Aerosmena hybrid thermal airships

Peter Lobner, updated 11 February 2022

1. Introduction

Russian engineer and visionary Orpheus (Orfey) Kozlov and aeronautical media expert Sergei Bendin founded the Aeroplatform Initiative Design Bureau AEROSMENA (AIDBA) in autumn, 2015. As the Chief Designer for the Aerosmena airship (or "aeroplatform" as a more exact name by this type of hybrid lighter-than-air craft), Kozlov continued the development of lenticular (lens-shaped) hybrid thermal (Rozier) airship construction in Russia, building on the "air ballasting" principle developed for the Thermoplane (1980s – 1992) and LocomoSkyner (2005 – 2012) airships. Sergei Bendin promoted the Aerosmena project to investors and gained official state support. After the death of Kozlov in July 2020, Mr. Bendin became CEO of ADIBA and head of the Aerosmena aeroplatform project.

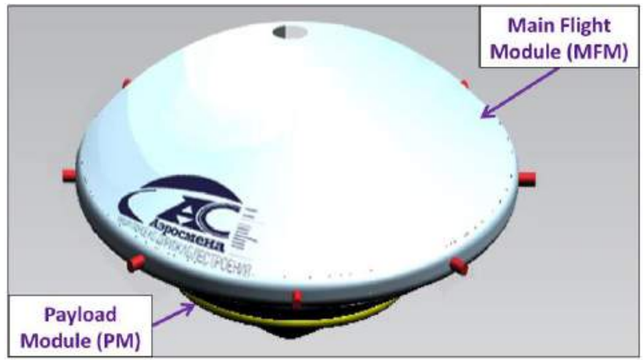
AIDBA's long-term goal is to build a family of aeroplatforms for transporting payloads ranging from 20 to 600 metric tons (22 to 660 tons). The aeroplatforms will create door-to-door logistics links between suppliers (factories, warehouses) and distant end-users, including those in communities in remote regions with poor or no roads or other reliable transportation infrastructure. Replaceable Payload Modules (PMs) enable Aerosmena aeroplatforms to be configured for a wide range of other missions, including disaster relief, environmental protection, fire fighting, military and various special operations.

AIDBA completed its initial research and development work in 2017. The 20 metric ton payload A20 will be the prototype for the entire Aerosmena family of aeroplatforms. The temporary Aerosmena website is here: https://t404t9.wixsite.com/aerosmena

Special thanks to AIDBA CEO Sergei Bendin for his thoughtful input for this article.

2. Basic design features

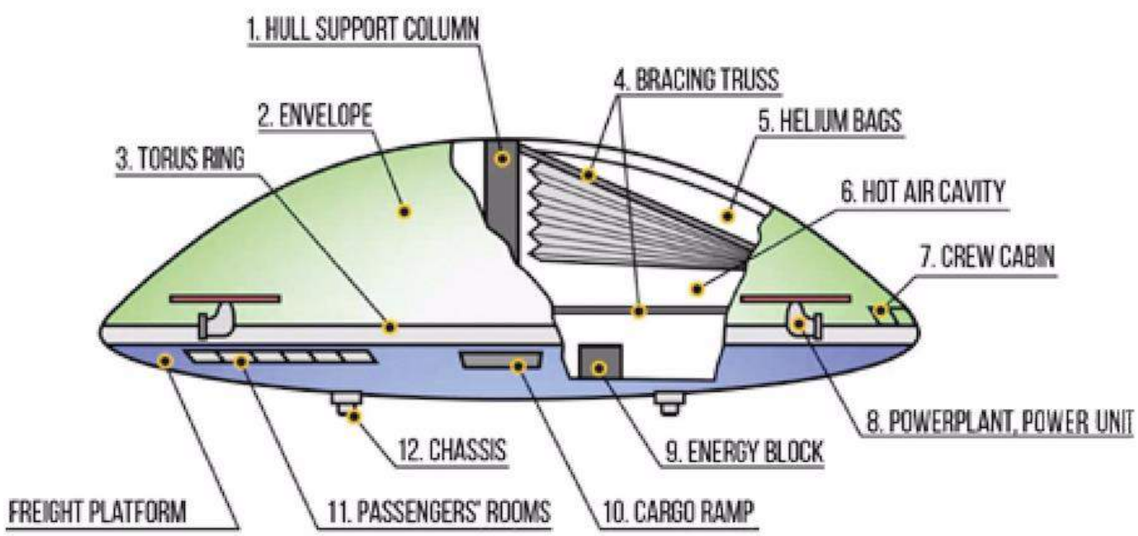
All AIDBA aeroplatforms consist of two modules, the Main Flight Module (MFM, which is the piloted airship) and the replaceable Payload Module (PM, which is mission-specific). All aeroplatforms have some common design features, which are described below.



