D.Z. Bimbat and Ural Public Airship Design Bureau (OKBD)

Peter Lobner, 11 February 2022

1. Introduction

In the early 1960s, several “Voluntary Design Bureaus” were formed in the Soviet Union to promote the development of dirigibles as a means for solving important national economic problems in cargo transportation, agriculture and research, and for filling an industrial void that had existed since before WW II. The first such bureau appears to have been the Leningrad Volunteer Design Bureau of Dirigible Construction, which was formed in 1961. Others design bureaus were established during the early 1960s in Kiev, Novosibirsk and the Urals.

In 1962, David Zalmanovich Bimbat, together with V. Okhlopkov, R. Kholmanskikh, Y.Burnashov, B. Maltsev and Y. Feofilaktov, organized the Ural Public Airship Design Bureau (Ural OKBD or UOKBD), in Nizhni Tagil, Urals, with Bimbat as the director. At Ural OKBD, Bimbat and his team developed designs for “ballastless” dirigibles in which the aerostatic lift could be changed by adjusting the amount of lift gas in the gas envelope and making a corresponding adjustment to the volume of the gas envelope. In June 1964, D.Z. Bimbat and designers R.N. Dobrov and V.A. Katashov filed a patent application for their novel means of buoyancy control and subsequently received USSR author's certificate No. 198925.

Конструктор Давид Залманович Бимбат был абсолютным романтиком — последовательным и чистым. Его любимым словом было — «необычно».

The caption reads: “The designer David Zalmanovich Bimbat was an absolute romantic - consistent and unremarkable. His favorite word was ‘unusual.’” Source: Aerosmena

This article provides an overview of the Ural OKBD and their family of airships. Much more information on DZ Bimbat and the Ural OKBD is available in a detailed biography written by Yuri Druzhinin (in Russian). My English translation of that biography is available here: https://lynceans.org/wp-content/uploads/2021/09/David-Zalmanovich-Bimbat-biography.pdf

2. A 1972 RAND report addressed the Ural OKBD and Bimbat

In 1972, RAND Corporation examined the state of Soviet airship research and development and, in Report-1001-PR, made the following observations related to DZ Bimbat's team at Ural OKBD.

> "An article in Soviet Weekly (London) reported in March (1965) that "scores of design offices are working on the problem" of airships. "The renewed interest in this type of air transport" was attributed to the availability of technology and materials necessary for fast and safe airships; the possibility of combining the properties of the airplane, the helicopter, and the ship in the airship, with fuel needed only for horizontal flight; the ability of the airship to carry "scores of tons of freight in any weather"; and the lack of need for airports. The work of two separate design bureaus is cited in the article. David Bimbat's team in the Urals has designed the Ural-1, an airship with detachable gondolas (pods), and "has started designing a plastic airship with a payload of some 20 tons. An un-named Leningrad institute is said to be designing "an airship for use in agriculture," to be 160 feet long and 45 feet in diameter, with two 200 hp engines giving it a speed of 60 mph."
>
> "The first detailed account to appear in the public press of some of the work of the OKBs (Voluntary Design Bureaus) was published in Izvestiia in December 1965. The article focused on the groundwork for the construction of dirigibles done by the OKB in Nizhni Tagil under the leadership of designer and theorist D. Bimbat. In addition to the more obvious possibilities of the use of dirigibles in such fields as agriculture, lumbering, and oil drilling, the employees of the OKB worked out a plan to use dirigibles to bear television antennas rather than constructing television towers. According to the article, the

> Nizhni Tagil OKB has already received orders for the design of dirigibles from two enterprises located in the same region”
>
> “The Nizhni Tagil OKB is said to have 26 employees and a circle of enthusiasts of more than 100. Three designers of that OKB have received certificates for the invention of the ballastless dirigible. The establishment of an OKB in the Urals is also referred to, where a dirigible for vertical loads is being designed, The article mentions that the first school for aeronauts has been created, but it does not reveal the location nor the agency under whose auspices the school was established.”

The “dirigible for vertical loads” would have been the Ural-3 airship.

3. DZ Bimbat’s “ballastless” buoyancy control system

The “ballastless” airship designed by DZ Bimbat and his team was able to increase or decrease its aerostatic lift. This was done by moving a portion of the lift gas between the gas cells in the main envelope and high-pressure storage tanks, and by making a corresponding change to the volume of the lift gas envelope. This variable buoyancy, variable volume airship implemented an operating principle that later was employed in France on Voliris airships and the EADS Tropospheric Airship.

- **To increase aerostatic lift:** Gas from the high-pressure storage tanks was released to the low pressure gas cells inside the envelope. At the same time, cables were released, allowing the envelope to expand, which increased its volume and aerostatic lift. This enables the airship to rise.

- **To decrease aerostatic lift:** Lifting gas was pumped out of the low pressure gas cells and compressed into the high-pressure storage tanks. At the same time, the volume of the envelope was reduced by winding in a set of cables with tie-down mechanisms. This causes the airship to descend and land.

The pressure of the lifting gas in the envelope was controlled with ballonets.

For this ballastless airship design, D.Z. Bimbat, together with designers R.N. Dobrov and V.A. Katashov, received the USSR author's certificate No. 198925 (application dated 12 June 1964).

4. Ural -1

The first ballastless airship design developed by the Ural OKBD was the Ural-1 airship, which had a detachable gondola suspended under the envelope. Ural-1 was not built.

Possibly Ural-1. Source: Y. Druzhinin

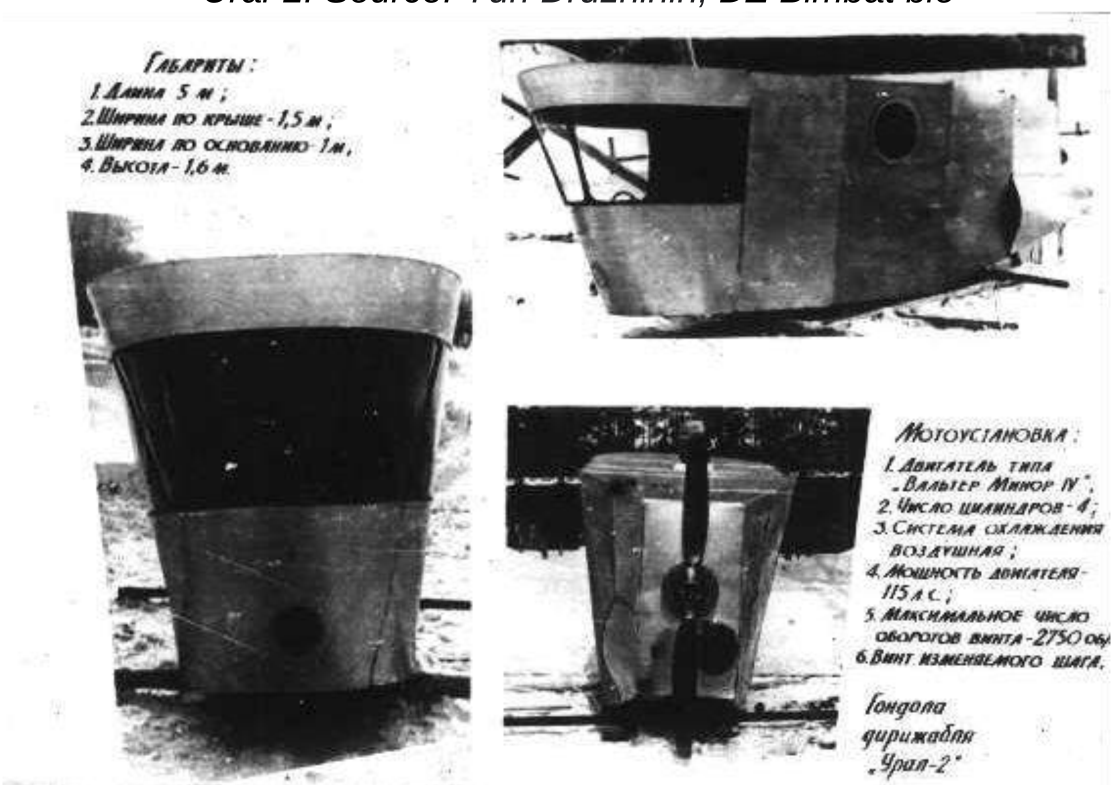
5. Ural-2

Ural-2 was a ballastless airship commissioned in the summer of 1964 by the Central Film Studio for Children and Youth in Gorky for use in a planned film. It was a semi-rigid airship with a suspended gondola supported by external catenaries that distributed loads into the sides of the gas envelope. The propulsion system was a single engine with a pusher-propeller installed in at the aft end of the gondola.

DZ Bimbat’s ballastless buoyancy control system was implemented with expandable longitudinal gores in the envelope, which allowed the envelope volume to be adjusted (increased or reduced) as needed.

On 16 March 1965, Ural-2, piloted by V. Naumov and DZ Bimbat, made its first flights near the village of Mashkino, about 48 km (30 miles) south of the city of Voronezh. During the next two weeks, Ural-2 performed a number of free flights and tethered ascents, becoming the first Soviet domestic helium airship.

Ural-2. Source: Yuri Druzhinin, DZ Bimbat bio



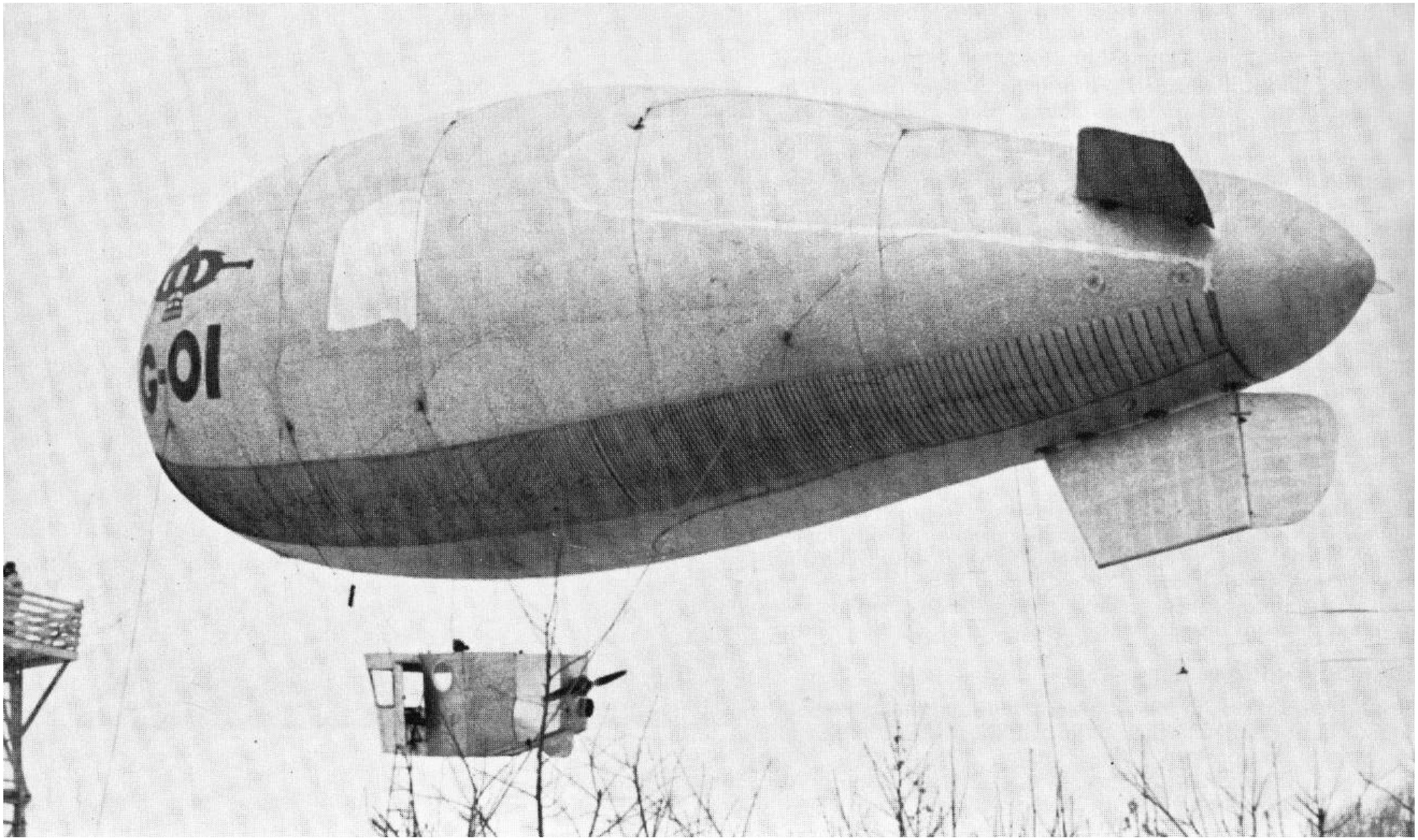
Ural-2 corrugated aluminum gondola details.
Source: Aircraft of the Ural OKBD

General characteristics of the Ural-2 airship

Parameter	Ural-2 ballastless airship
Envelope length	25 m (82 ft)
Envelope diameter	8 m (26.2 ft) nominal, but expandable longitudinal gores in the envelope allowed the envelope volume to be adjusted (increased or reduced) as part of the buoyancy control system.
Envelope volume	725 to 800 m^3 (25,600 to 28,252 ft^3)
Gondola dimensions	• Length: 5 m (16.4 ft) • Width: 1.5 m (4.9 ft) at roof; 1 m (3.2 ft) at the base • Height: 1.6 m (5.2 ft)
Accommodations	1 x pilot, 2 x passengers
Propulsion	1 x air-cooled Walter-Minor IV engine rated @ 115 hp (85.7 kW) installed at the aft end of the gondola, driving a variable pitch pusher propeller.

The Ural-2 airship appeared in the 1965 film "*The Hyperboloid of Engineer Garin*" (Russian: Гиперболоид инженера Гарина), which was based on the 1927 science fiction novel with the same title by Alexi Tolstoy. The scenes with the Ural-2 airship occur at about 1:08:00 and 1:26:00.

Ural-2 in the film "The Hyperboloid of Engineer Garin."
Source: Screenshot from film.



