Tumenecotrans BARS and Bella-1 semi-buoyant aircraft

Peter Lobner, updated 8 March 2022

1. Introduction

A unique aviation project undertaken in the 1980s – 1990s by Russian engineer and chief designer Alexander Filimonov, JSC Tumenecotrans (http://www.tumenecotrans.ru/index2.html) and the Siberian Scientific Research Institute of Aviation (SibNIIA) produced a semi-buoyant, fixed-wing, hybrid aircraft named BARS (Airfieldless Aircraft with Aerostatic Unloading). This air vehicle combines positive attributes of an airship (aerostatic lift), an airplane (aerodynamic lift, high speed, long range), a helicopter (propulsive lift), and a hovercraft (ground effect air cushion). The general configuration of a BARS aircraft is shown in the following figure. The helium lift gas cells are in the thick, circular center section of the fuselage.

Model of a hybrid vehicle BARS (circa mid-1990s)

2. BARS operational characteristics

A semi-buoyant BARS aircraft is a heavier-than-air vehicle. On the ground, it has the stability a conventional fixed wing aircraft. The air cushion landing system provides mobility on unprepared surfaces as well as on an airport runway. Like a conventional aircraft, a BARS can be taxied between the runway and its parking spot or hanger without the need for a ground crew. In light wind, it does not need to be tethered like an airship. However, in some higher wind conditions, BARS would need to be secured to the ground or ballasted (i.e., with cargo) to maintain stability.

BARS has extreme short takeoff and landing (STOL) capabilities using its air cushion landing system to operate from any unprepared flat surface (water, swamp, snow, soil) or conventional runway. After a short takeoff run, the combination of aerostatic lift, propulsive lift, and increasing aerodynamic lift gets BARS quickly into the air. Propulsive lift in secured when no longer needed during cruise flight, when BARS flies much like a conventional aircraft. Aerostatic lift reduces the power requirements in all flight modes (climb, cruise, descent).

BARS flies a conventional landing approach, except that the propulsive lift system enables the aircraft to fly a relatively slow, steep approach. The air cushion system is operating for touchdown and it enable BARS to taxi and move off the runway.

Basic features of a BARS aircraft are summarized below:

- High speed: up to 300 kph (186 mph); much faster than airships and most helicopters
- Long range: much longer range than helicopters
- Large load carrying capacity: scaleable up to 500 metric tons (550 tons); able to carry much greater loads than helicopters and most airships and aircraft
- Can make a short takeoff and landing (STOL) from any flat surface: ground, water, marsh, snow, ice, or conventional airstrip

- Able to operate without a ground crew; more like an aircraft or helicopter than an airship
- Good cross-wind stability on the ground; much like a conventional aircraft
- High efficiency / lower cost of transportation; lower cost per ton-mile than helicopters

3. The BARS patents

Filimonov's concept for the BARS off-airfield aircraft with aerostatic unloading is addressed in the following three patents:

- Russia, patent 2092381C1, "Hybrid airship"
- USA, patent N 5909857A, 'Filimonov's hybrid dirigible craft"
- European patent EP0861773A4