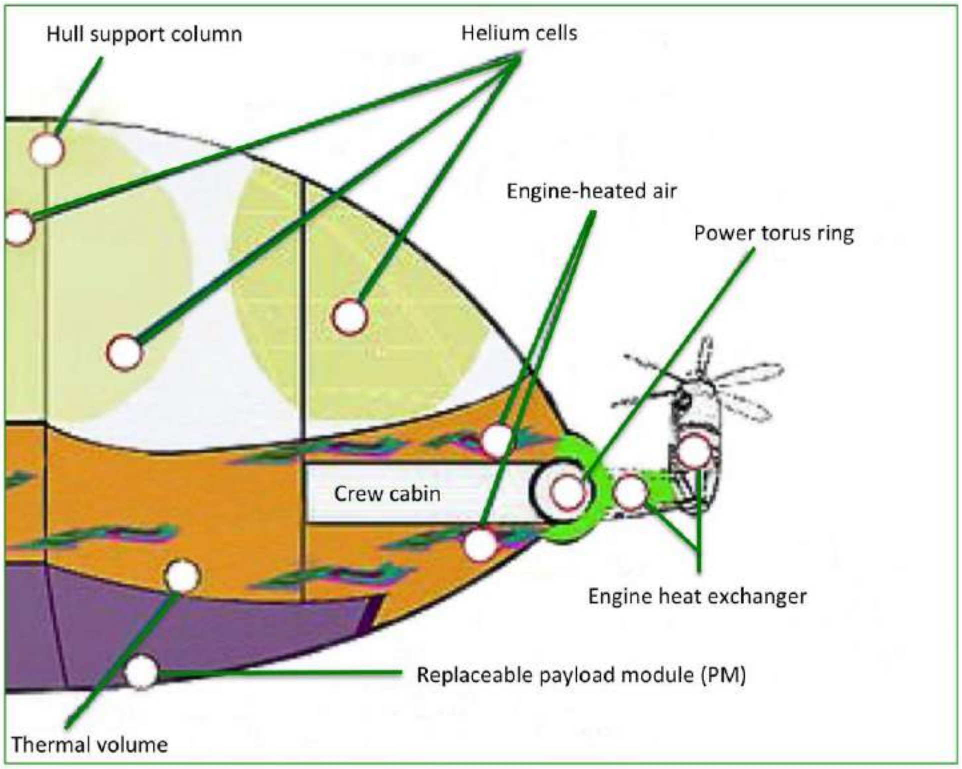
Source: AIDBA

Variable buoyancy control

Aerosmena is a variable buoyancy rozier-type hybrid gas-thermal airship. Aerostatic lift is produced by the combined buoyancy of a fixed amount of helium lift gas and hot air with variable temperature in separate chambers inside the hull. This is called "thermal ballasting". With helium alone, an unloaded Aerosmena aeroplatform is heavy by 5% - 10% of total mass. Takeoff requires additional aerostatic lift from hot air and/or propulsive lift from thrust vectoring propulsors.



General arrangement of an Aerosmena aeroplatform. The rigid hull structure includes the central hull support column, the torus ring around the periphery & the internal bracing trusses. Source: AIDBA



Internal details showing the engine and heat exchangers in the hot air supply system. Source: adapted from AIDBA

The dome-shaped upper hull (the "cupola") is divided into eight sectors, each containing one helium lift cell. The pressure in the helium cells does not exceed atmospheric pressure by more than 0.3% to 0.5%.

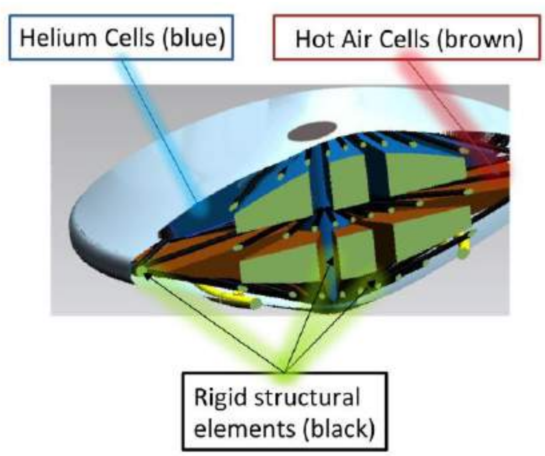
The lower level of the hull also is divided into eight sectors, each containing one hot air chamber made of heat resistant material. The hot air chambers can be heated to 200°C (392°F) via heat exchangers that capture exhaust heat from the gas turbine engines used for propulsion. From a cold condition, preparing for takeoff takes about 15 minutes. Some of the hot air is directed by inside channels into the cupola of the envelope where the helium cells are located.

The Aboard Smart Control System (ASCS), designed within the Russian aerospace industry, coordinates the variable buoyancy control and engine management functions that enable load exchanges to be conducted from a hover as follows:

- **To pick up a load**: The neutrally buoyant aeroplatform hovers and connects to a load on the ground. Then the air in the thermal volume is rapidly heated to increase gross lift enough to establish positive buoyancy at the higher gross weight. The loaded aeroplatform ascends and proceeds to the delivery site.
- **To unload cargo:** At the destination, the neutrally buoyant loaded aeroplatform hovers precisely over the delivery site. The load is lowered to the ground, but initially, all of the load is still supported by the aeroplatform. The ASCS decreases buoyancy to transfer the weight of the load to the ground. This is done by venting hot air from the thermal volume and replacing it in the correct proportions with cooler ambient air. When the weight is fully transferred to the ground and the unloaded aeroplatform is trimmed for neutral buoyancy, there will be slack in the support cables, which then can be safely disconnected from the cargo. Then the aeroplatform can ascend and proceed to its next destination.