Ural-2 in the film "The Hyperboloid of Engineer Garin." Note the expandable gore section below the mid-plane of the envelope. Source: "Janes Pocket Book of Airships," (1977)

Ural-2 in the film "The Hyperboloid of Engineer Garin."
Source, both photos: Screenshots from film.

In spite of the success of the Ural-2, and support from the Central Ural Economic Council, funding from the central government was not forthcoming in 1965 to sustain a revival of a Soviet airship industry. At that time, DZ Bimbat was designing a catamaran airship for transporting large pneumatic structures to an installation site, with the ship's crew acting as installers. The airship was not built.

Being resourceful, DZ Bimbat “reinvented” the OKBD and expanded its production base to include pneumatic structures, which were manufactured to meet orders from industrial enterprises in the Urals. As it turned out, the pneumatic structures business was successful and it provided the necessary funds and materials for the OKBD to continue their airship design and development work.

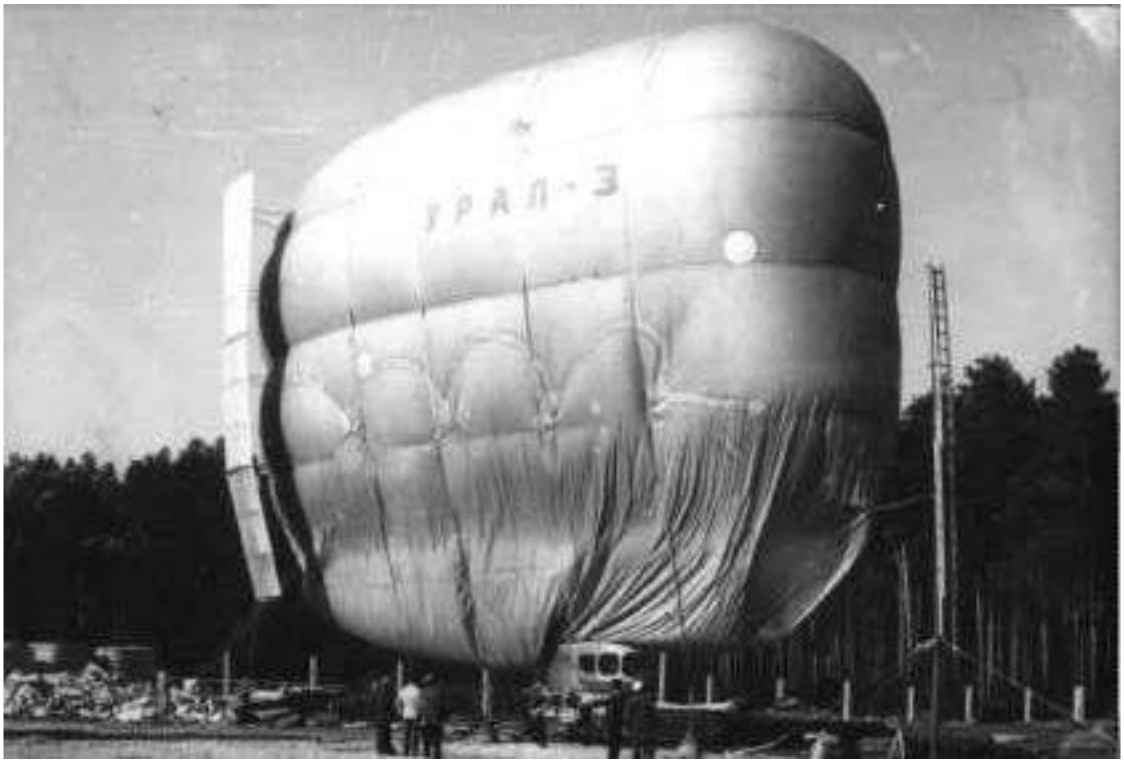
6. Ural-3 (1981 - 83)

Fifteen years later, UOKBD (by then also known as OK-50) developed the airship that would become known as Ural-3 to accomplish the following objectives:

- Test the elements of the airship structure,
- Study the stability and controllability of the airship operating as an air crane,
- Study the stability and controllability of the aircraft when transporting suspended linear cargo over short distances (i.e., from the assembly site of pre-fabricated high-voltage electrical transmission towers to the hard-to-reach installation sites),
- Develop technology for using airships to construct power transmission lines in remote areas of Western Siberia.

OK-50 began construction of Ural-3 in September 1981. The shape of the airship's hull resembled a thick, short, vertical wing with an elliptical forward section and a parabolic aft section. This airship had higher drag than a conventional cylindrical airship, but its compact, vertical shape made it well-suited for handling heavy loads while working in small, cleared areas of a forest. In addition, the short length of the gas envelope reduced the bending moments acting on the hull when it was carrying a heavy load. This made it possible to maintain the shape of the gas envelope at a lower internal gas overpressure.

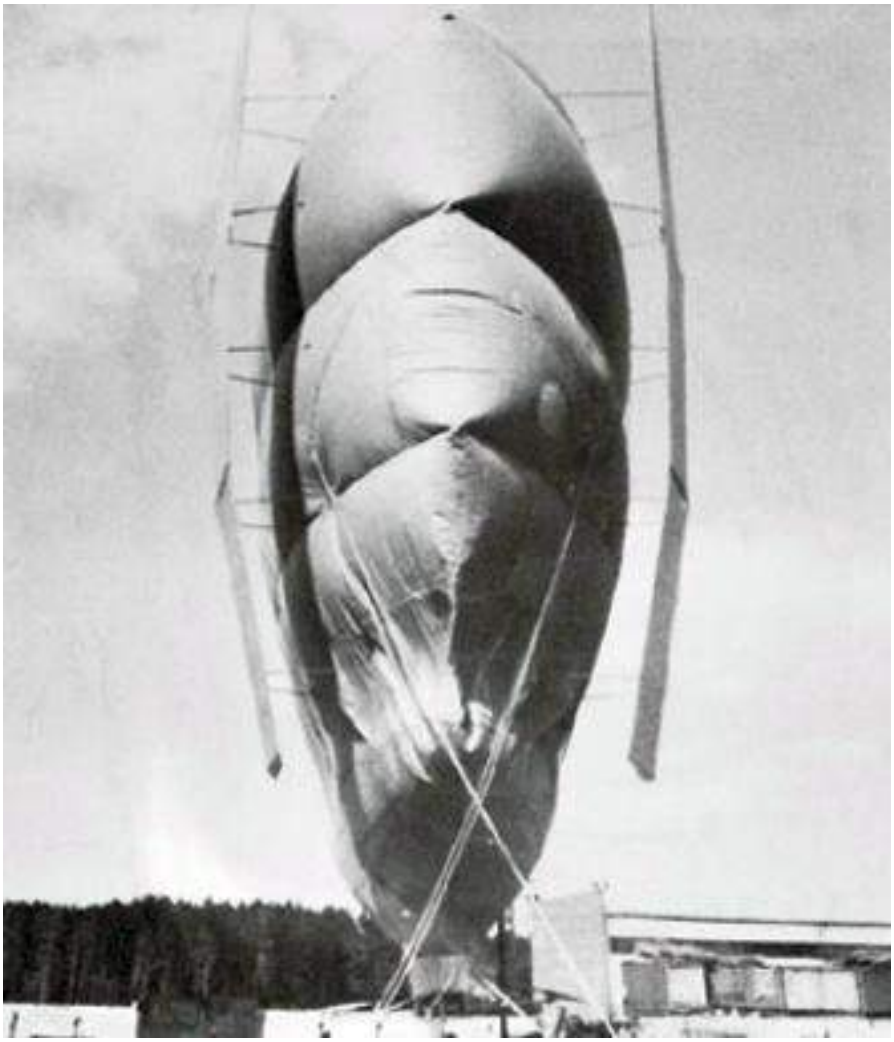
Two ballonets were installed inside the gas envelope. Two long, vertical fixed stabilizers were mounted at the aft end of the envelope.



Ural-3, bow quarter view. Source: Aerosmena

General characteristics of the Ural-3 airship

Parameter	**Ural-3 ballastless airship**
Envelope length	22 m (72.2 ft)
Envelope height	15.5 m (50.9 ft)
Envelope width	7.5 m (24.6 ft)
Envelope volume	1,550 m^3 (54,738 ft^3)
Ballonet volume	2 ballonets, 135 m^3 (4,767 ft^3) total
Propulsion	2 x Ural-M-66 motorcycle engines, each rated @ 23.9 kW (32 hp), installed in an open bay under the gondola, each driving a two-bladed, thrust vectoring tractor propeller cantilevered from the gondola.
Payload	About 3 metric tons (3.3 tons)
Vertical tail plate length	12 m (39.4 ft)
Vertical tail plate chord	2 m (6.6 ft)
Speed, cruise	50 kph (31 mph)
Altitude, operating	800 m (2,625 ft)
Range, max	100 km (62 miles)



Ural-3 stern view showing the supports for the tail plates.
Source: Aerosmena

The airship speed and direction were controlled by differential thrust vectors from the two propellers installed on the gondola. “Pendulum stability” arising from the large vertical separation between the center of buoyancy and the lower center of gravity provided longitudinal and lateral stability. There were no aerodynamic control surfaces (i.e., rudders or ailerons).

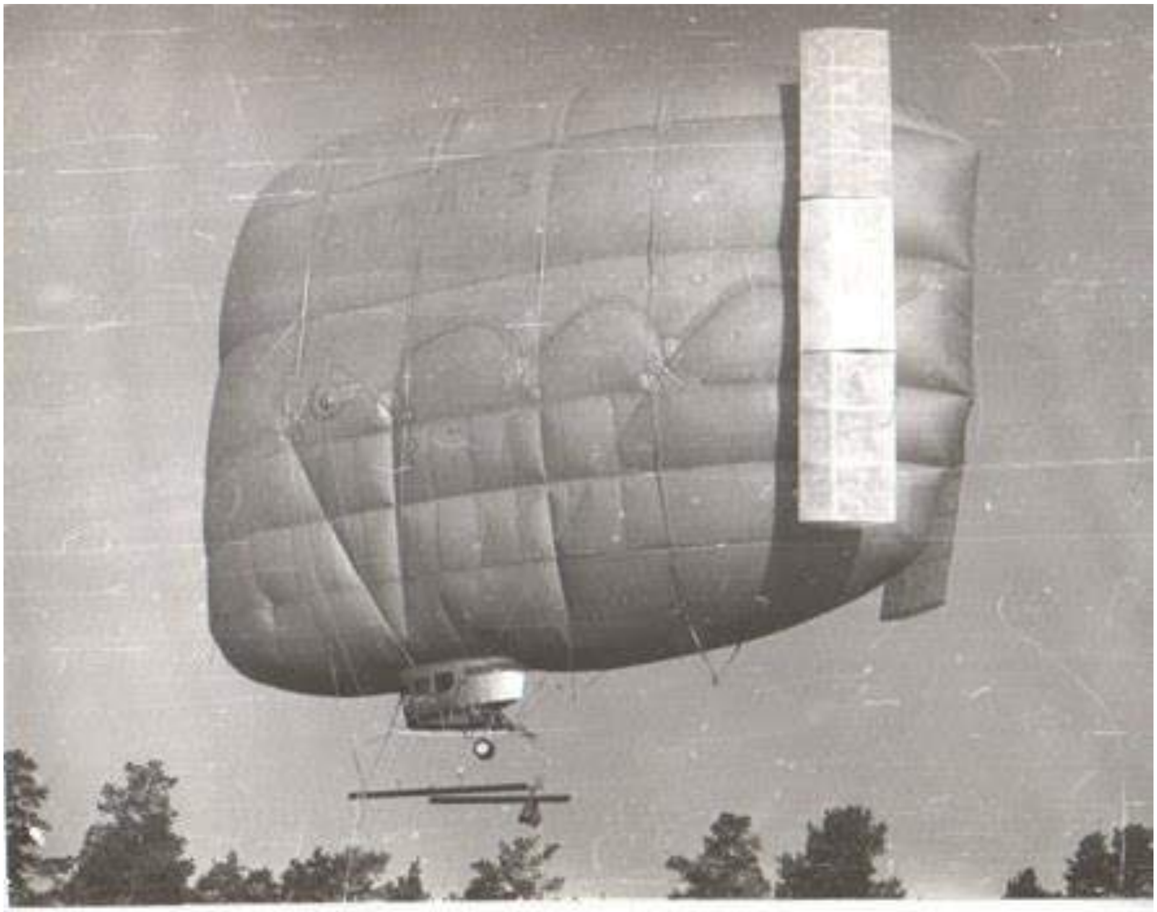
Preliminary tests of the Ural-3 took place from March to May 1982. The first tethered flight on 8 May 1982 was reached an altitude of 15 m (49 ft). The first free flight, to an altitude of 30 m (98 ft), took place the following day. The early flight testing demonstrated the stability, controllability and maneuverability of the Ural-3 in a relatively sheltered, low-wind environment.

Ural-3, bow quarter view, in a forest clearing.

Gondola showing the long drive shafts for the cantilevered propellers. Source, both photos: Aerosmena

Gondola viewed from the front showing the engine bay under the gondola and the cantilever arms for the propellers.