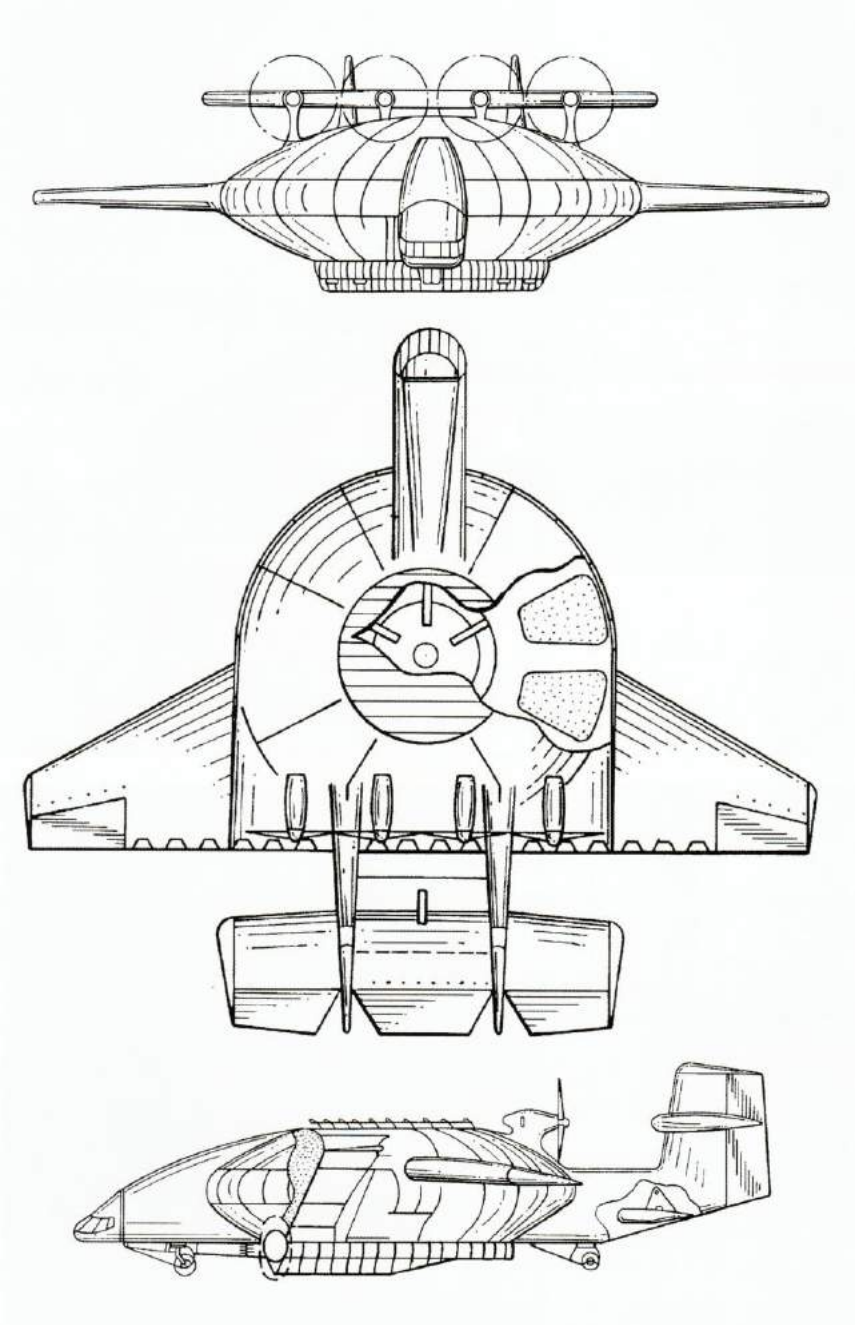
In his patents, Alexander Filimonov described the design features of a much larger BARS aircraft, with a gross weight of 350 metric tons (383 tons).

Parameter	350 tonne BARS aircraft
Length	145 m (475.7 ft)
Wingspan	140 m (459.3 ft)
Height	40 m (131.2 ft)
Takeoff mass	350 tonnes (386 tons)
Empty mass	100 metric tonnes (110 tons)
Payload	200 tonnes (220 tons) / 800 passengers
Cruise speed	200 kph (124 mph)
Ceiling	3,000 m (9,843 ft)
Range at max load	3,000 km (1,864 miles)

Tumenecotrans identified the following potential applications for a large BARS aircraft:

- Construction and repair of pipelines
- Timber processing and moving
- Servicing oil and gas fields

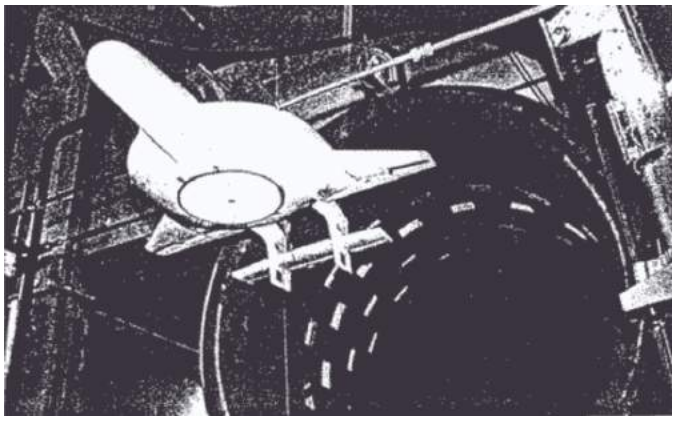
- Fighting wild fires: After landing on the nearest body of water, the craft fills its water tanks and can return quickly to fighting the fire
- Agricultural works
- Removing pollutants from a water surface with a cleaning device lowered from the craft