Rigid structure and semi-rigid envelope of the Main Flight Module (MFM)

The MFM has a load-bearing, rigid structural skeleton formed by the central hull support column, the "general torus" ring around the periphery of the hull and internal bracing trusses made of light alloys or carbon fiber composite material. This rigid internal framework resembles a bicycle wheel with a "wheel rim" (the torus), "spokes" (the trusses) and a "wheel hub" (the support column) at the center. The interior of the cupola-shaped upper segment of the hull is divided into sectors by eight load-bearing arched "power trusses." The torus ring is a continuous composite structure around the widest point of the hull. It is connected to the internal bracing trusses and serves as the rigid structure for mounting various mechanisms and systems (i.e., the engines and hot air heat exchangers).



Source: adapted from AIDBA

The outer envelope is a durable semi-rigid structure that is supported by the rigid, load-bearing, arched power trusses. The outer envelope protects the internal structures from environmental influences, and establishes the aerodynamic shape of the aeroplatform. With some hot air flowing through the interior of the cupola, the upper part of the outer envelope is heated too, creating a "warm regime" that prevents or removes snow / ice accumulations.

Replaceable payload modules (PMs)

Replaceable PMs allow you to quickly change the functionality of the aeroplatform for different missions. This can improve the overall utilization of MFM.

Examples of replaceable Payload Modules (PMs). Source: AIDBA

In the above diagram, the flat cargo PM (left) has a loading ramp for roll-on-roll-off (Ro-Ro) loading of containers, trucks, road machinery, bulk construction material, etc. The housing / office PM (middle) is a multi-story structure that can be configured to serve as a tactical command post, civil defense accommodations, a hospital, temporary lodging for a remote site, or a sky hotel for long distance tours on the aeroplatform. The fire fighting PM (right) contains water supplies and distribution / water cannon systems for fighting large fires (forest fire, petrochemical fire). This PM also includes pumps for refilling the onboard storage tanks with water from any nearby source.

The payload module is suspended from, and locked onto, the rigid internal cross-truss structure of the MFM. Module replacement is expected to take less than an hour. An installed PM does not touch the surrounding hot air chambers.

Thrust vectoring propulsion and flight control system

Propulsion and propulsive lift are provided by eight variable speed, reversible, thrust vectoring propulsors with large helicopter-style rotors. These are installed on pylons attached to the power torus ring and evenly spaced around the perimeter of the aeroplatform.

Representative hull layout showing the pylon-mounted propulsors. Source: AIDBA

The Aboard Smart Control System (ASCS) is the integrated flight control system that coordinates operation of the individual thrust-vectoring propulsors and the buoyancy control system throughout the flight envelope, including during hover and in-flight load exchanges.

The aeroplatform is designed for vertical takeoff and landing (VTOL) and hovering operations and can fly in any direction without rotating around its vertical axis.

Aerodynamics

The lenticular rigid hull functions as a wing and generates aerodynamic lift in forward flight.

The symmetrical hull reduces sensitivity to changing wind directions. The ASCS improves longitudinal stability in these conditions.

Ground support

Traditional airship mooring equipment, large landing sites and large ground crews are not required. The aeroplatform has landing gear and can operate from small undeveloped fields, such as remote construction sites. It also can make a water landing.

An unloaded Aerosmena aeroplatform is heavy by 5% - 10% of total mass when the hot air system is shut down. In this condition, it can be parked on the ground without tethers at wind speeds up to 25 m/s (55.9 mph). At higher wind speeds, the aeroplatform can be tethered to the ground or the vectoring propulsors could be activated to produce a stabilizing downforce. In extreme conditions, the eight sectors of the outer envelope can be “folded”, thereby opening the inner structure to airflow and reducing the force of the wind on the hull.

No hangar is required. The semi-rigid envelope, supported by the rigid internal structure, provides protection from the weather.

Payload handling

Bulky, oversized cargo (too large for the internal cargo bay) can be carried on an external sling with loading and unloading while hovering above the destination. Winches are installed in the payload bay, supported from the rigid internal truss structure.