One cantilever arm and thrust vectoring propeller, vectored "Up." Source, both photos: Screenshots from Airships (1984) video

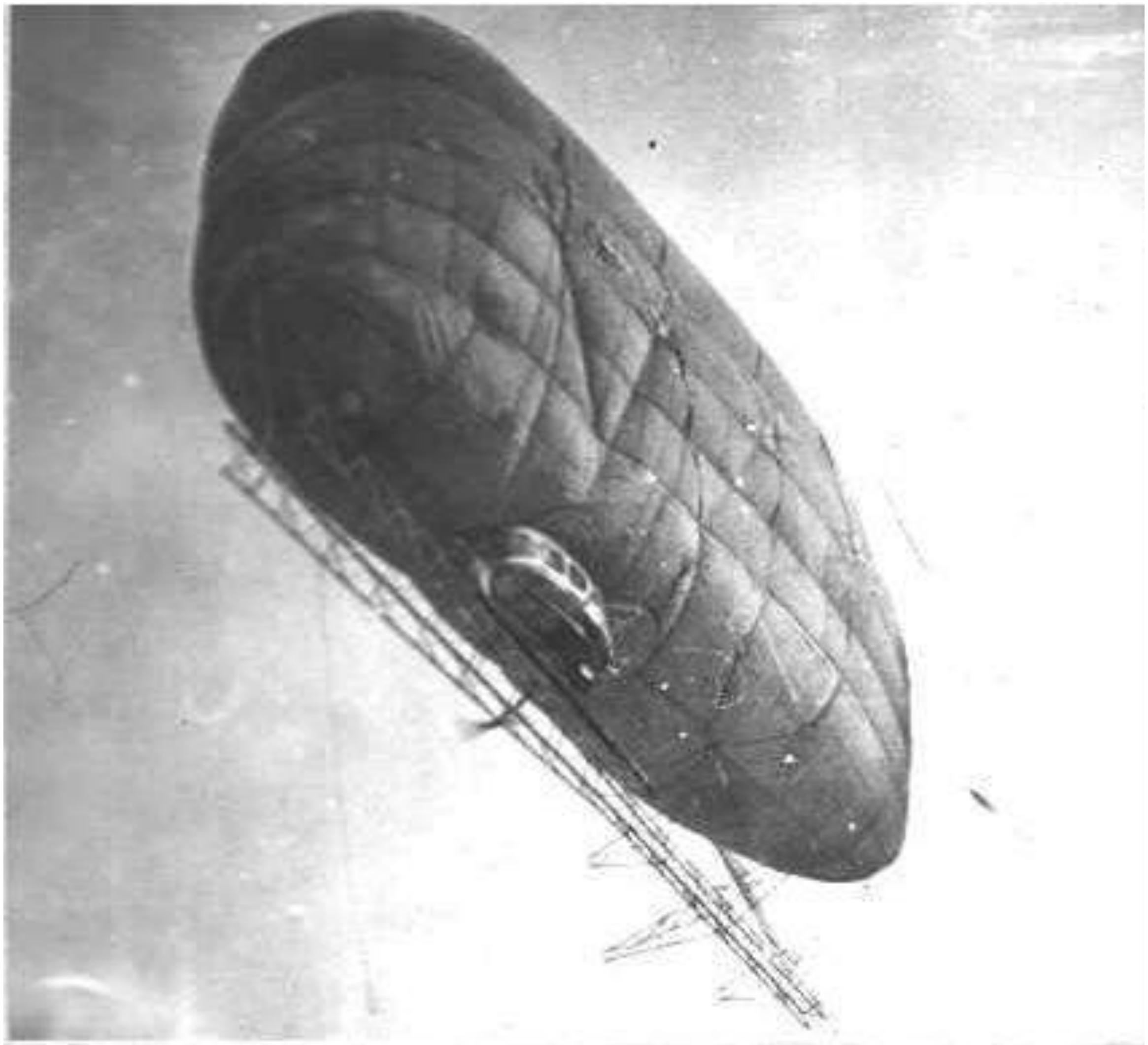


Ural-3 carrying logs. Source: Aerosmena

Based on the promising early results, OK-50 was directed on 20 January 1983 to carry out a second stage of field experiments with Ural-3 to demonstrate the technology for transporting and installing a one-piece pre-fabricated tower for a high-voltage transmission line. The goal of the first test was to operate the airship as a flying crane and carry a 15 m (49.2 ft), 80 kg (176 lb) model of a transmission tower between two cleared sites about 300 m (984 ft) apart in an area surrounded by a forest of tall trees. After ascending above the protection of the trees, the stronger prevailing wind prevented the underpowered airship from making headway and reaching the target destination. Instead, the pilot turned downwind and made an unassisted landing about 30 km (18.6 miles) from the launch site.

This flight of the Ural-3 was notable because to was the first time that an airship operated as a 'flying crane." Enabled by its ballastless design, Ural-3 also was the first airship to make an unassisted landing, without a ground crew or mooring devices.

The flight test revealed that the Ural-3 was underpowered and in need of replacement engines. These engines were not provided and the airship never flew again.



Ural-3 transporting a 15 m (49.2 ft) metal model of a high voltage electric transmission tower. Source: Aircraft of the Ural OKBD

7. Ural OKBD (OK-50) concept airships

In the 1980s and 1990s, DZ Bimbat and the Ural OKBD (OK-50) examined a wide range of airship configurations, largely for cargo-carrying applications to serve remote regions of the Soviet Union. Examples included:

- Vertical wing (in the style of Ural-3)
- Horizontal wing
- Double hull
- Triangular (delta) wing
- Lenticular (disk-shaped)
- Hybrid winged
- Conventional blimp
- Thermostat – a hot-air airship
- Heliostat – a partially solar-powered airship
- Stratospheric airship

Each is addressed in the following sections. Color illustrations of several of these designs are briefly shown in a Russian newsreel entitled “Airship (1984),” produced by Sverdlovsk Newsreel Studio. The newsreel puts a useful 1984 “time stamp” on these designs.

In the mid-1980s, Ural OKBD sought government support to develop three types of experimental airships:

- An airship using helium lift gas
- A Thermostat
- A Heliostat

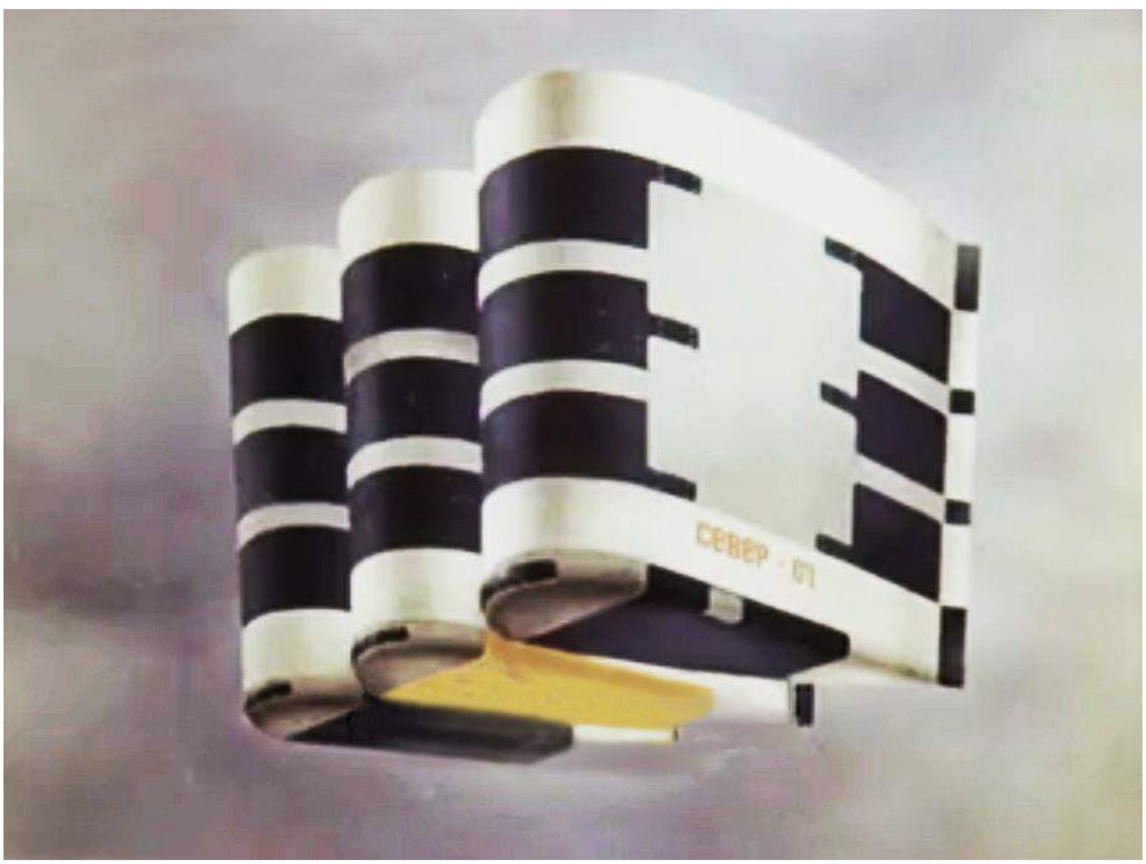
Based on the results of this research and development work, the OKBD proposed to select the best option for a technical project to manufacture a full-scale prototype airship.

The OKBD proposed to conclude by 1987 “agreements on economic and scientific and technical cooperation with research organizations and industrial enterprises for the implementation of R&D, research and development and the purchase of products and materials.” Unfortunately, the planned program wasn’t funded and none of the concept airships were developed as full-scale prototypes.

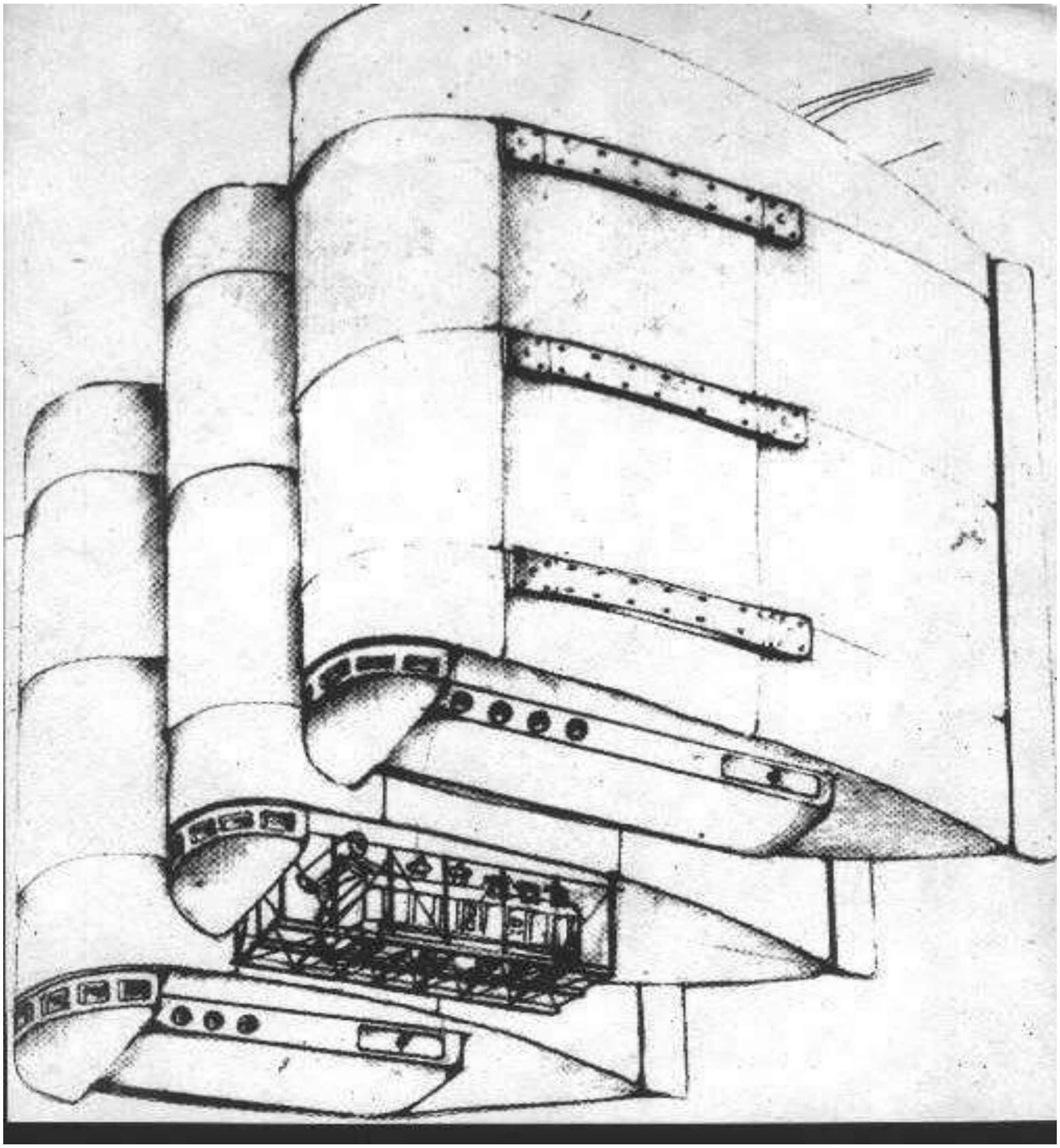
Vertical wing airship

The vertical wing airship is a modular airship based on the design of the Ural-3 and intended primarily for operation as an “air crane” for the transportation of bulky cargo over short distances. However, a variety of standardized, replaceable gondola modules can be installed behind the fixed cockpit at the bottom of the gas envelope. This gives the airship the flexibility to carry a mix of passengers, internal cargo and bulky external cargo.

The following graphic shows three modular vertical wing airships joined together side-by-side and flying in formation. A heavy payload would be connected under the center module and the load would be distributed to the other modules by a framework that is not evident in the graphic. After delivery of the payload, the three airship modules could be divided into separate vehicles or reconstituted into another configuration for their next mission.



Ural OKBD heavy-lift, vertical wing airship concept, circa 1984, based on the Ural-3 airship. Source: adapted from Airships (1984) video.