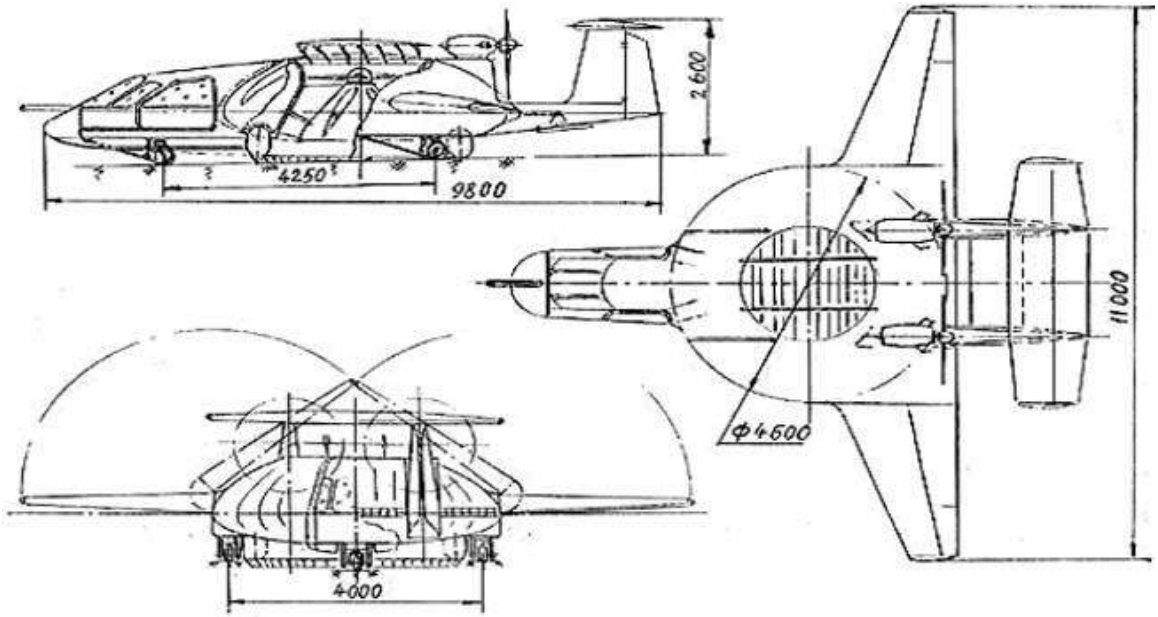
BARS three-view drawing. Source: Russian Agency for Patents and Trademarks (1997) via Bill Rose, Flying Saucer Technology (2011)

4. Bella-1 prototype

In 1987, Alexander Filimonov secured State funding for JSC Tumenecotrans to build a prototype, which became known as *Bella-1*. The aircraft had three engines; two externally-mounted engines drive the two pusher propellers for propulsion, and one internally-mounted engine drives the vertically-mounted ducted lift fan in the center of the fuselage. Shutters on the inlet to the lift fan modulate the lift produced by the lift fan.



Wind tunnel tests began in 1989 and the prototype was completed in 1994. Source: Tumenecotrans



General arrangement of Bella-1. Source: Tumenecotrans

Bella-1 inside its hangar.
Source, both photos: Tumenecotrans

General characteristics of Bella-1

Parameter	Bella-1
Length	10 m (32.8 ft)
Wingspan	11 m (36.1 ft)
Height	2.6 m (8.5 ft)
Takeoff mass	2,000 kg (8,818 lb)
Empty mass	1,100 kg (2,425 lb), no fuel, crew, payload
Payload	600 kg (1,323 lb)
Accommodations	1 or 2 pilots, 5 to 6 passengers
Propulsion	2 x Teledyne Continental 10-360-ES @ 210 shp (156.6 kW) each
Lift	1 x Teledyne Continental 10L-200 @ 110 shp (82.0 kW) driving a 1.8 m (5.9 ft) lift propeller
Cruise speed	250 kph (155 mph)
Ceiling	3,000 m (9,843 ft)
Range at max load	1,000 km (621 miles)
Ferry range, 2 x pilots	3,000 km (1,864 miles)

Above: Bella-1 general arrangement. Note wings folded (right).
Below: Bella-1 cockpit. Source, all photos: Tumenecotrans

Ground tests began in 1995 at the Ulianovski Avia Industrial Complex.

