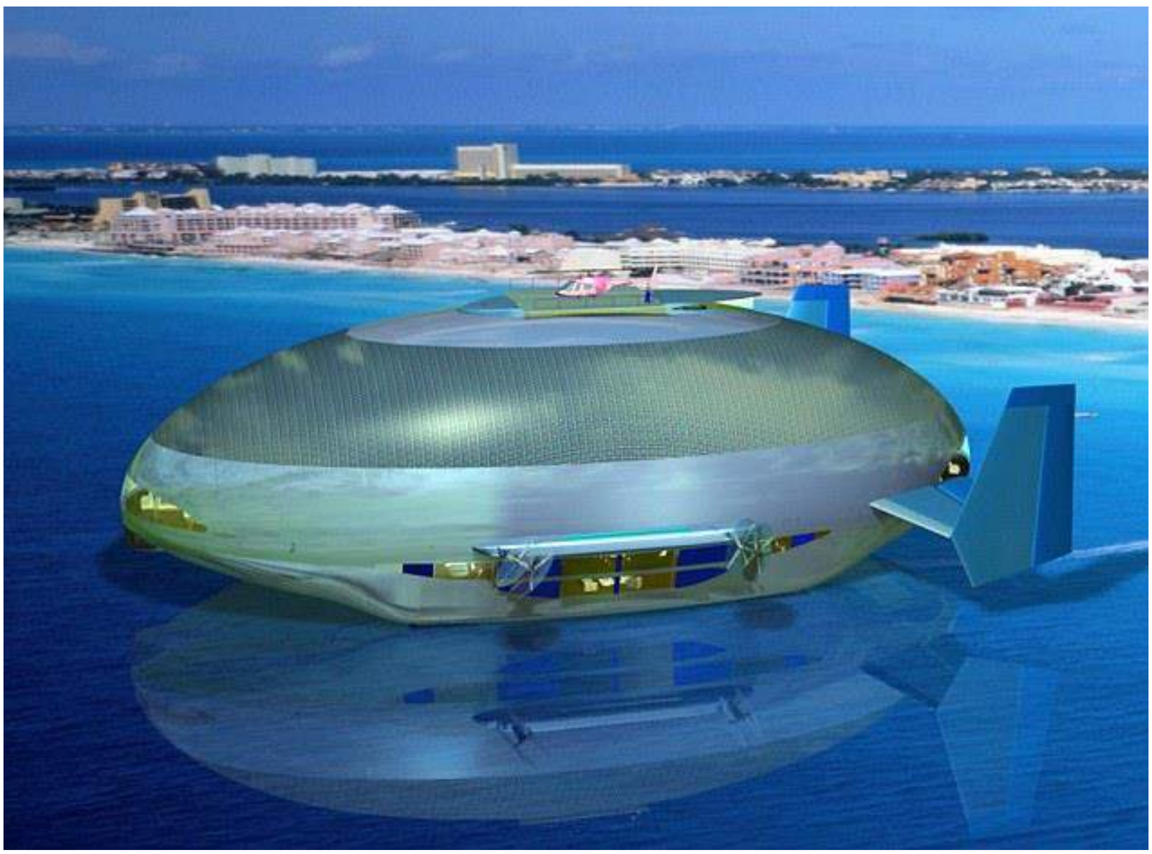
ATLANT 100 was the larger member of the ATLANT family. The gas envelope of the ATLANT 100 is comparable in size to the hybrid Airlander 50 airship, which also is being designed to handle 60 metric ton loads.




*ATLANT 100 three-view drawing. Source: RAS*

## General characteristics of the ATLANT 100

| Parameter | ATLANT 100 |
|---|---|
| Length | 110 m (361 ft) |
| Width, envelope | 48 m (157 ft) |
| Width, overall | 71 m (233 ft) |
| Envelope volume | 100,000 $m^3$ (about 3,531,000 $ft^3$) |
| Payload | 60 metric tons (60,000 kg; 132,277 lb) |
| Accommodations | 3 crew and up to 200 passengers |
| Speed, cruise | 140 kph (87 mph) |
| Range at full load | 2,000 km (1,243 miles) |