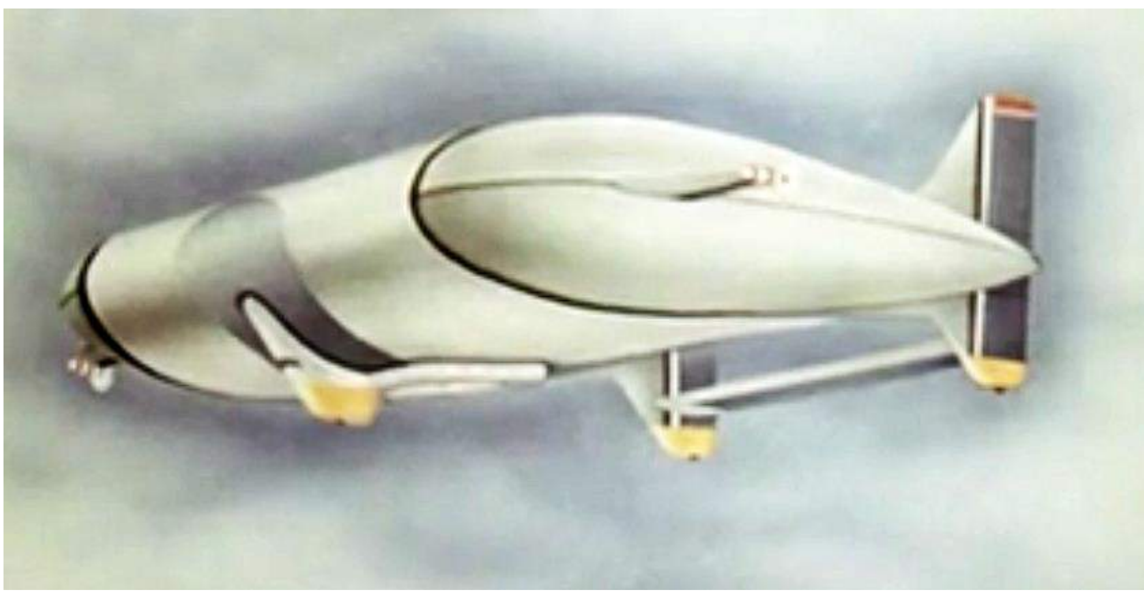


Different types of gondola modules can be installed. In the above graphic, the two outer gondola modules appear to be passenger / internal cargo modules and the center module appears to be an open platform carrying a large unitary item.
Source: Aircraft of the Ural OKBD

Horizontal wing airship

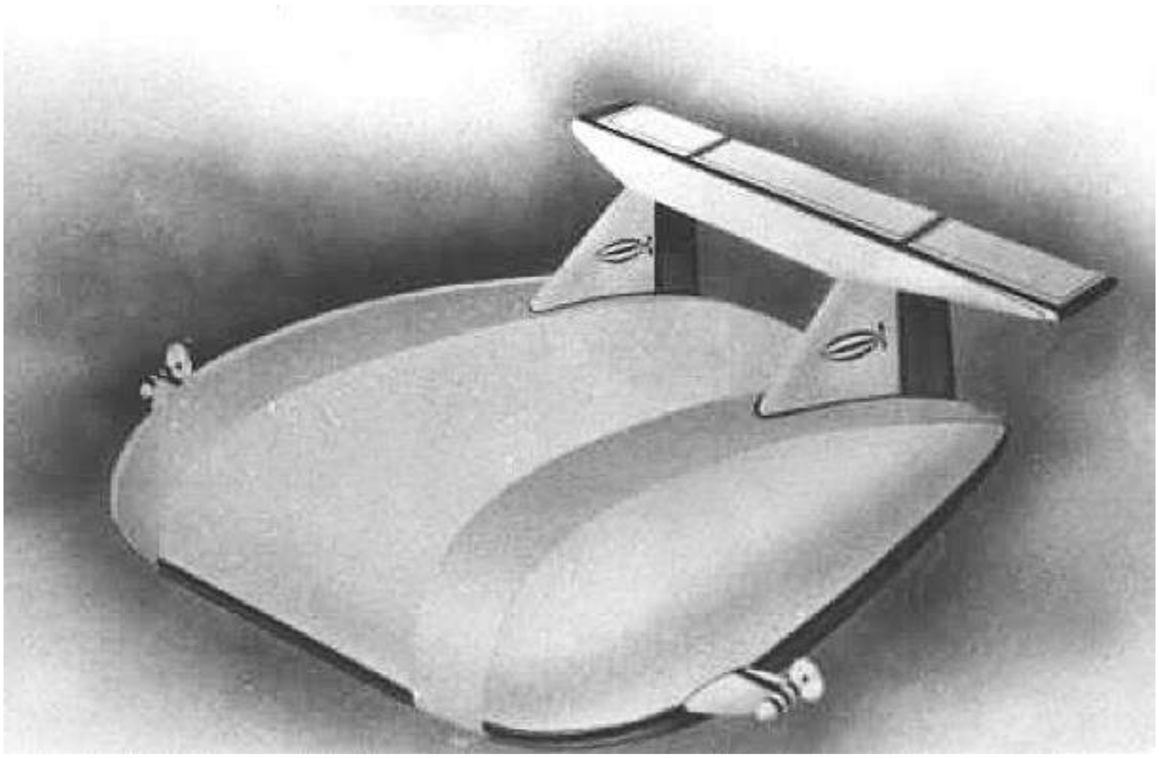
The horizontal wing airship has a lifting body hull that offers a large, variable gas envelope volume for carrying heavy cargo. As with the vertical wing airship, a variety of standardized, replaceable gondola modules made it possible to tailor the airship for changing transportation needs.

- Gondola for passenger transport
- Gondola with a multi-function cargo bay for transporting agricultural products, liquid and bulk products and animals. The gondola also could be configured to dispense agricultural fertilizers from the air or dispense water for fighting wild fires.
- External sling for transporting large indivisible loads that can't be carried inside a gondola.

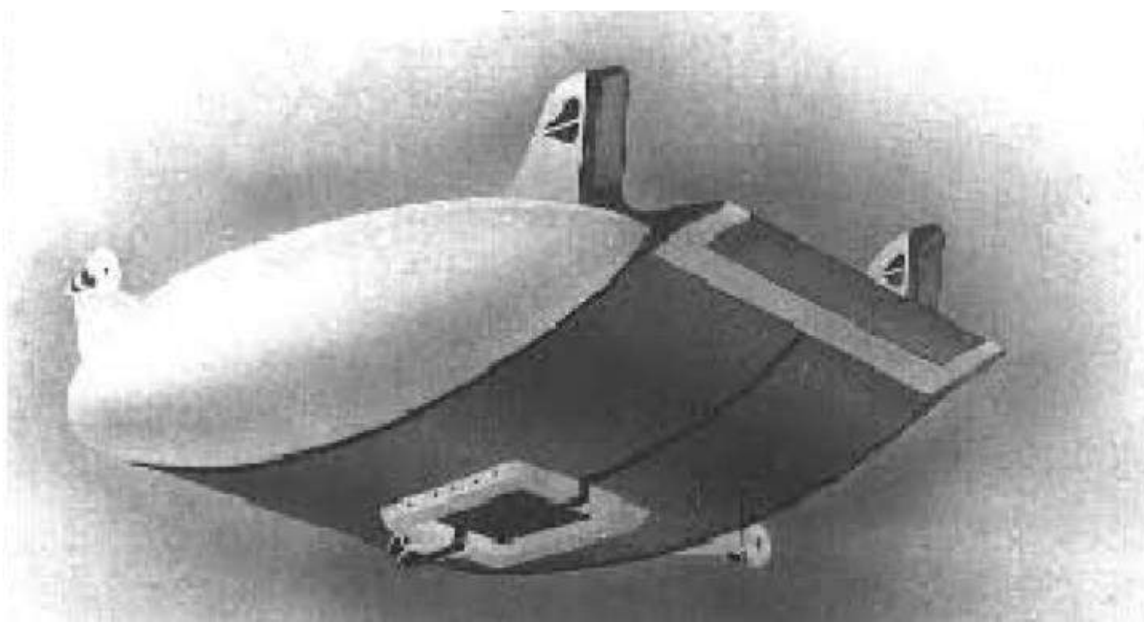


Ural OKBD horizontal wing design concept with a lowered tailplane, circa 1984. Source: adapted from Airships (1984) video

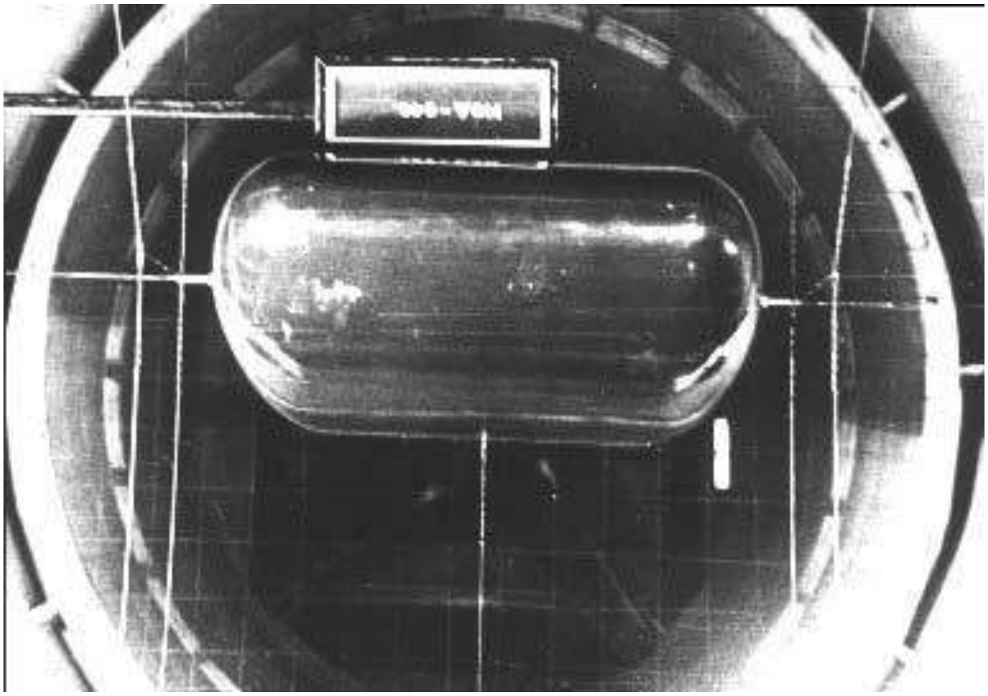
Ural OKBD developed several variants of their horizontal wing airship, seeking to optimize the overall design and, in particular, the placement of the horizontal and vertical stabilizers.



Ural OKBD horizontal wing design concept with a raised tailplane. Source: Aircraft of the Ural OKBD

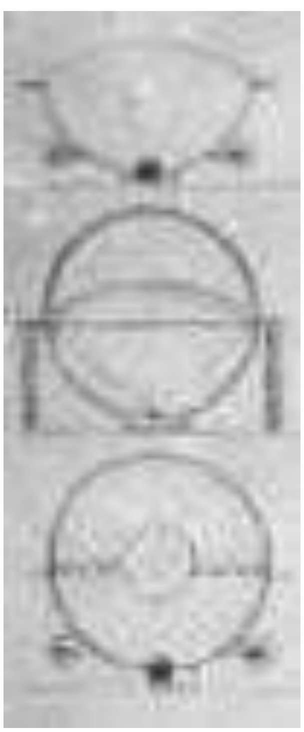


Ural OKBD horizontal wing design concept with a tailplane along the trailing edge of the hull. Source: Aircraft of the Ural OKBD



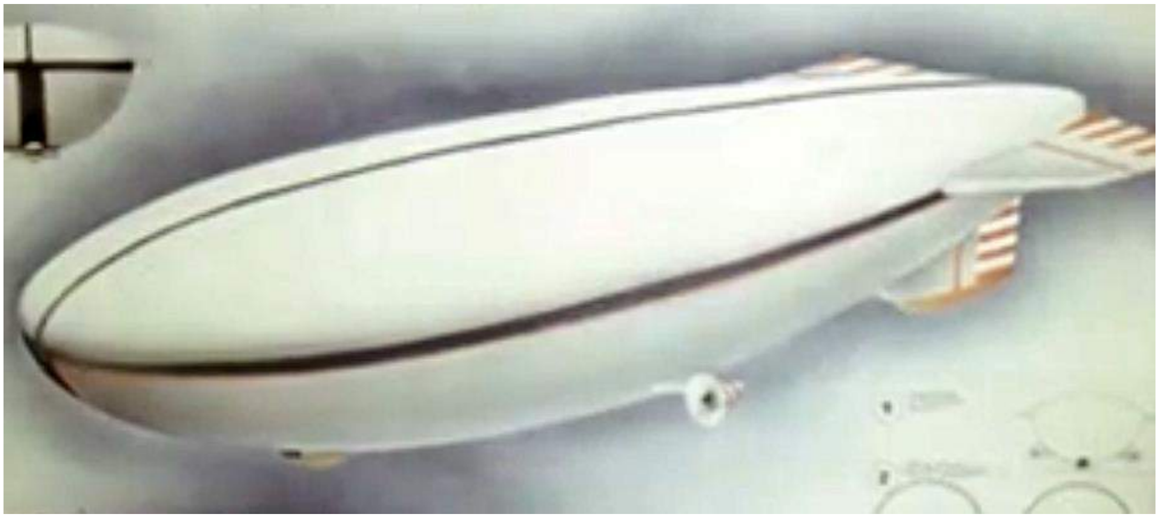
Bow-on view of a broad horizontal wing airship model in a wind tunnel. Source: Aircraft of the Ural OKBD

Double-hull airship

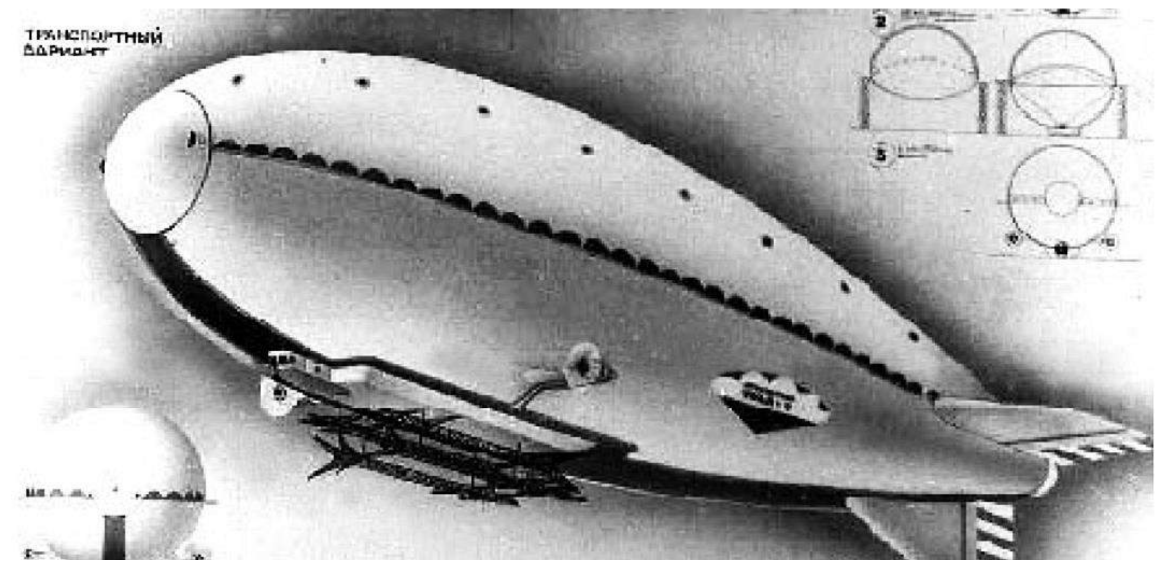


This airship consisted of two parts, a “lower shell” and an “upper shell.” The “lower shell,” with a relatively flat upper surface, is the basic rigid airship, complete with the gondola, cargo handling equipment, propulsion system and aerodynamic control surfaces. The removable, non-rigid “upper shell” is a supplementary lifting gas envelope that is designed to attach to the “lower shell” and increase the lifting capacity of the complete airship. After the two parts of the double hull have been connected, a nose cap is installed to refine the aerodynamic shape of the joined double hull.