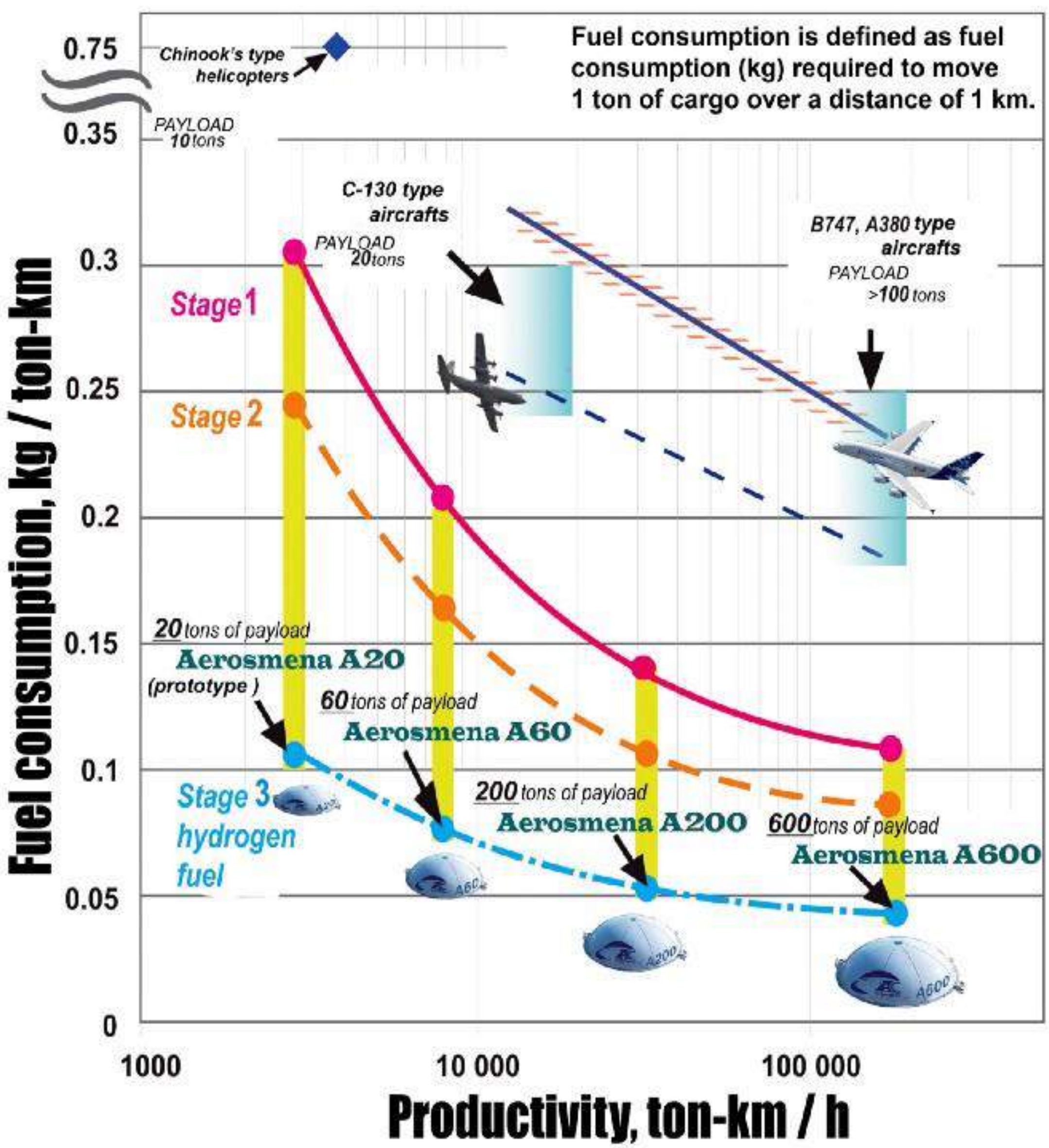
For example, a whole manufactured building could be delivered for installation directly onto a prepared foundation. The ASCS enables precise positioning while hovering with the load attached.

Cargo pickup and delivery to stationary or underway ships at sea can be accomplished.

3. The planned production aeroplatforms

AIDBA's long-term goal is to build a family of multi-mission aeroplatforms with 20, 60, 200 and 600 metric ton payload capacities.

The following AIDBA chart summarizes the expected economic productivity of Aerosmena aeroplatforms. Stage 1 has a conventional propulsion system, Stage 2 has a hybrid propulsion system, Stage 3 uses hydrogen fuel and generates zero CO_2 emissions.



Source: AIDBA

General characteristics of AIDBA aeroplatforms

AIDBA aeroplatforms	**A20 (Prototype)**	**A60**	**A200**	**A600**
Hull diameter	70 m (229.7 ft)	110 m (360.9 ft)	180 m (590.6 ft)	246 m (807.1 ft)
Hull thickness, max	25 m (82.0 ft)	80 m (262.5 ft)	90 m (295.3 ft)	102 m (334.6 ft)
Loading area diameter	50 m (164.0 ft)	100 m (328.1 ft)	130 m (426.5 ft)	132 m (433.1 ft)
Envelope volume	100,000 m^3 (3,531,500 ft^3)	212,000 m^3 (7,486,700 ft^3)	600,000 m^3 (21,188,800 ft^3)	2,500,000 m^3 (88,286,700 ft^3)
Cargo area height	5 m (16.4 ft)	8 m (26.2 ft)	12 m (39.4 ft)	12 m (39.4 ft)
Cargo module replacement time	15 min	30 min	45 min	60 min
Takeoff weight	25 metric tons (27.5 tons)	150 metric tons (165 tons)	1,000 metric tons (1,100 tons)	1,500 metric tons (1,650 tons)
Payload	20 metric tons (22 tons)	60 metric tons (66 tons)	200 metric tons (220 tons)	600 metric tons (660 tons)
Speed, max	100 kph (62.1 mph)	150 kph (93.2 mph)	170 kph (105.6 mph)	170 kph (105.6 mph)
Speed, cruise	90 kph (55.9 mph)	130 kph (80.8 mph)	150 kph (93.2 mph)	150 kph (93.2 mph)
Takeoff time at full load	20 min	22 min	25 min	30 min
Range, max	1,000 km (621 mles)	2,500 km (1,553 miles)	5,000 km (3,107 miles)	6,000 km (3,728 miles)
Ferry range, without cargo	1,500 km (932 miles)	3,000 km (1,864 miles)	5,000 km (3,107 miles)	8,000 km (4,971 miles)
Altitude, max	3,000 m (9,843 ft)	5,000 m (16,404 ft)	7,000 m (22,966 ft)	7,000 m (22,966 ft)
Wind speed, max	25 m/s	30 m/s	35 m/s	35 m/s
Annual flying hours, max	5,000 hrs	7,000 hrs	7,200 hrs	8,000 hrs
Operating temp range	-60 to +50 ºC (-76 to 122 ºF)	-60 to +50 ºC (-76 to 122 ºF)	-60 to +50 ºC (-76 to 122 ºF)	-60 to +50 ºC (-76 to 122 ºF)
Crew	2	2	4	6