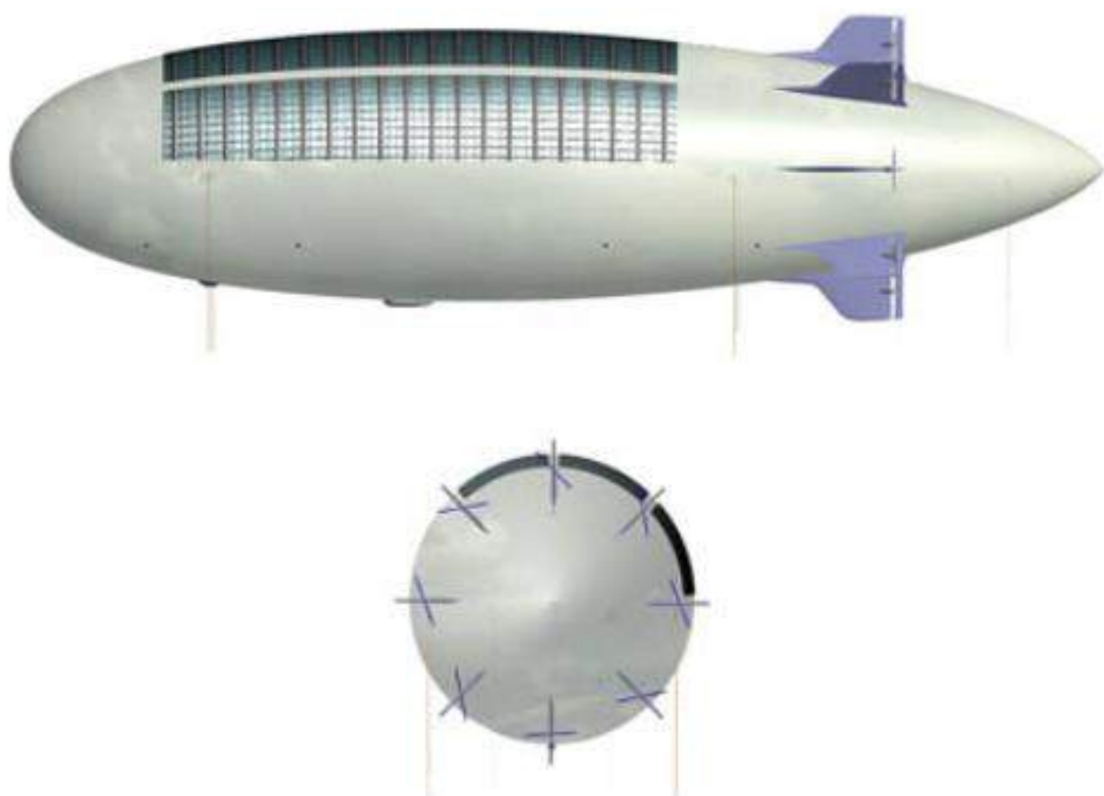
*Rendering of the ATLANT 100. Note the helicopter pad on the top of the aeroshell. Source: RAS*

In 2009, RAS expected to have the ATLANT 100 developed by 2016. By 2015, the Daily Mail reported that RAS had announced plans to deliver a version for the Russian Defense Ministry by "as early as 2018." No ATLANT 100 airship was completed and rolled-out before RAS was acquired by Atlas in 2018.

## 7. RosAeroSystems (RAS) High Altitude Airship (HAA) Berkut

RosAeroSystems described the HAA Berkut as follows:

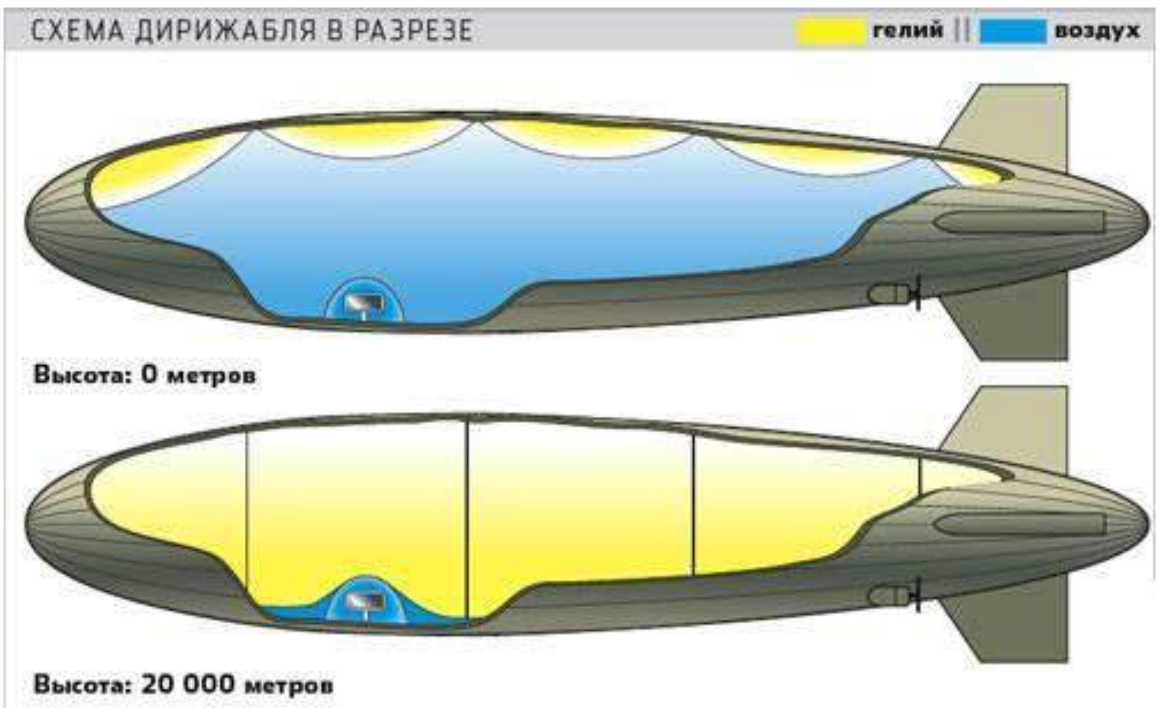
> "The HAA Berkut is a solar powered airship capable to keep its position over a certain place on a 20 - 23 km altitude. The Berkut can carry up to 1,200 kg of various communication and surveillance equipment and supply it with electrical power. Geostationary performance (station keeping) enables it to provide various communications, broadcasting and observation services to the territory of more than one million square kilometers. It covers any large metropolitan areas and such countries as France or United Kingdom. Unlike geostationary satellites, the HAA allows to repair, upgrade or replace the equipment every 3 - 4 months while the airship perform service landing."