Top to bottom: Combining the parts of the double-hull airship. Source: Aircraft of the Ural OKBD



The “lower shell” of the Ural OKBD double-hull airship design concept, circa 1984. Source: adapted from Airships (1984) video

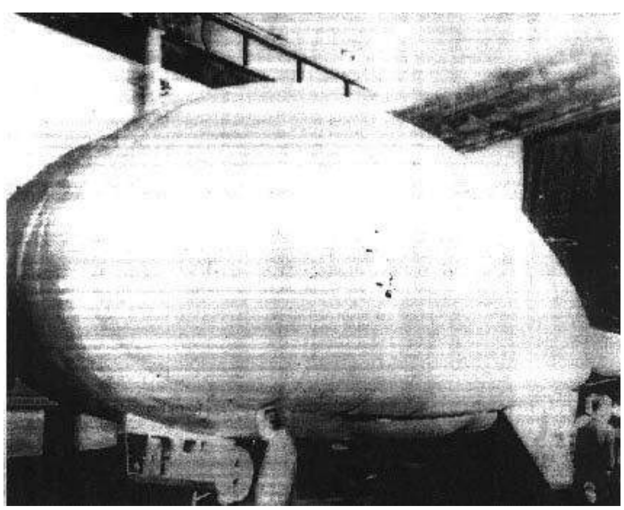


The Ural OKBD double-hull airship with both hulls and a nose cap installed. Note the large cargo item (transmission towers) carried externally under the hull. Source: Aircraft of the Ural OKBD

The airship was designed to operate as a flying crane and transport large unitary items. As such, it likely would have incorporated a version of the Ural OKBD variable volume buoyancy control system. An interesting challenge would be to have this buoyancy control system operate with both parts of the double hull.

In the early 1990s, Ural OKBD produced a 20 m^3 (706 ft^3) flying model of a double-hull airship implemented as a broad horizontal wing. The model was commissioned by the Krylo Design Bureau in Omsk. Both hulls could be separated and reassembled in one unit. The model was flight tested on a tether and is reported to have shown good flight performance.

Stern-quarter view of the sub-scale flying model of the double-hull airship, circa early 1990s. Source: Yuri Druzhinin, DZ Bimbat bio



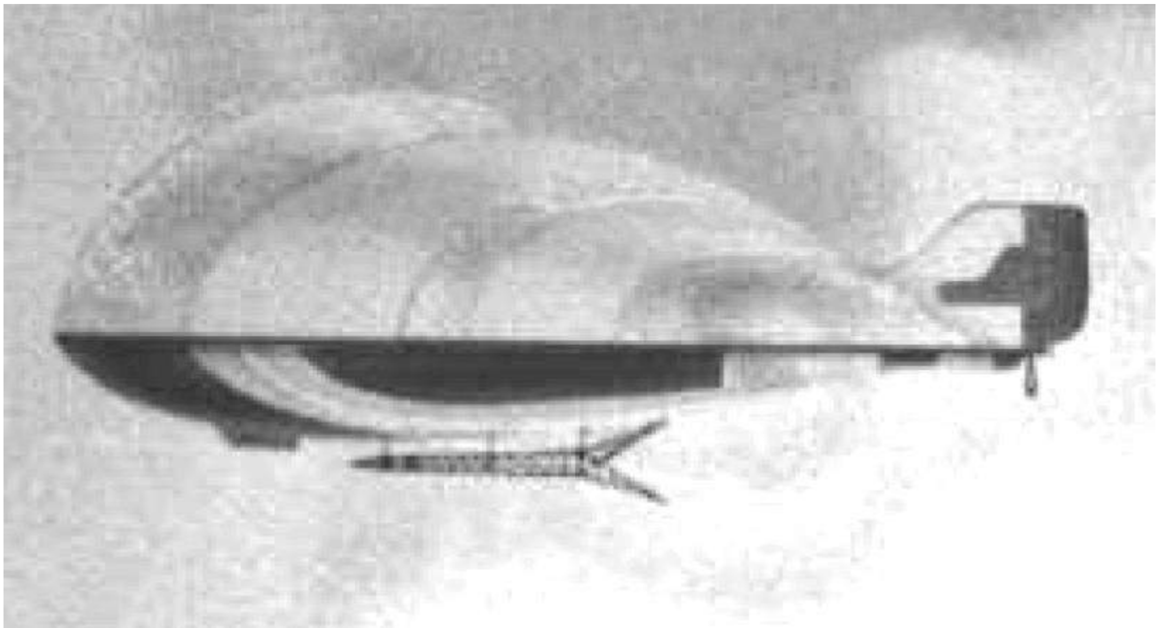
Bow-quarter view of the sub-scale flying model of the double-hull airship. Source: Aircraft of the Ural OKBD

Testing the sub-scale flying model of the double-hull airship. Source: Aircraft of the Ural OKBD

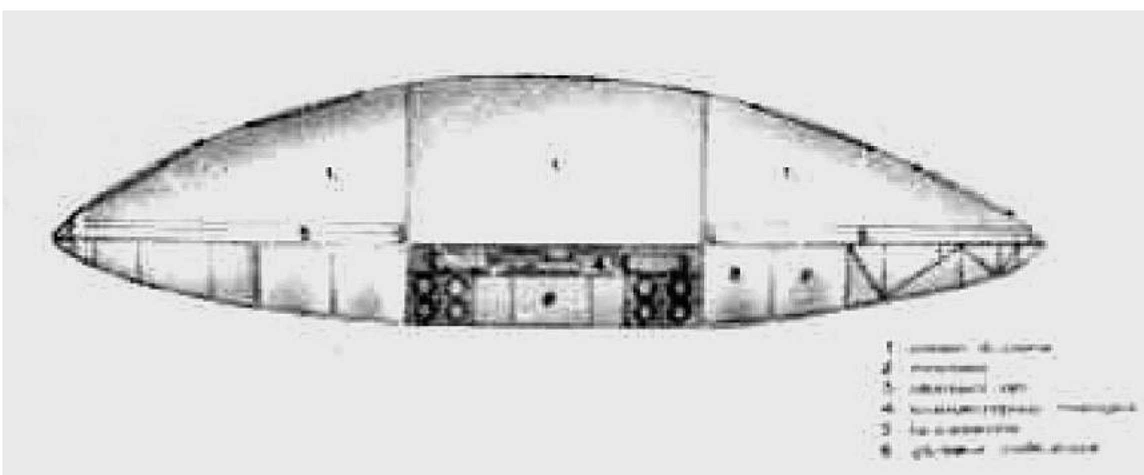
<u>Triangular (delta) wing airship</u>

The triangular wing airship was another design for a heavy-lift, ballastless, variable volume airship.

Ural OKBD triangular wing airship viewed from below. Source: adapted from Airships (1984) video



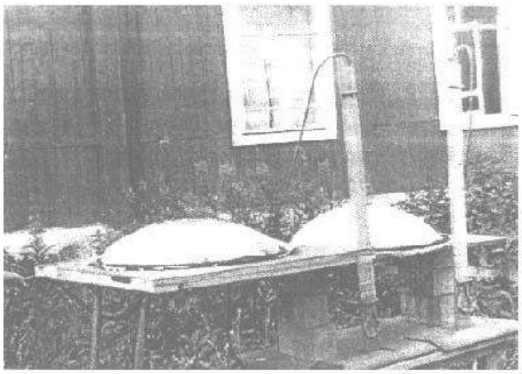
Ural OKBD triangular wing airship side view. Note the voluminous, soft upper surface. Also note the high-voltage electrical transmission tower (a set of three towers) carried externally, under the hull. Source: Aircraft of the Ural OKBD



Ural OKBD triangular wing airship transverse cross-section. Source: Aircraft of the Ural OKBD

Lenticular (disk-shaped) airship

This ballastless airship was designed to operate as an “Air Crane.” The variable volume buoyancy control system enables load exchanges to be accomplished without exchanging external ballast.



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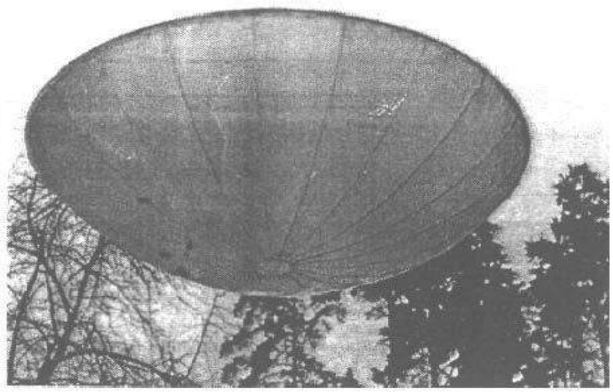
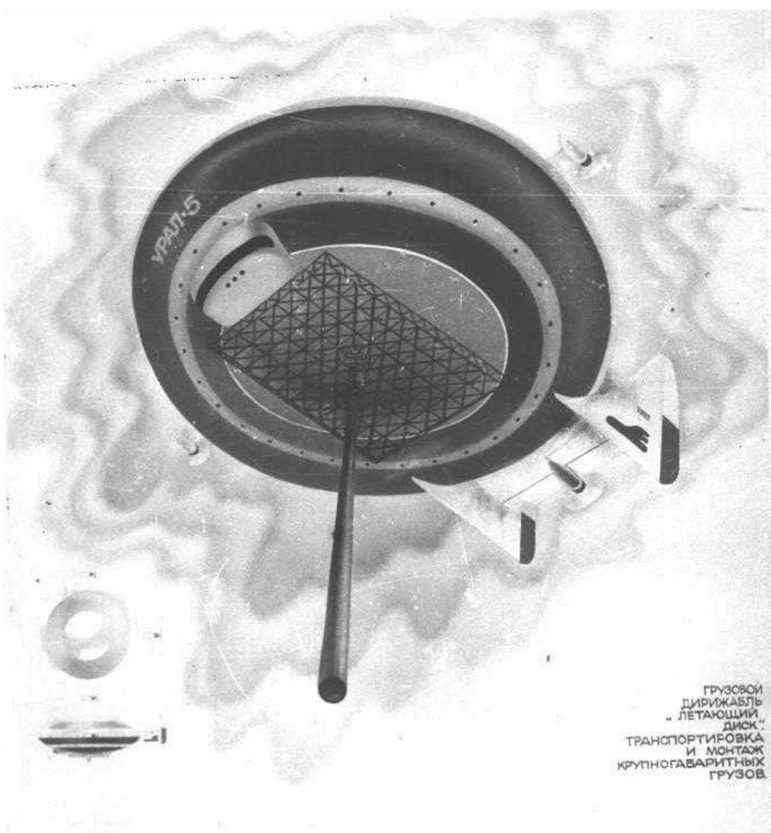
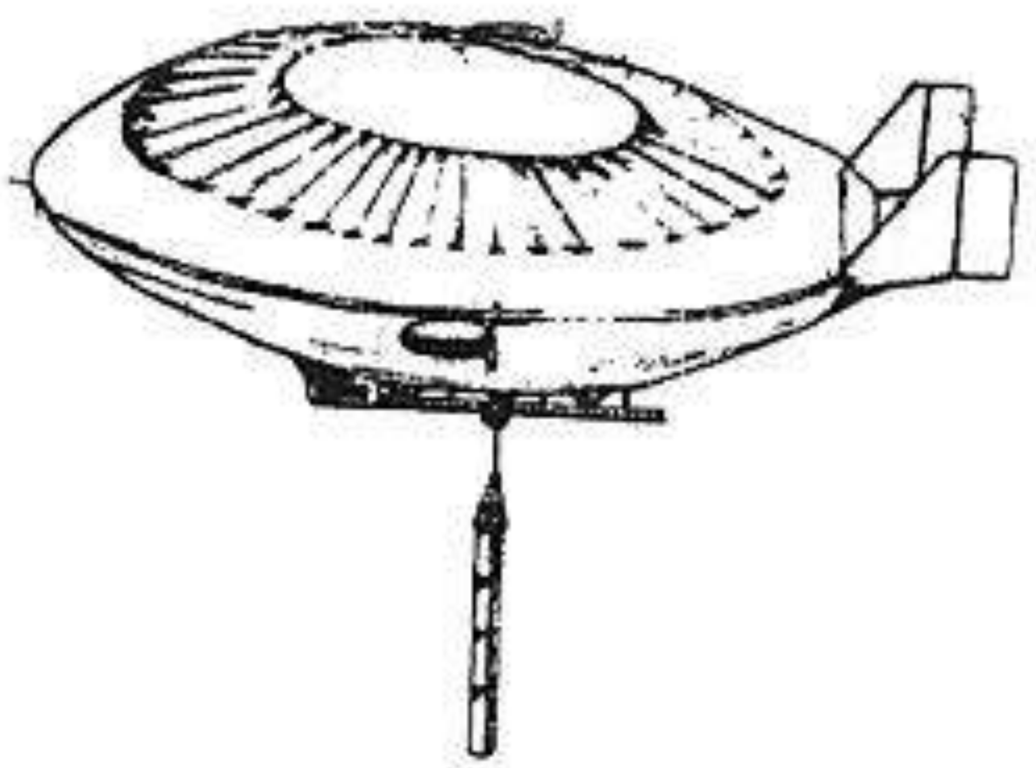