Source: AIDBA

A20 prototype and utility aeroplatform

The 20-metric ton (22-ton) payload A20 will be the prototype for the entire Aerosmena family. This 70-meter (230 ft) diameter utility aeroplatform can be configured for a variety of missions, such as:

- Passenger or cargo transport with loader crane
- VIP lounge for sporting events
- Flying headquarters and observation point
- Mobile medical outpatient unit
- Mobile workshop
- Local fire fighter

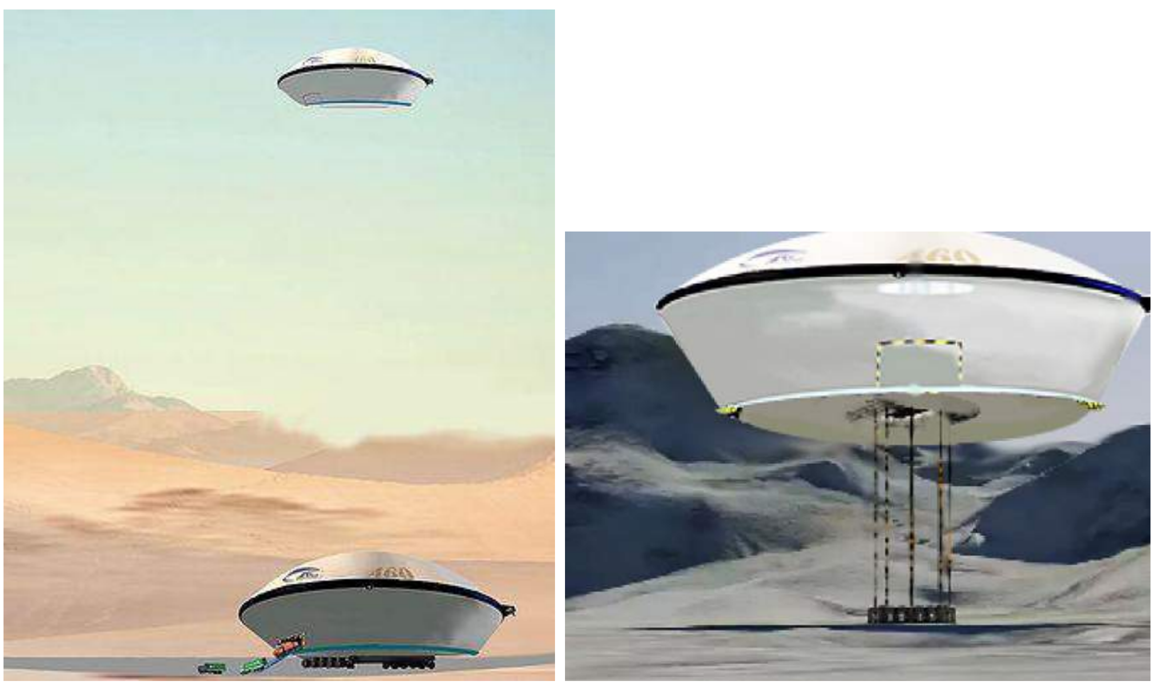
Renderings of A20 in flight. Source, both graphics: AIDBA

A60 short-haul transport aeroplatform

This 110-meter (361-ft) diameter multi-purpose transport is designed to carry a 60-metric ton (66-ton) payload. Potential applications include:

- Passenger transport
- Cargo transport for containers and bulk solid, liquid or gaseous freight
- Firefighting / rescue system
- Mobile workshop to repair heavy equipment
- Mobile hospital block
- Flying luxury hotel / corporate or private yacht.

The minimum landing zone needs to be at least 120 m (394 ft) in diameter (just a bit bigger than the aeroplatform itself). AIDBA expects the cost for the A60 project, from development to certification, to be about $120 million.



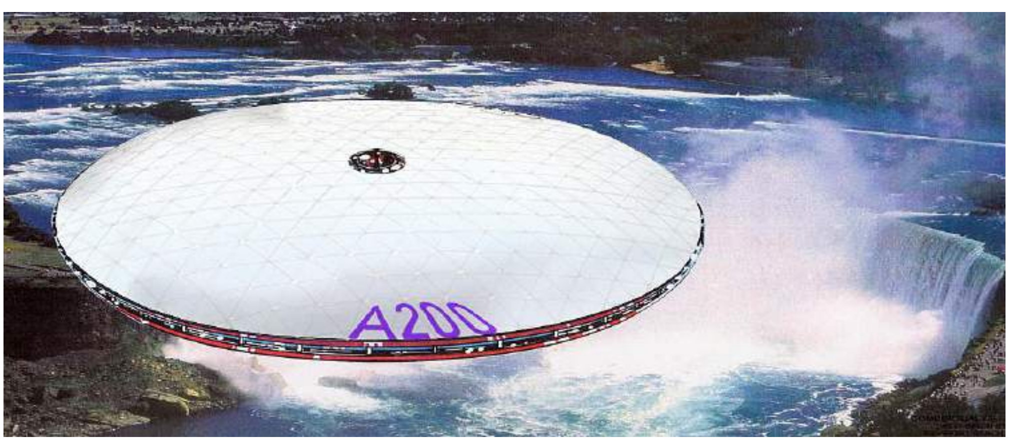
A60 short-haul transports making deliveries to remote sites.
(Left) Unloading vehicles from a cargo PM.
(Right) Unloading cargo from a hover, without landing.
Source, both graphics: AIDBA