*Exterior profile and stern views of the HAA Berkut.*
*Source: RAS*

At sea level, “standard” atmospheric conditions are defined as an absolute pressure of 14.7 psi (101.3 kPa) at 59 ºF (15 ºC).  At Berkut’s operating altitude of 20,000 m (65,600 ft), atmospheric pressure decreases to 0.8 psi (5.5 kPa) at about -12 ºF (-56.5 ºC) . A volume of helium lift gas at sea level will expand by a factor of almost 18 as the Berkut airship climbs to its operating altitude.

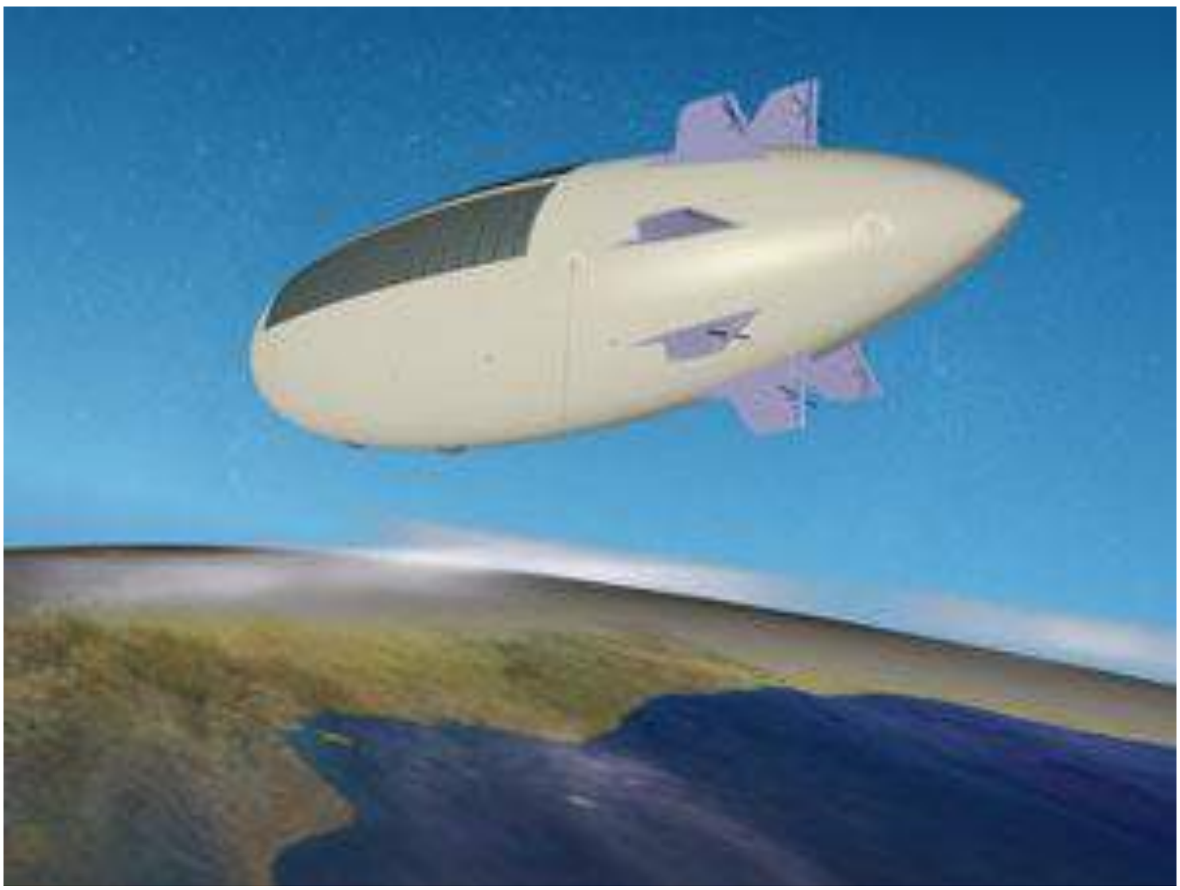
An airship’s “pressure altitude” is the altitude at which there is no more air in the ballonets of non-rigid and semi-rigid airships, when the lifting gas takes up the entire envelope volume available inside the gas envelope. To accommodate an expansion factor of 18, Berkut launches with a small helium charge that is just sufficient for liftoff. The very large envelope provides the space needed for Berkut’s five lift gas cells to expand fully, as shown in the following diagrams.