Bella-1 operating from water. Source: Tumenecotrans

Bella-1 operating on snow. Source: Tumenecotrans

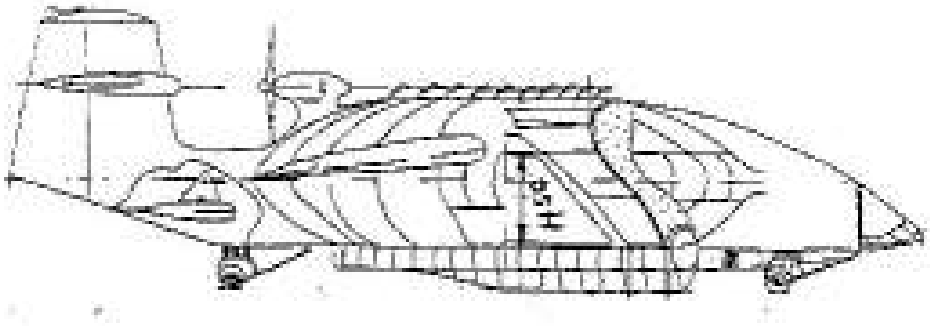
Bella-1 in flight. Note the hovercraft-style skirt under the aircraft and the skis on the tricycle landing gear to assist landing on unprepared surfaces. Source, both photos: Tumenecotrans

While *Bella-1* proved capable of STOL flight and operation on snow, ice and water, the program was terminated, likely due to the weak Russian economy after the breakup of the former Soviet Union in 1991. It appears that *Bella-1* was put in storage.

5. Third Dimension project “rescue sloop” & “hybrid micro RVK”

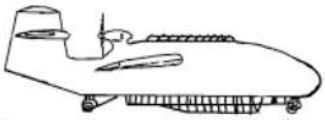
The Russian Tretye Izmereniye (Third Dimension) project (http://ngsw.ru) is leading the development of a concept for a “New Great Silk Road” cargo transportation route across Russia using very heavy lift airships (RVKs) as the primary transport vehicles. The RVKs are based on the SHa-3500 rigid airship designed by Vyacheslav Shalavyev (Shalaev).

In connection with this “New Great Silk Road” concept, a Bella-1-type semi-buoyant aircraft was proposed as a “manned, highly maneuverable aeronautical rescue sloop-boat” that was intended for emergency rescue operations along the transportation routes flown by the very heavy lift RVKs.



“Sloop boat.” Source: Russian Aeronautical Transport Company

In addition, a small, highly-maneuverable, unmanned “micro RVK” version of a BARS semi-buoyant aircraft was proposed to fly autonomously or under the control of a remote operator while providing general security services in the vicinity of the airship ports.



“Micro RVK.” Source: Russian Aeronautical Transport Company

As shown in the following diagram, each RVK was equipped with two landing platforms on the upper outer and inner lower decks for landing a rescue vehicle or a micro RVK.

Giant SHa3500 RVK airship with landing stations for a Bella-1 type rescue sloop and a micro RVK.
Source: Russian Aeronautical Transport Company

See my separate article on the Third Dimension project for more information on these Tumenecotrans semi-buoyant vehicles.

7. For more information

- "Tumenecotrans company presents off-airfield aircraft BELLA-1," 2002: http://www.tumenecotrans.ru/index2.html
- "Unmanned Aircraft: Terminology, Classification, Current State," Subsection 1.2.2.5, "UAV of aerostatic type," (in Russian), 2012: https://arsenal-info.ru/b/book/3398882726/12
- Bill Rose, "Flying Saucer Technology," pp. 121 -124, Ian Allan Publishing Ltd., UK, ISBN 978-1-857803-31-0, 2011

BARS Patents

- Russian patent RU2092381C1, "Hybrid airship," Inventor: Alexandr Filimonov, application filed 31 October 1995, granted 10 October 1997: https://patents.google.com/patent/RU2092381C1/en?oq=RU2092381C1

- US patent US5909857A, “Filimonov hybrid dirigible craft,” Inventor: Alexandr Filimonov, application filed 8 April 1998, granted 8 June 1999: https://patents.google.com/patent/US5909857A/en?oq=5909857
- European patent EP0861773A4, "Dirigeable hybride de filimonov," (“Hybrid-starrluftschiffe von filimonov,” application filed 7 October 1996, granted 22 March 2000: https://patents.google.com/patent/EP0861773A4/fr

The Third Dimension project

- "New Great Silk Road" (in Russian), Russian Aeronautical Transport Company: http://ngsw.ru/index.php/sredstvo-osushchestvleniya#rvk

Other *Modern Airships* articles

- *Modern Airships - Part 1*: https://lynceans.org/all-posts/modern-airships-part-1/
- *Modern Airships - Part 2*: https://lynceans.org/all-posts/modern-airships-part-2/
    - Third Dimension Project
- *Modern Airships - Part 3*: https://lynceans.org/all-posts/modern-airships-part-3/