A200 medium range transport aeroplatform

Rendering of an Aerosmena A200. Source: AIDBA

This 180-meter (591-ft) diameter aeroplatform can carry a 200-metric ton (220-ton) payload for a variety of missions, such as:

- Tourist flights at scenic destinations
- Aerial drone carrier
- Bulk cargo carrier for various solid, liquid and gaseous cargo
- Fire fighting / rescue system
- Support construction and installation operations
- Mobile workshop to repair heavy equipment in remote locations
- Mobile power supply unit
- Flying luxury hotel / corporate or private yacht



Rendering of an Aerosmena A200 configured for tourism.
Source: AIDBA

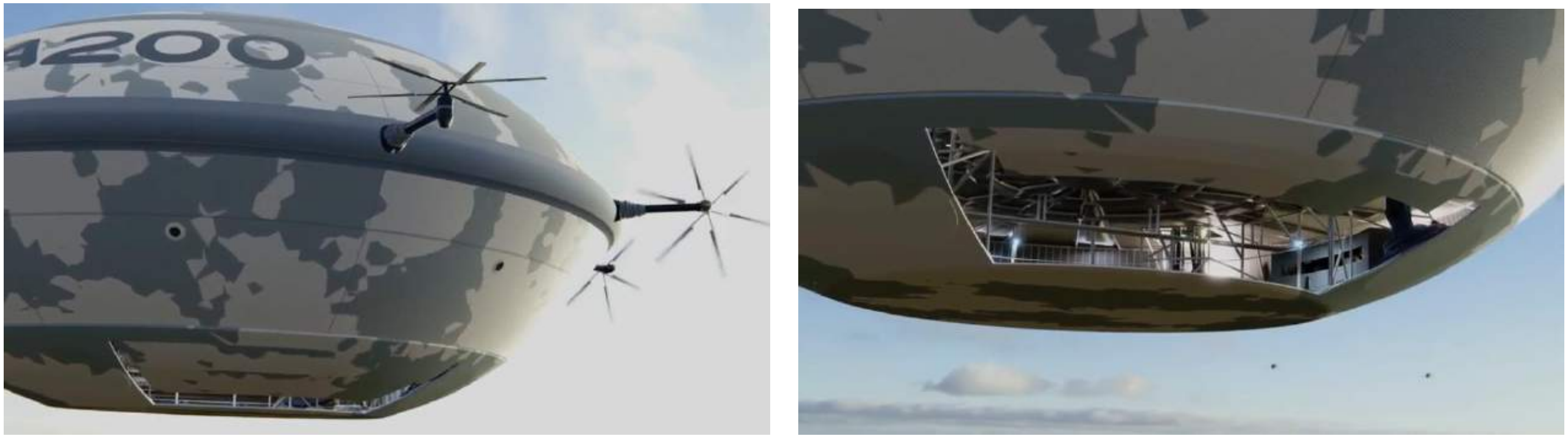
AIDBA notes that the A60 and A200 are well suited for a fire fighting role. An A200 will be able to fill on-board tanks with water from any natural or artificial basin in hovering flight in about 40 minutes. If conditions over the fire permit, the water can be delivered accurately a zero airspeed. Water cannons can be used to direct the spray.

Renderings of an A200 fighting a forest fire with a bulk water drop (left) and directional water cannons (right). Source: AIDBA

AIDBA expects the cost for the A200 project, from development to certification, to be about $150 million.

An A200 can be employed as a flying “aerobase” for UAVs that are launched from the airship to carry out a combat mission on the "last mile," at a distance of tens of miles from the launch point. After completing their missions, all surviving UAVs return to the aerobase either to leave the battle area or renew their combat ammunition load and execute another mission. An A200 airship operating as an aerobase is depicted in a 2021 animated video at the following link: https://www.youtube.com/watch?v=AcMwUYnkNB0

Rendering of an A200 drone carrier in flight with the door to internal drone bay open.
Source: Screenshot from 2021 AeroCrat video



A200 drone bay door opening (left) and drone launch from internal drone bay (right).