*Berkut lift gas cells (yellow) and ballonet (blue) at sea level (0 meters) and at operating altitude (20,000 m / 65,600 ft).*
*Source: https://stavklass.ru/*

RAS explained that higher latitudes have shorter days during the winter and the sun is lower in the sky, thereby limiting solar power generation.  In addition, the stratospheric wind speeds at higher latitudes can be 1.5 times greater than at mid- and low-latitudes. Thus, more power is required for station keeping at high latitudes.

Therefore, three versions of the HAA Berkut were contemplated, each delivering the same performance, but optimized for deployment in a specific range of latitudes (equatorial / tropical; mid-latitudes from 30 to 45 degrees; high latitudes from 45 to 60 degrees).  The biggest variables among the three versions were related to the electrical power required for station keeping in the different average wind conditions and the area of solar cells required to deliver that power.



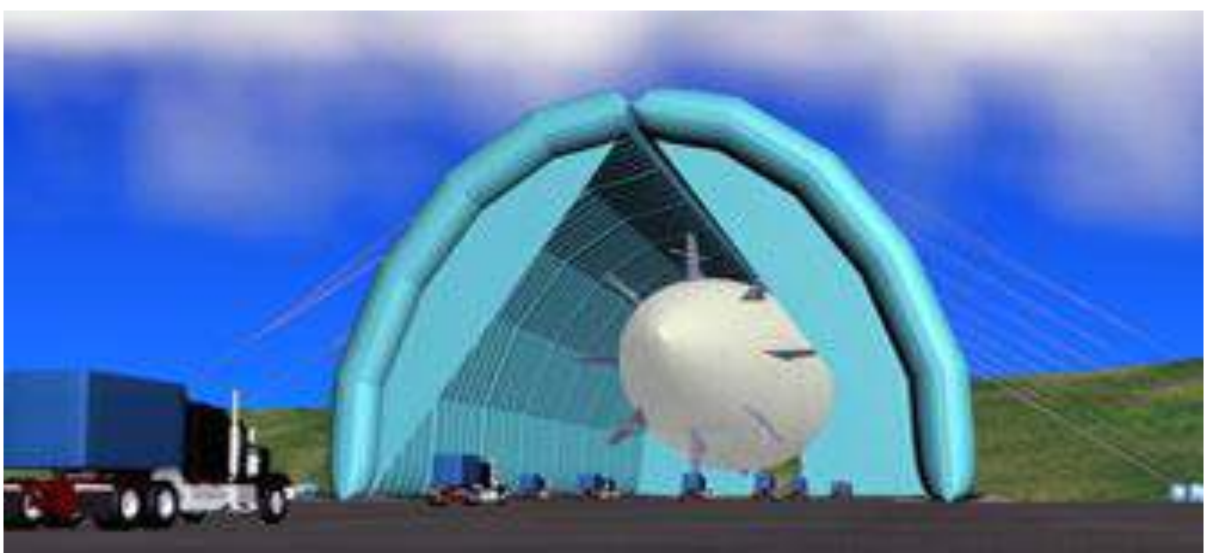
*Rendering of the HAA Berkut flying in the stratosphere.*
*Source: RAS*

Basic characteristics of the mid-latitude HAA Berkut are listed below. The equatorial version was 50 meters (164 ft) shorter, and the high-latitude version was 50 meters longer.

**General characteristics of the HAA Berkut**

| **Parameter** | **HAA Berkut** |
|---|---|
| Length | 200 m (656 ft) |
| Width, overall | 50 m (164 ft) |
| Envelope volume | 256,000 $m^3$ (about 9,000,000 $ft^3$) |
| Solar cell area | 5,800 $m^2$ (62,431 $ft^2$) |
| Propulsion | 5 tail fins with engines / propellers:<br>5 @ 50 kW (68 shp) max. each |
| Payload | 1,200 kg (2,646 lb) |
| Operating altitude | 20 – 23 km (12.4 – 14.3 miles) |
| Endurance | 4 months |