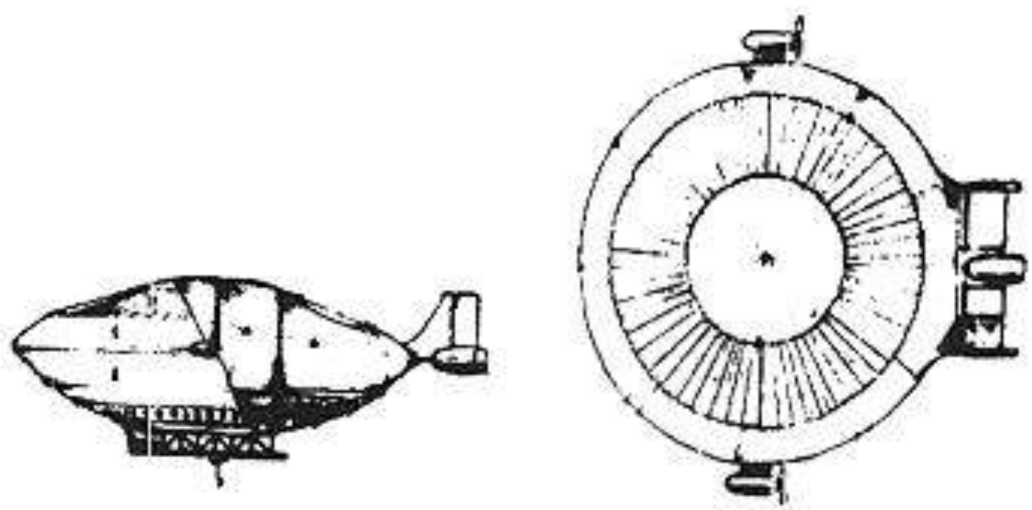
A flying sub-scale model of the lenticular airship.
Source: Aircraft of the Ural OKBD



The lenticular Air Crane viewed from below while carrying a long vertical load.
Source: Aircraft of the Ural OKBD



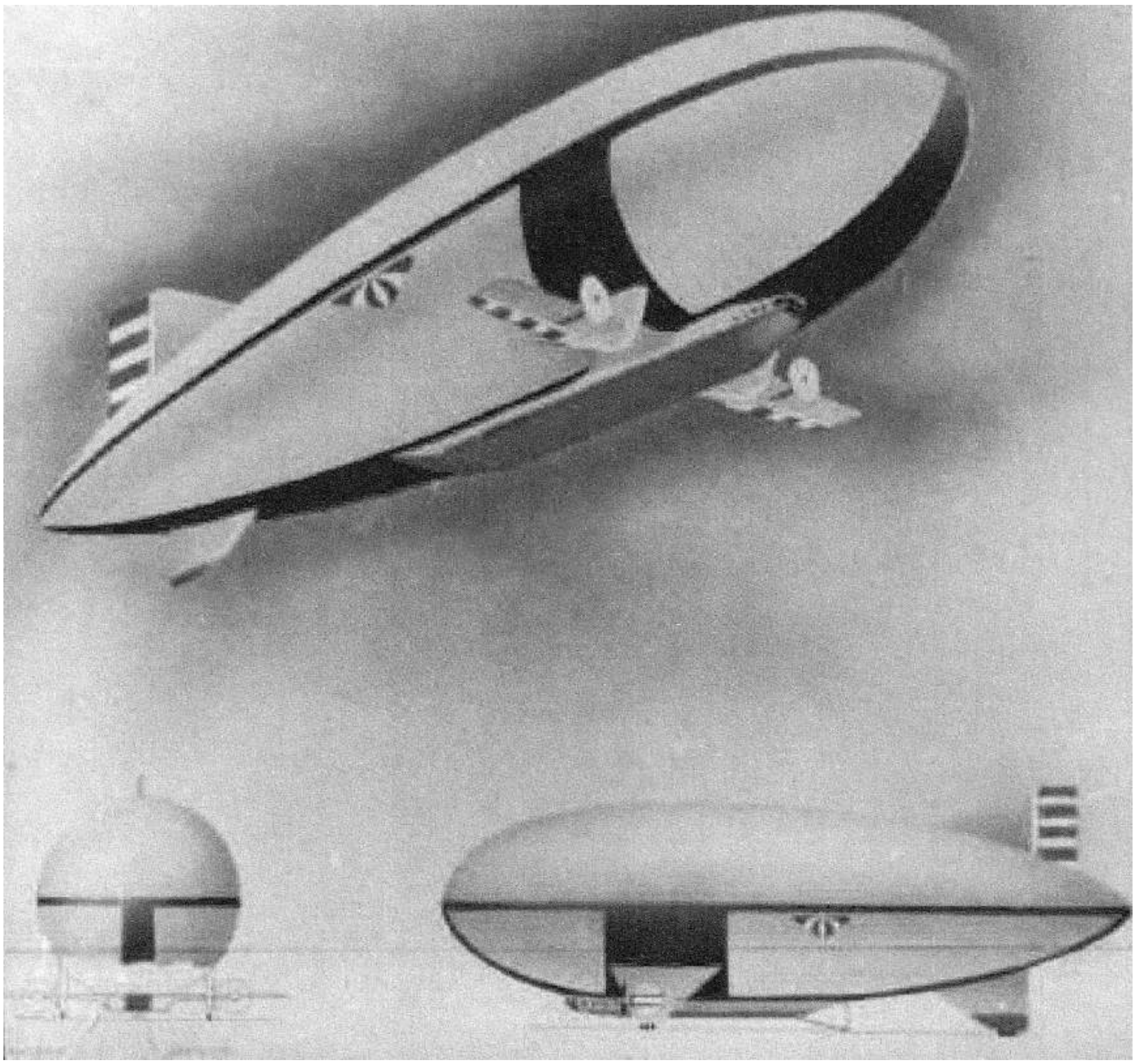
Oblique view showing the lenticular Air Crane carrying a long vertical load. Source: Aircraft of the Ural OKBD



Side view (left) and top view (right) of the lenticular Air Crane. Source: Aircraft of the Ural OKBD

Hybrid winged airship

This hybrid airship combines a large conventionally-shaped gas envelope with large, low-mounted, airplane-style fixed wings that carry the two propulsion engines and the forward landing gear. A long, freight-carrying gondola under the airship's centerline is capable of carrying long loads inside the cargo bay.

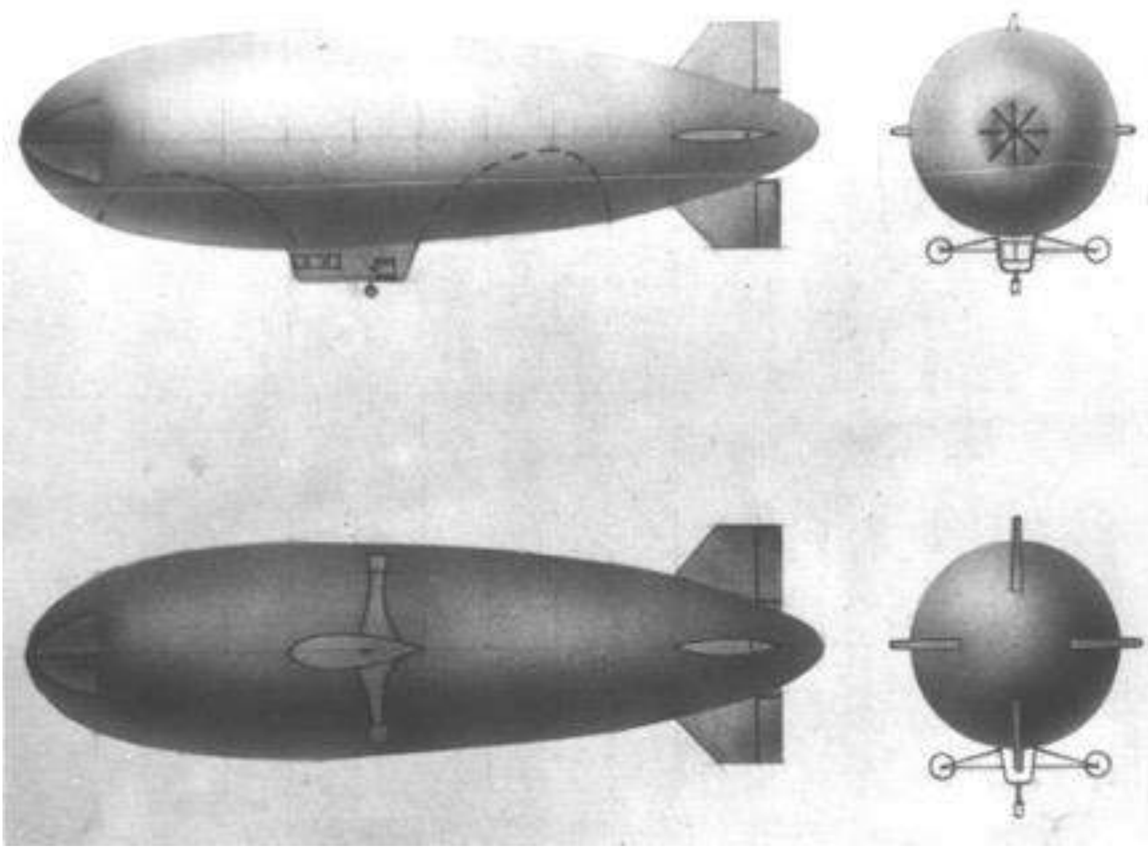


Ural OKBD hybrid winged airship.
Source: Alastair Reid, Russian Airships (2016)

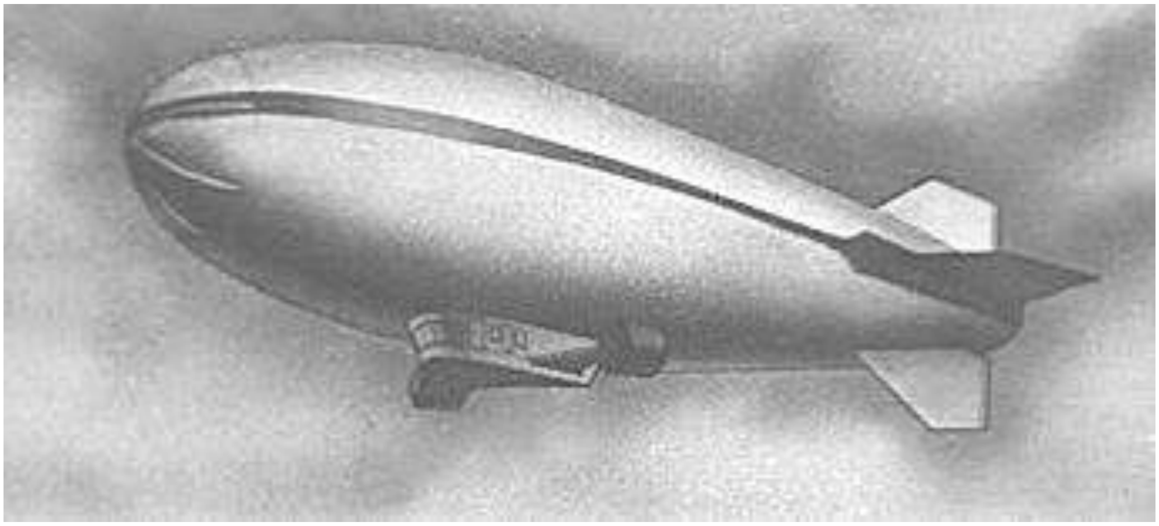
Non-rigid conventional blimp

Ural OKBD developed the design for a conventional, non-rigid airship (blimp) for use in transporting special research equipment in flights over land and sea at low speeds and altitudes. The airship was designed for operating year round during daylight hours only in fair meteorological conditions with wind speeds up to 15 m/s (54 kph / 34 mph). It also could be used for patrolling and for transporting people and goods.

The design called for a payload, including special equipment, crew, fuel, lubricants and ballast, of at least 2,000 kg (4,409 lb), of which up to 700 kg (1,543 lb) would be special research equipment. The special equipment required a 6 kW power source.



General layout of the non-rigid transport airship.
Source: Aircraft of the Ural OKBD



Oblique view of the non-rigid transport airship.
Source: Aircraft of the Ural OKBD

The non-rigid envelope was a multi-layer fabric:

- The main fabric provided the required mechanical strength for the gas envelope.
- An interior gas-retaining film had a helium leak rate of no more than 1 liter per day / square meter of envelope surface. Total envelope surface area was 2,012 m^2, (21,679 ft^2) making the total helium leak rate about 2 m^3/day (71 ft^3/day).
- An outer polyurethane layer was coated with titanium dioxide.

In flight, the airship was controlled by lightweight aerodynamic elevators and rudders installed on the cruciform fins. The fins and control surface structures consisted of a fiberglass or carbon fiber spar surrounded by a foam core and covered with a hard three-layer skin (fiberglass-foam plastic-fiberglass).

An internal catenary system supported the semi-monocoque gondola and propulsion system. Cables inside the gas envelope carry and distribute loads into the upper portion of the envelope.

Aerostatic buoyancy was controlled by the following:

- Two air ballonets in the gas envelope, with electric-powered, reversible fans for adding or discharging air.