A200 internal drone bay details (left) and drone recovery (right).
Source, all graphics: Screenshots from 2021 AeroCrat video

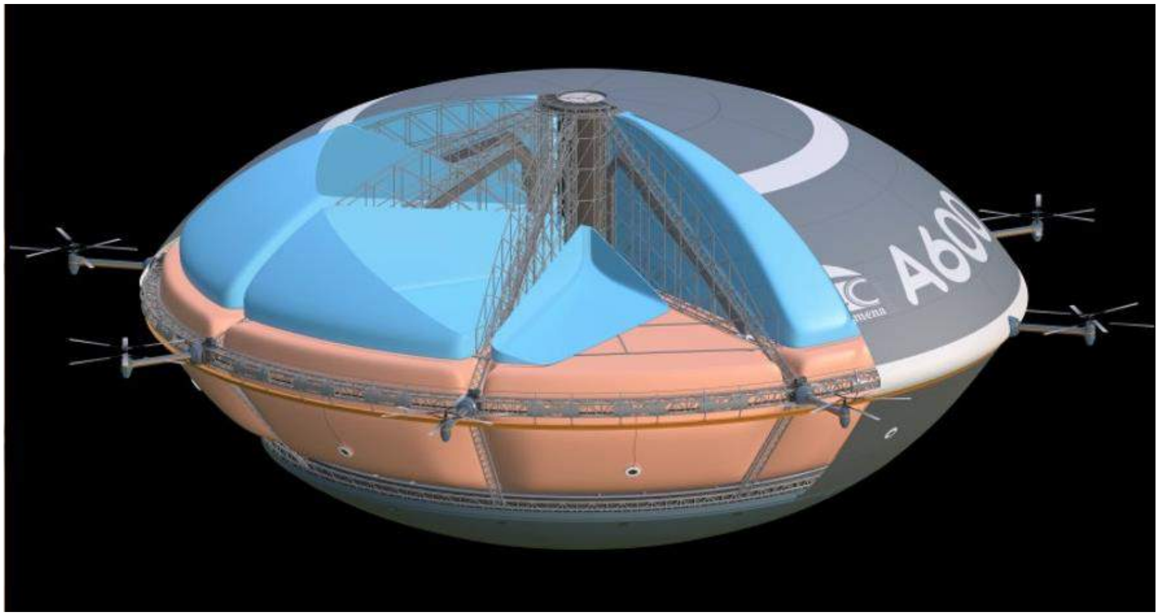
A600 long range heavy transport

This is the largest of the Aerosmena aeroplatforms, a truly massive aeroplatform with a hull diameter of 246 meters (807 ft) and an envelope volume of 2.5 million cubic meters (88.2 million cubic feet), more than 12 times the volume of the Hindenburg. It is designed to carry a 600 metric ton (660 ton) payload.

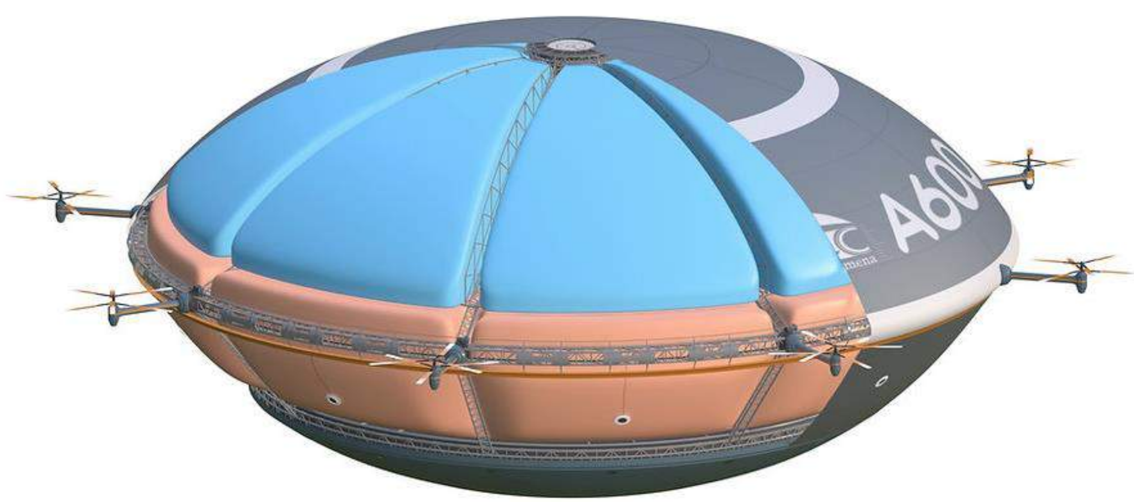
Rendering of the heavyweight Aerosmena A600 with an early propulsion system configuration. Source: ADIBA, image designed by Mario Merino Alegre

Like the smaller Aerosmena aeroplatforms, this is a multi-mission platform that can take on new missions because of its great size and lifting capacity. In addition to being a heavy freight transporter, other potential roles include:

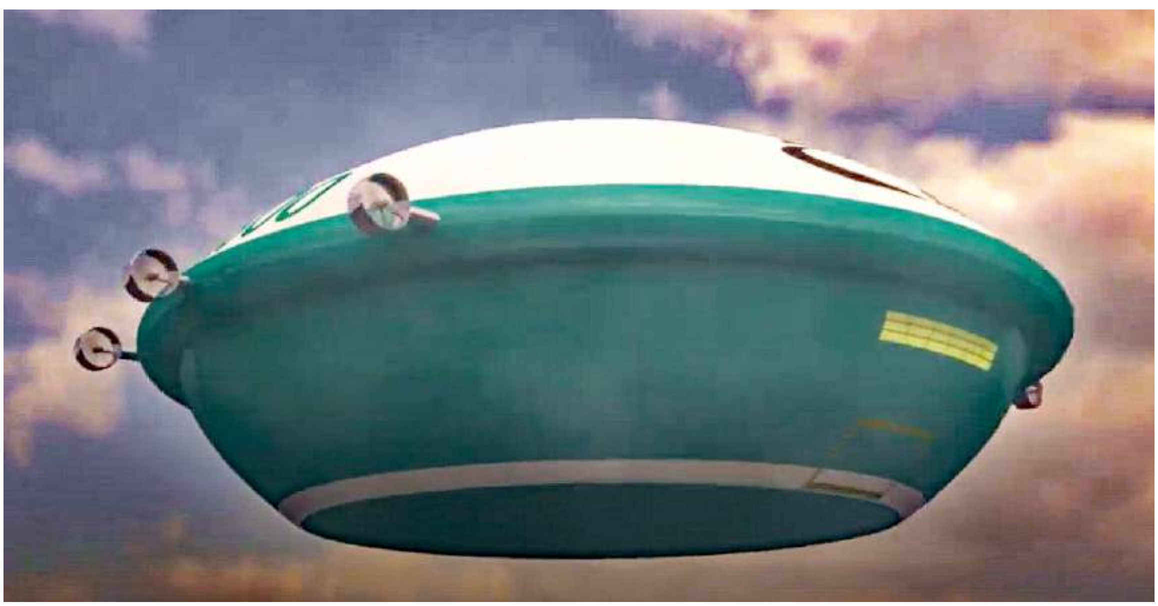
- Aircraft and drone carrier
- Rocket / spacecraft launch vehicle
- Support construction and installation operations
- Fire fighting / rescue system
- Military transport (delivery a complete large military unit with its vehicles and supplies)



A600 cut-away drawing showing the primary internal structures: the central support column, the radial bracing trusses, and the circumferential torus ring, which supports the propulsion units. The lifting gas cells (blue) and the hot air cells (ochre / reddish color) are installed in the sectors between the bracing trusses. Source: AIDBA (2021)



A600 with the outer shell pulled back to show the placement of lifting gas cells (blue) and the hot air cells (ochre / reddish color). Source: AIDBA (2021)



Renderings of the heavyweight Aerosmena A600 with an early propulsion system configuration. Source, both graphics: AIDBA, image designed by Mario Merino Alegre

In 2020, AIDBA announced plans to launch their 600 metric ton payload A600 aeroplatform program in 2024. However, the continuing global pandemic and its effect on the global economy have temporarily weakened the potential market for the A600. As a consequence, the launching of this Aerosmena project is being postponed.

AIDBA expects the cost for the A600 project, from development to certification, to be about €400 million (about $482 million). The cost to manufacture a single A600 aeroplatform is expected to be about US $90-95 million, while the cost of producing a series of them would reduce the per-unit cost to around $70 million.

Rendering of an A600 handling cargo from a hover, at sea.
Source: AIDBA

Rendering of the Aerosmena A600 on the ground.
Source: AIDBA (2021)

Rendering of the Aerosmena family of airships: A20, A60, A200 and A600. Source: AIDBA

4. For more information

- "Russia will have flying saucers: so will its peculiar airships for passengers and goods," The Canadian, 31 March 2021: https://thecanadian.news/2021/03/31/russia-will-have-flying-saucers-so-will-its-peculiar-airships-for-passengers-and-goods/
- Chris Young, "Is that a UFO? No, It's a 600 Ton-Capacity Russian Cargo Airship," Interesting Engineering, 19 March 2021: https://interestingengineering.com/ufo-russian-cargo-airship
- Juergen Bock, "The Flying Saucer – Concept for an Economical, Ecological and Operational Aerial Carrier," Naval Airship Association, Noon Balloon, No. 103, pp. 22 – 26, Fall 2014: https://650a8e8c-0be3-466b-9728-1ece39a725e3.filesusr.com/ugd/fbd712_f7e489836ce44a1ca852984814a90e4a.pdf
- "Russian airship set to fly in 2022," Aeroplatform, Vol. 11, No. 9, September 2019: https://twitter.com/v_bendin/status/1182782057258389509/photo/1
- "African Pilot - Aerosmena," 1 December 2019: https://www.pressreader.com/south-africa/african-pilot/20191201/281543702765723
- Thelma Etim, "Why Russia's latest cargo airship project is not just hot air," AirCargoEye, 7 March 2020: https://aircargoeye.com/russias-cargo-airship-not-just-hot-air/
- "Aerosmena's "UFO" shaped airship aiming for 2024 launch," FINN – The Aviation Industry Hub, 30 October 2020: https://www.wearefinn.com/topics/posts/aerosmenas-ufo-shaped-airship-aiming-for-2024-launch/
- Chris Young, "Is that a UFO? No, It's a 600 Ton-Capacity Russian Cargo Airship," Interesting Engineering, 19 March 2021: https://interestingengineering.com/ufo-russian-cargo-airship

Videos

- "AEROSMENA cargo airship project by Orfey Kozlov chief designer of the Aerosmena Initiative DB," (0:44 minutes), AeroCrat Concept, 11 July 2020: https://www.youtube.com/watch?v=GsejJOxrHWo

- "Russian project of the multifunctional aeroplatform Aerosmena: military version A200 mobile aerobase," (1:02 minutes), Aero Crat, 22 April 2021: https://www.youtube.com/watch?v=AcMwUYnkNB0

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    - Thermoplane - hybrid thermal airships
    - LocomoSky - hybrid thermal airships
    - Thermo-Skyships Ltd. (TSL) - hybrid thermal airships
    - Boeing - hybrid thermal airship
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