*A relocatable, inflatable hanger for HAA Berkut. Source: RAS*

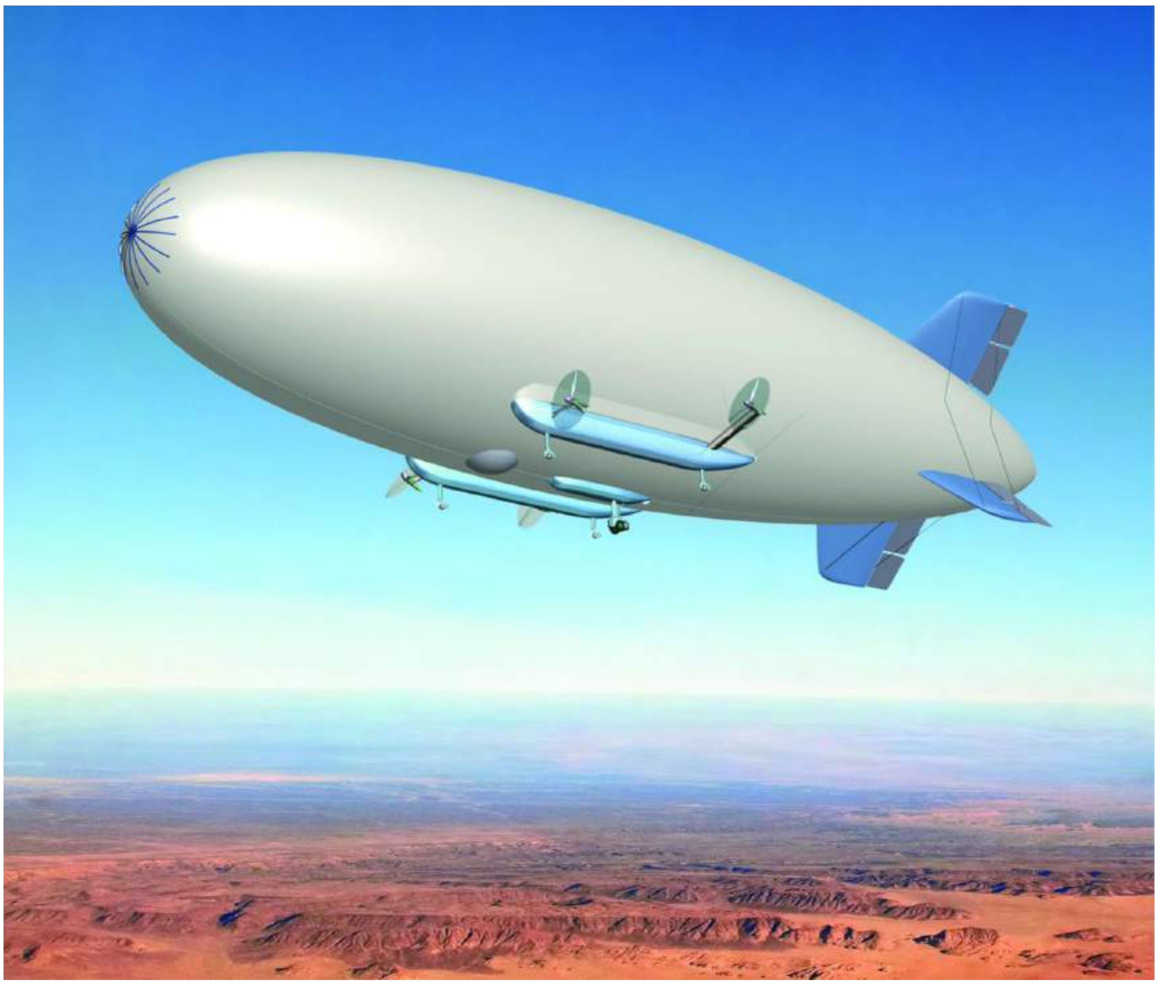


No HAA Berkut airships are known to have been built.

## 8. RosAeroSystems (RAS) unmanned airship SOKOL

RosAeroSystems designed the SOKOL as a modest-sized, medium-altitude, non-rigid airship for reconnaissance and patrol missions, such as:

- Borders and economic interest zone control
- Electronic warfare and intelligence
- Air and ballistic missile defense



*Rendering of the SOKOL in flight. Source: RAS*

*Rendering of the SOKOL in flight. Source: RAS*

### General characteristics of the SOKOL

| Parameter | SOKOL |
|---|---|
| Length | about 59 m (193 ft) |
| Width, overall | 50 m (164 ft) |
| Envelope volume | 10,400 $m^3$ (about 317,800 $ft^3$) |
| Solar cell area | 5,800 $m^2$ (62,431 $ft^2$) |
| Payload | 500 kg (1,102 lb) |
| Speed, cruise | 72 kph (45 mph) |
| Speed, max | 120 kph (75 mph) |
| Operating altitude | 5 - 7 km (16,400 – 23,000 ft) |
| Endurance | 10 days with an average wind speed of 10 m/s (22 mph) |

No SOKOL airships are known to have been built.