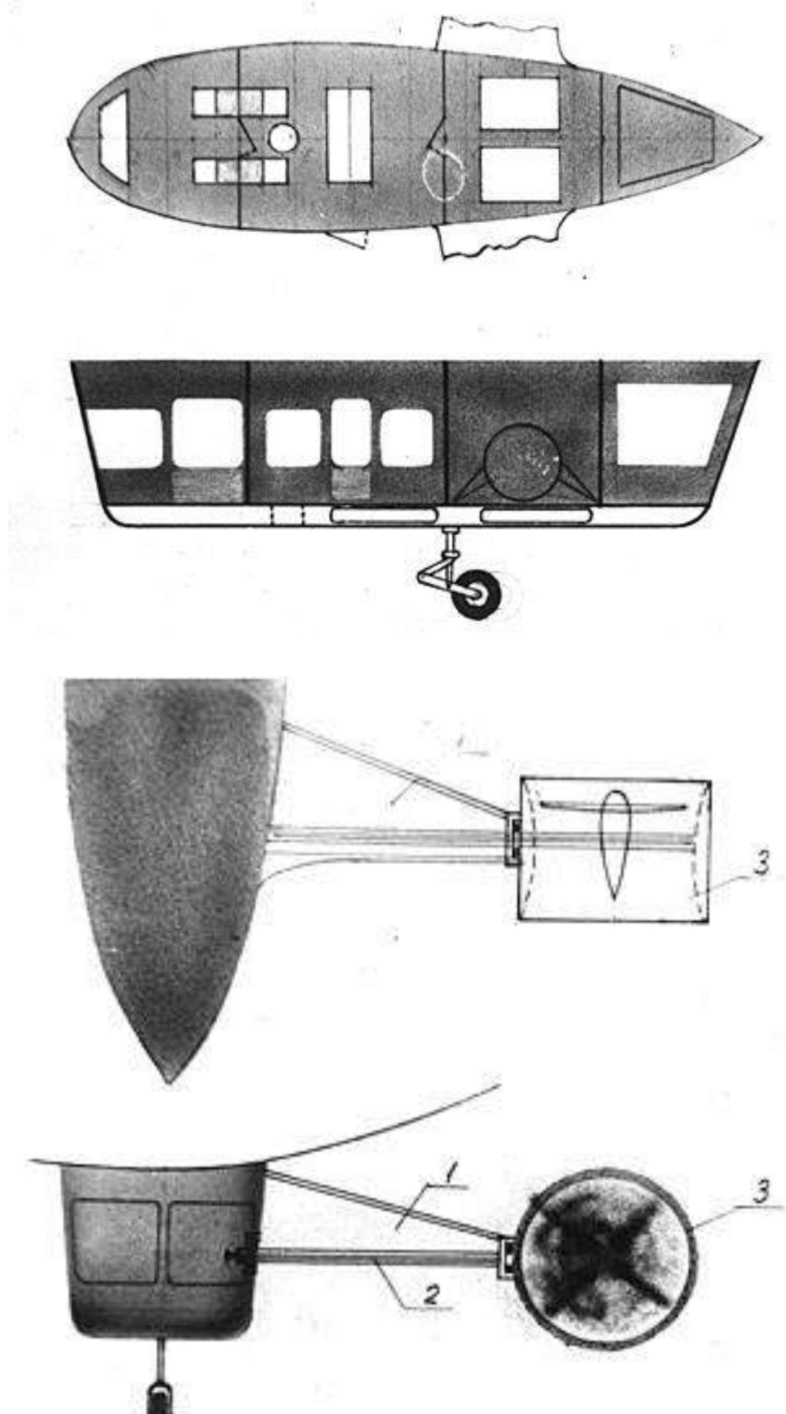
- A water ballast system with soft storage containers under the gondola floor can be discharged on the ground or in flight and refilled from an external water source.
- Six gas valves on the gas envelope can quickly relieve excess helium pressure when needed.

General characteristics of the Ural OKBD non-rigid airship

Parameter	**Non-rigid transport airship**
Length	55.5 m (182 ft)
Diameter, max.	14.8 m (48.6 ft)
Envelope volume	6,200 m^3 (218,951 ft^3)
Ballonets	2, total volume 950 m^3 (33,549 ft^3, 15% of envelope volume)
Propulsion	• 2 x piston engines, each rated at 265 – 295 kW (355 to 396 shp), housed inside the gondola and driving thrust vectoring, 4-bladed shrouded propellers cantilevered from the gondola. • Propellers vector 50º up & down.
Electric power system	Powers airship systems plus 6 kW reserved for special equipment payload
Aerodynamic controls	Cruciform rudders and elevators at the tail
Airship mass, empty, dry	1,941 kg (4,279 lb)
Payload	2,105 kg (4,641 lb), with 700 kg (1,543 lb) reserved for special equipment
Accommodations	2 x crew and 2 x equipment operators
Gondola dimensions	• Length, max: 9.0 m (29.5 ft) • Width, max: 2.5 m (8.2 ft) • Height: 2.3 m (7.5 ft)
Operating altitude	500 m (1,640 ft)
Operating speed	120 kph (74.6 mph)
Endurance	6 hours, with 730 kg (1,609 lb) fuel

Propulsion was provided by two thrust vectoring shrouded propellers that were cantilevered from the gondola. Thrust vectoring would be used at takeoff, during climb to cruising altitude and, if necessary, to maintain the desired altitude. At the end of the flight, thrust vectoring would be used again to descend back to the ground.

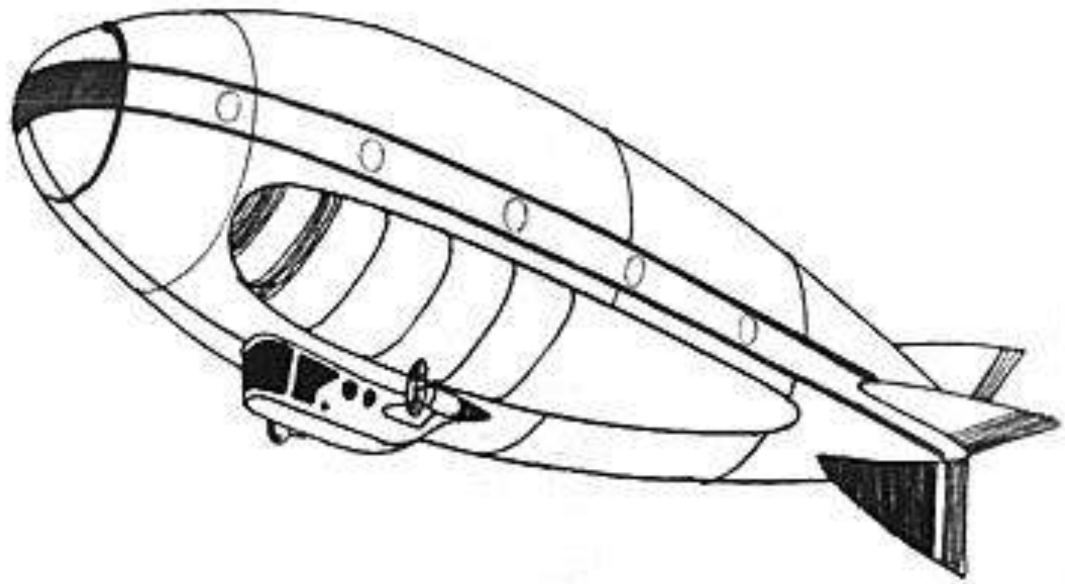
The airship has a fly-by-wire electric primary flight control system with a backup mechanical cable system.



Gondola and thrust vectoring propulsor details. Propellers (3) are driven by long transmission shafts (2) from the engines in the aft section of the gondola. Source: Aircraft of the Ural OKBD

The Thermostat – a hot-air airship

The Thermostat was a design for a hot-air airship in which all of the aerostatic lift was generated by hot air that had been heated by an onboard system fueled by natural gas. The first Thermostat was intended to be a mobile aeronautical manned vehicle for scientific research. It was designed for operating year round during daylight hours only in fair meteorological conditions with wind speeds up to 15 m/s (54 kph / 34 mph). UOKBD noted that "the Thermostat can be used in various sectors of the national economy for transporting people and various goods, including large-sized ones, to hard-to-reach regions of the country and for the production of construction and installation works"



General arrangement of a conventionally-shaped ("spindle"-shaped) Thermostat. The "blisters" on the flanks of the envelope are the storage cells for natural gas fuel. Source: Aircraft of the Ural OKBD

UOKBD identified the following advantages of Thermostats:

- In the absence of ground handling and storage facilities for airships filled with gas (helium, hydrogen), it is advisable to use Thermostats. On the ground, the Thermostat can be deflated and stored in a folded position in an open field and does not require additional special hangar facilities.

- The Thermostat is a ballastless airship. The static equilibrium of the Thermostat is achieved by changing the temperature of the heated air in the shell. No ballast or helium needs to be discharged during flight.
- Air heating is done with infrared emitters fueled by natural gas and supplemented by heat from propulsion engine exhaust gas for pre-heating ambient air.
- The use of natural gas as a fuel for heating the air and for operating propulsion engines will allow Thermostats to be used in all regions of the country throughout the year.

The envelope is made from soft, heat resistant reinforced fabrics with a lightweight honeycomb insulation layer. The envelope is inflated with ambient air by fans that are part of the air circulation and heating system. When ready for flight, the air in the Thermostat is heated to + 200 to 250 °C (392 to 485 °F) to create aerostatic lift. An onboard computer system manages the specific heating requirements based on current airship loading, flight and atmospheric conditions.

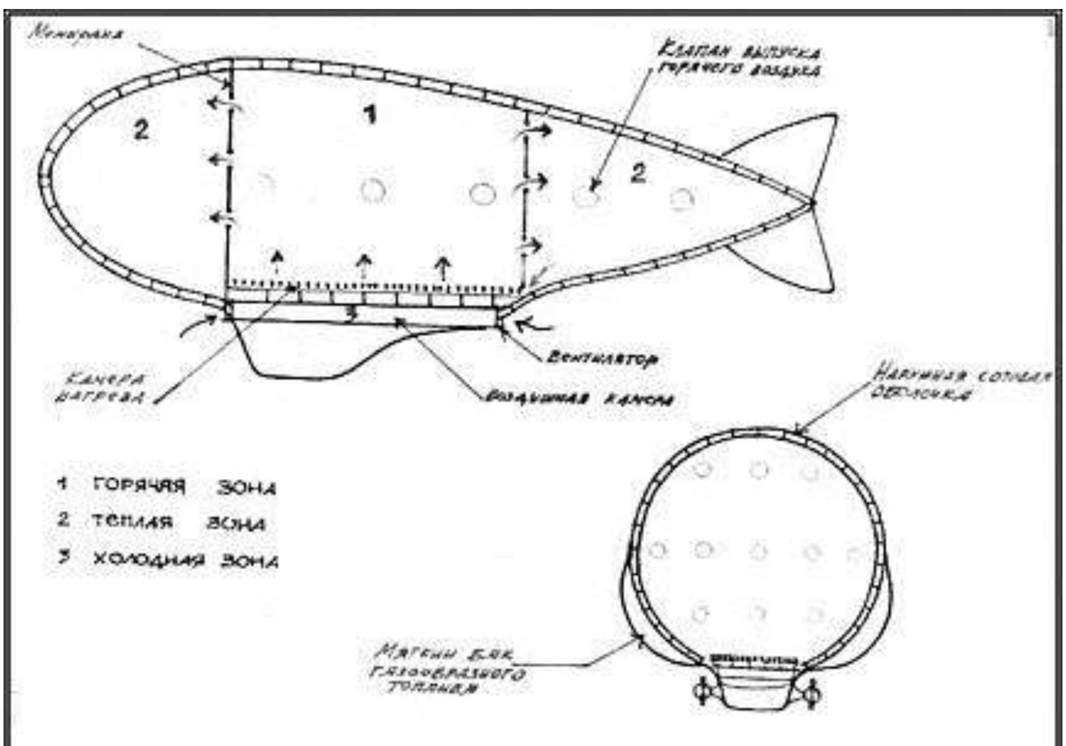


Рис.6.4 Схема термостата

Longitudinal and transverse sections showing the interior arrangement of a “spindle”-shaped Thermostat.
Source: Aircraft of the Ural OKBD

The Thermostat's envelope is divided into "compartments" that establish the airflow paths through the envelope. With the fans operating, ambient air is drawn into the ventilation chamber (3) and directed to the heating chamber (also 3) where heating devices with natural gas fueled infrared emitters heat the air as it flows through ducts into the middle "hot" compartment. From there the air flows through diaphragms into the bow and stern "warm" compartments (2). From there, the air circulates back to the ventilation chamber (3), where it pre-heats incoming ambient air before being exhausted to the atmosphere, or possibly recirculated for heating.

Natural gas fuel for heaters and propulsion engines is stored in the "blisters" on the lower sides of the envelope, as shown in the transverse section diagram.