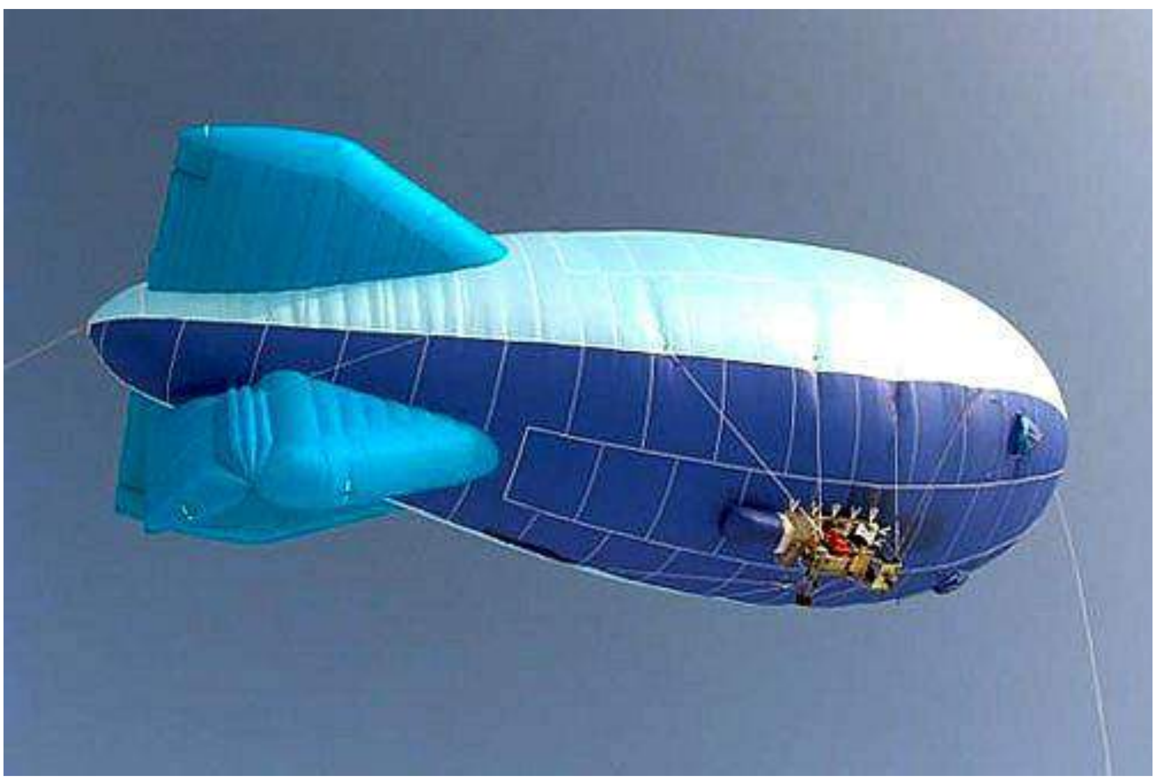
## 9. Augur Au-29, Au-31, Au-35 and Au-37 thermal airships

Augur Aeronautic Center CJSC produced several thermal airships in the early 2000s. Each is a propelled airship with hot air as the lift gas.

### Au-29 Finch (2005)

The Au-29 single-seat thermal airship was built in 2005. The airship is 23-meters (75.5-ft) long, with an 855 $m^3$ (30,194 $ft^3$) envelope and is powered by a 37.3 kW (50 shp) engine.

The Au-29 set three records for FAI class BX-02. On 1 March 2006, pilot Valery Shkulenko set a record speed of 27.5 kph (17.1 mph) for this class (FAI Record ID 13163). On 20 February 2007, Nikolai Galkin achieved records for range (18.5 km / 11.5 miles) and altitude (458 m / 1,502 ft) (FAI Record IDs 14472 and 14473, respectively).



*Au-29 thermal airship. Source: https://vdv-dmitrov.ru/*

## Au-31 Woodpecker (2003)

The “micro-thermal airship” known as Woodpecker was introduced in 2003. It is a minimalist single-seat thermal airship measuring 16-meter (52.5 ft) long, with a 340 $m^3$ (12,007 $ft^3$) envelope. The pilot and 11.2 kW (15 hp) engine are suspended under the envelope without a gondola.

The envelope burst several times during testing, thankfully without injury to the pilot or ground crew. During public appearances, the Au-31 flew at low altitude. It had a reputation for poor flying characteristics. It may still be in operation with the sports and technical club Rosto.