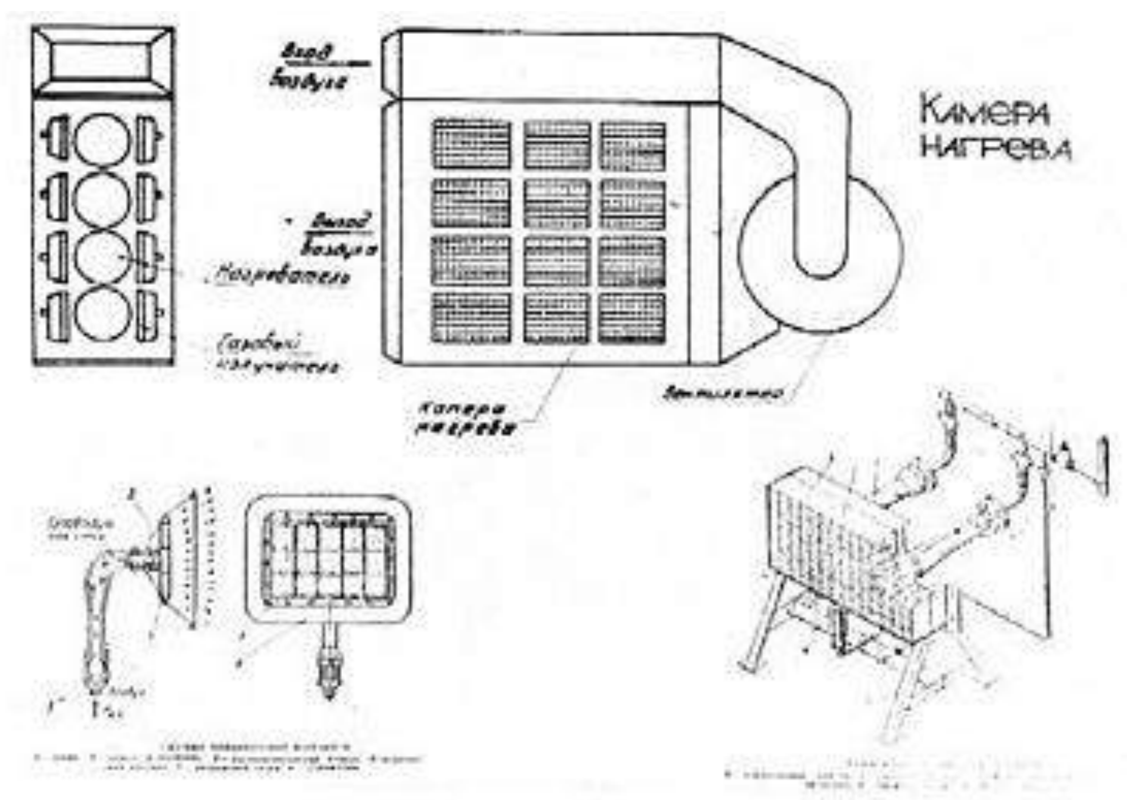


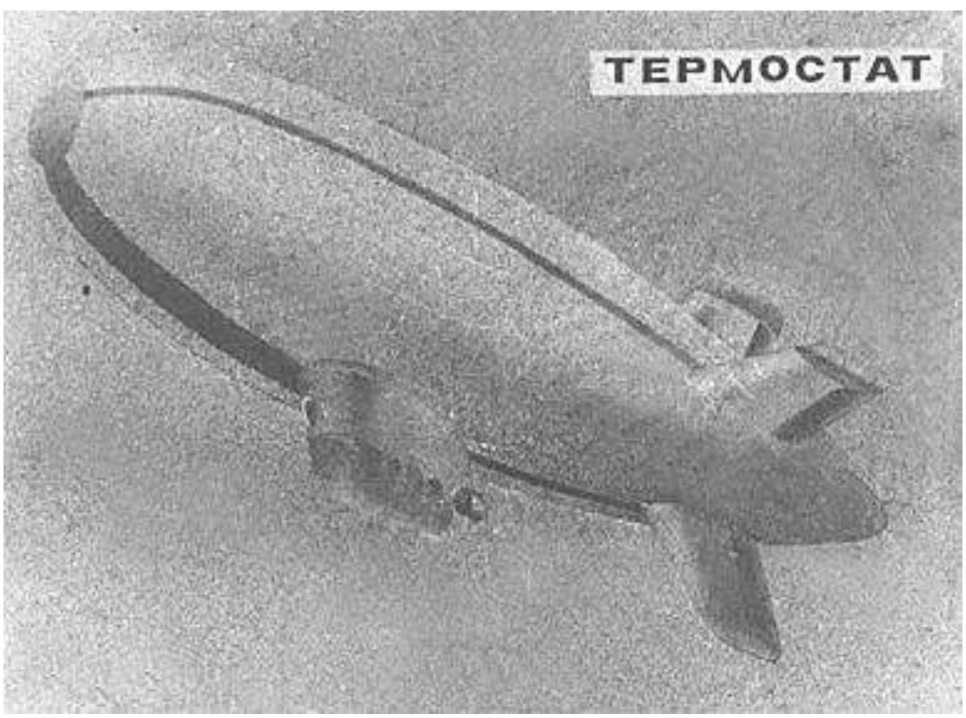
Рис.6.5 Схема камеры нагрева

Assembled heater / fan module (top) and infra-red heater units that are installed inside the module (bottom).
Source: Aircraft of the Ural OKBD

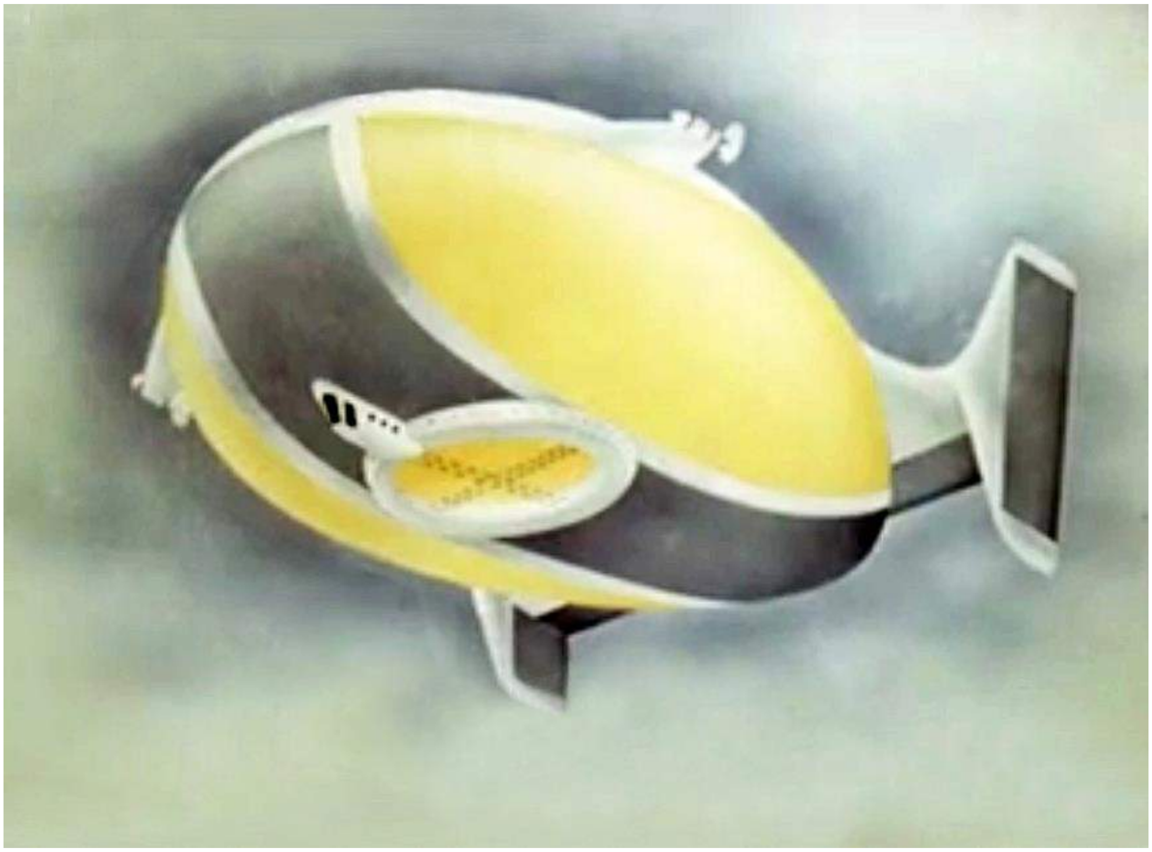
To confirm the utility of the Thermostat design, the OKBD proposed building a conventionally-shaped ("spindle"-shaped) unmanned flying model and a larger, lenticular (disk-shaped) manned prototype.

General characteristics of the Ural OKBD thermal airships

Parameter	**Unmanned flying model Thermostat**	**Manned prototype Thermostat**
Geometric shape	Spindle	Disk
Shell length, overall	26.6 m (87.3 ft)	35 m (114.8 ft)
Shell diameter	7.6 m, max (24.9 ft)	35 m (114.8 ft)
Shell height	7.6 m, max (24.9 ft)	9.7 m, max (31.8 ft)
Shell volume	850 m^3 (30,017 ft^3)	7,000 m^3 (247,203 ft^3)
Structural weight	450 kg (992 lb)	3,000 kg (6,614 lb)
Payload	50 kg (110 lb)	1,000 kg (2,205 lb)
Operating altitude	200 m (656 ft)	1,000 m (3,281 ft)
Speed, max	60 kph (37.3 mph)	60 kph (37.3 mph)
Speed, operational	40 kph (24.9 mph)	40 kph (24.9 mph)
Speed, min	0	0
Propulsion	2 x natural gas powered engines each rated @ 20 kW (26.8 shp)	2 x natural gas powered engines each rated @ 75 kW (100.6 shp)



Ural OKBD conventionally-shaped ("spindle"-shaped) Thermostat. Source: Aircraft of the Ural OKBD

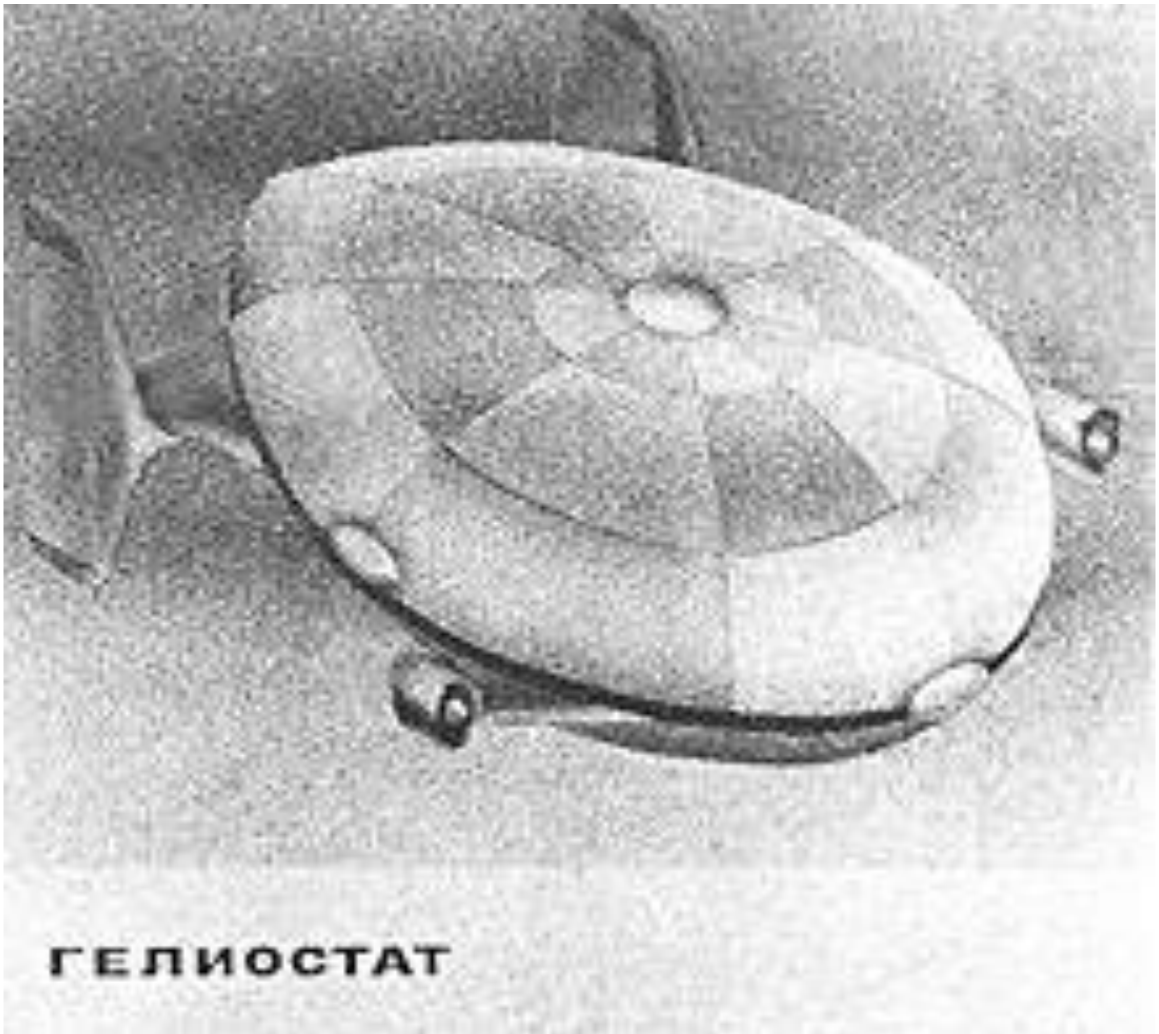


Ural OKBD lenticular (disc-shaped) Thermostat.
Source: adapted from Airships (1984) video

The Heliostat – a partially solar-powered airship

UOKBD developed a design for a partially solar-powered airship intended to save onboard energy resources and fuel on airships operating in Central Asia and in the southern regions of the country. With thin-film photovoltaic (PV) arrays installed on the upper surface of the gas envelope, the Heliostat could deliver fuel savings that translated into lower operating cost and longer mission times and/or non-stop range.

This UOKBD design exercise looked at the use of supplementary solar power on a disk-shaped Thermostat. UOKBD estimated that a 1,000 m^2 (10,764 ft^2) thin-film array could be installed on the upper surface, yielding a solar electric generating capacity of 15 kW. This was twice the power needed for operating the Thermostat hot air system (fans, heaters and related equipment). Excess electrical energy would be stored in silver-zinc batteries.



Ural OKBD "Heliostat" version of the disk-shaped Thermostat, with thin-film PV arrays on the top of the gas envelope. Source: Aircraft of the Ural OKBD

Stratospheric airship

In 1986, DZ Bimbat proposed using unmanned, solar-powered airships to conduct long-duration patrols in the upper atmosphere. The lenticular airship design had a non-rigid helium gas envelope. An internal suspension system supported a control gondola containing the mission equipment. The airship was designed to patrol an area with a radius of 10 km (6.2 miles) from a designated geostationary point.

General characteristics of the Ural OKBD stratospheric airship

Parameter	1986 Stratospheric airship
Envelope diameter	46 m (151 ft)
Envelope height	14.7 m (48.2 m)
Envelope volume	18,500 m^3 (653,321 ft^3)
Power system	Hybrid solar electric system with batteries to support operation at night.
Payload	800 kg (1,764 lb)
Speed, operating	60 kph (37 mph)
Altitude, operating	15,000 m (49,213 ft)
Endurance	30 days

8. The last projects

In 1990, DZ Bimbat becomes the director of the Ural research and production company "Aerotransstroy". In the 1990s, Ural OKBD produced only two flying airship models:

- Ural-4 (aka MIASS-1): This was an unmanned, small-volume "ecology service" airship commissioned by the Central Design Bureau of Rocket and Space Systems (Miass).

Ural-4 / MIASS-1. Source: Yuri Druzhinin, DZ Bimbat bio.

- Ural-5: This is the previously described 20 m^3 (706 ft^3) model of a double-hull airship implemented as a broad horizontal wing, commissioned by the Krylo Design Bureau in Omsk, where it was flight tested on a tether.

The last work of DZ Bimbat was the development in 2007 of a draft design of an experimental patrol and assembly airship with a carrying capacity of 3 metric tons (3.3 tons) for Sverdenergomash LLC.

DZ Bimbat died on 6 July 2008.

9. For more information

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- Alastair Reid, "Russian Airships – An Illustrated History in English," 2016, self-published and available thru Lulu: https://www.lulu.com/it/it/shop/alastair-reid/russian-airships/paperback/product-1km4n9zw.html?page=1&pageSize=4

<u>Videos</u>

- "Airships (1984)," Documentary No. 39665, 2 parts (19:17 minutes total, in Russian), Sverdlovsk Newsreel Studio: https://www.net-film.ru/en/film-39665/
- "The Hyperboloid of Engineer Garin," (1:41:00 / 101 minutes, in Russian), YouTube: https://www.youtube.com/watch?v=Ns4ZXPpKXxU

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