*Au-31 thermal airship. Source: https://vdv-dmitrov.ru/*

## **Au-35 Polar Goose (2005)**

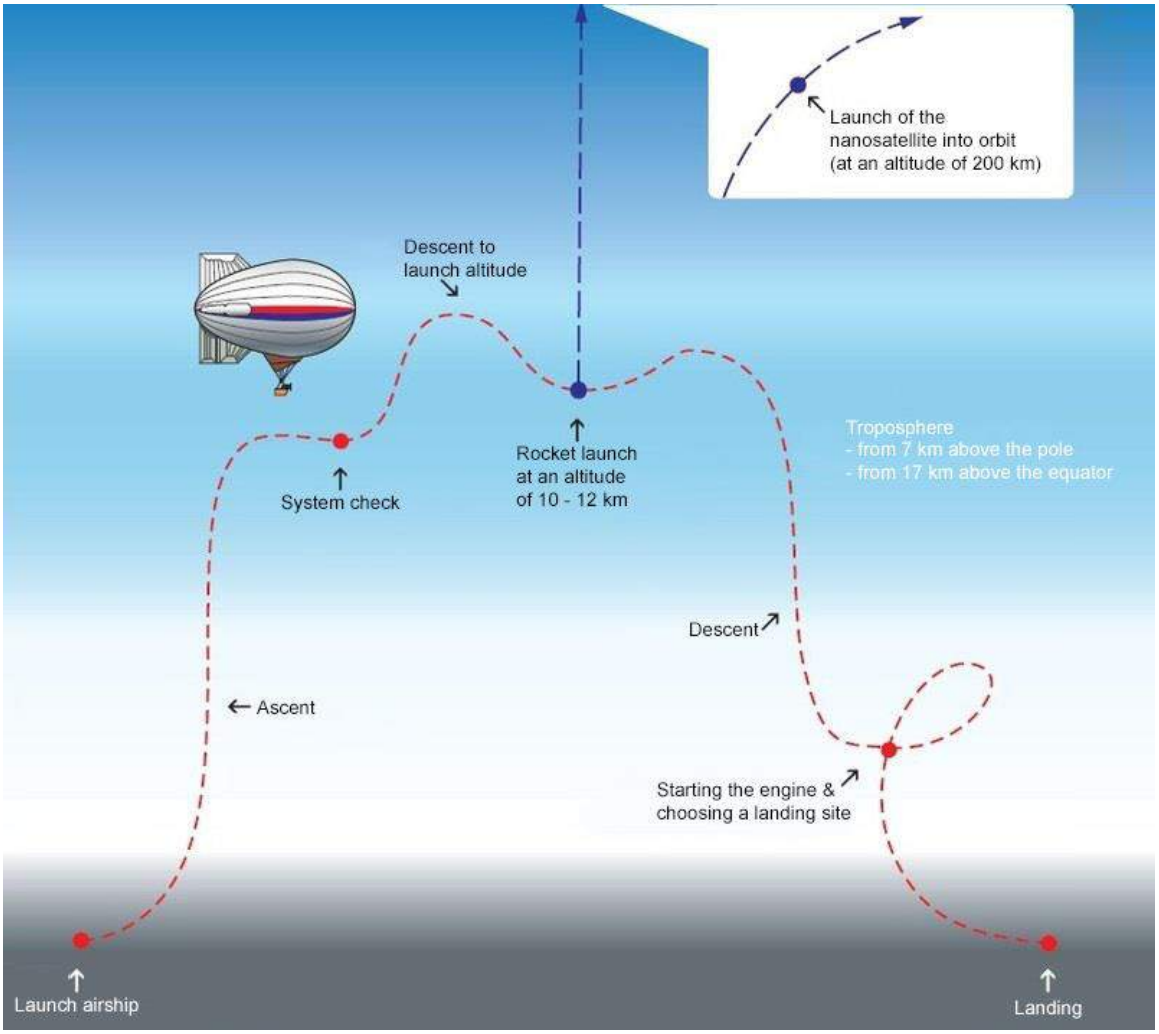
The Au-35 "Polar Goose" thermal airship was designed with the goal of establishing an airship world absolute altitude record. In 2005, Augur Aeronautic Center CJSC placed an order with the firm "NPP Rusbal" to build the 2,950 $m^3$ (104,178 $ft^3$) envelope, which was later equipped with a small gondola and a 11.2 kW (15 shp) RAKET-120 AERO engine. The completed thermal airship was registered in FAI class BX-04 as the Au-35 "Polar Goose."


*Au-35 thermal airship. Source: Russian Aeronautical Society*

Operated by Augur-Aerostate Systems, and piloted by Stanislav Fedorov on 17 August 2006, the Polar Goose establishing an FAI Class-B (airship) absolute altitude record of 8,180 m (26,837 ft). This flight eclipsed the prior record of 6,234 m (20,453 ft) set in 2003 by balloonist and airship designer Hokan Colting in his 21st Century Airships SPS 62.5 spherical airship with helium lift gas. This Polar Goose Class B – absolute record (FAI Record ID 14411) still stands in mid-2021.

*Au-35 thermal airship. Source: [https://vdv-dmitrov.ru/](https://vdv-dmitrov.ru/)*

The Au-35 altitude record flight was related to a Russian project known as "High Start," which was a project of the Russian Aeronautical Society and the Metropol Group of Companies to develop a capability to launch lightweight spacecraft from high-altitude airships. A thermal airship offered an alternative to a conventional airship using helium or hydrogen lift gas. The long-term goal was to develop a High Start aerospace complex in Russia that could economically take small private satellite, in the 10-15 kg (22 to 33 lb) range, into orbit. One of the target markets for High Start was the launch of geophysical payloads for studying Arctic regions. An example of a Polar Goose missile launch mission profile is shown in the following diagram.

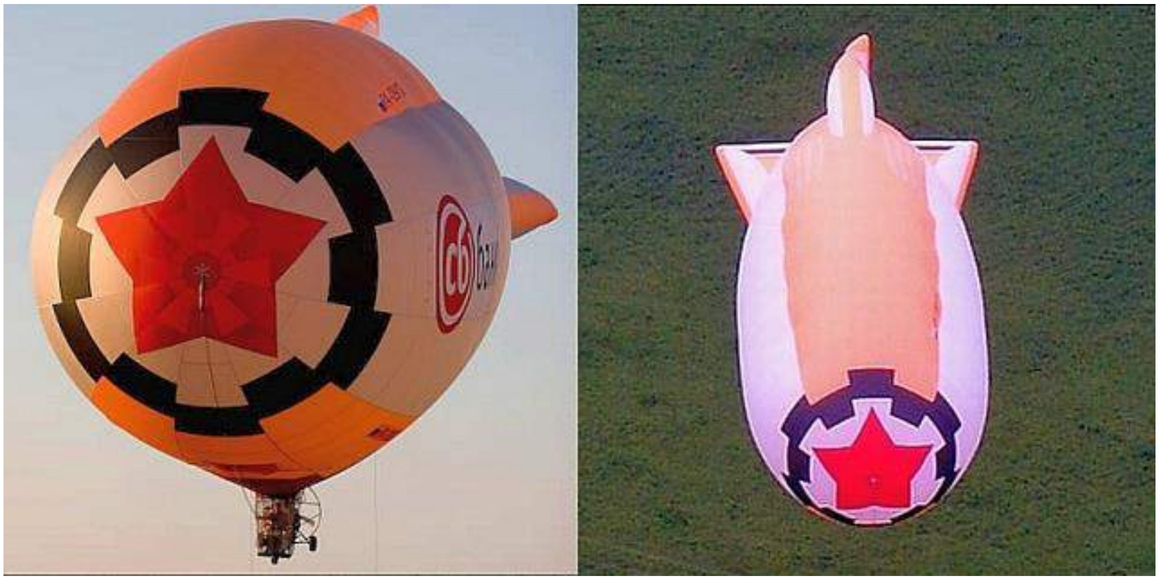



*Example of a Polar Goose missile launch mission profile.*
*Source: translated from [https://stavklass.ru](https://stavklass.ru)*

## Au-37 Merciless (2009)

The largest and most advanced domestic thermal airship built by the Augur Aeronautic Center CJSC was the Au-37 "Merciless," which was a special order for banker and pilot L. Tyukhtyaeva, who planned to participate in various competitions and set records in the FAI subclass VK-03. The 29-meter (95.1-ft) long airship has a 1,600 $m^3$ (56,503 $ft^3$) envelope and is propelled by an Austrian-made 48.5 kW (65 shp) Rotax 582 engine.

L. Tyuktyaev established two FAI subclass VK-03 world records: range – 99.1 km / 61.6 miles (3 February 2009) and duration of the flight - 5 hours 5 min. (24 February 2009).



*Au-37 thermal airship. Source: https://vdv-dmitrov.ru/*

*Au-37 thermal airship. Source: BennieBos*

## 10. For more information


- Yu.S. Boyko, “Aeronautics: Tethered, Free, Managed,” (in Russian), ISBN 5.8122-0233-8, Publishing house MGUP, Moscow, Russia, 2001
- Gennady Veba, “ATLANT : The future technology for Northern Territories,” RosAeroSystems presentation at the IsoPolar Airships to the Arctic V Conference, Calgary, Canada, October 2009: https://isopolar.com/wp-content/uploads/2013/03/Gennady-Verba-presentation-ATLANT-The-Future-Technology-for-Northern-Areas-Development.pdf
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- “Easy airship on gas run. Huge military airships take off in the Russian sky,” : https://stavklass.ru/en/real-estate/legkii-dirizhabl-na-gazovom-hodu-ogromnye-voennye-dirizhabli-vzletayut-v.html

## <u>Video</u>

- "ATLANT - promising Russian hybrid airship" (3:05 minutes, in Russian), TV Augur, 25 September 2013: https://www.youtube.com/watch?v=ogEeY7-PgrQ

## <u>Other *Modern Airships* articles</u>

- *Modern Airships - Part 1*: https://lynceans.org/all-posts/modern-airships-part-1/
    - Voliris airships (Voliris V900 has Au-12 envelope)
- *Modern Airships - Part 2*: https://lynceans.org/all-posts/modern-airships-part-2/
    - Atlas LTA Advanced Technology airships (continuing development of the ATLANT)
    - Aerostatica (collaborative rigid airship project)
- *Modern Airships - Part 3*: https://lynceans.org/all-posts/modern-airships-part-3/