Airship Industries Ltd.

Peter Lobner, updated 6 November 2024

1. Introduction

The life cycle of the UK firm Airship Industries, with its many linkages to predecessor and successor firms, is a complex tale that is outlined step-by-step in this section.

Aerospace Developments (1970 – June 1979)

Jeffrey R. (Roger) Munk and John Wood founded the UK firm Aerospace Developments (AD) in 1970 and the giant Shell methane gas transporter rigid airship became the firm's first major project until it was cancelled in 1974. You'll find details on this novel airship project in my separate article on the Shell-AD methane gas transporter.

In 1975, Roger Munk reported that AD was examining the business potential for "nonrigid, advanced technology airships in the half to ten ton payload range" for "general freight, surveying and airborne jeep" applications. A year later, Venezuelan company Aerovision had signed a contract with AD to construct and deliver in 1977 the first airship from an order for 22 airships, in a range of sizes and payload capacities, that would be delivered over a period of 10 years. The business plan was for airship production to start in the UK and be transferred later to Venezuela.

Starting in 1976, AD developed and built its first blimp, designated AD500, which now generally is credited as being the first modern blimp because it introduced the use of vectored thrust propulsors, modern envelope materials, and lightweight composite materials in various structural components (monocoque gondola, nose cap, tail fins). The AD500 was assembled at Cardington and made its first flight on 3 February 1979. A month later, it was severely damaged while moored outdoors during a sustained windstorm. AD's Venezuelan sponsor, Aerovision, subsequently withdrew its financial support, forcing the liquidation of AD assets on 8 June 1979.

Airship Developments, Ltd. (September 1979 – May 1980)

In September 1979, Roger Munk founded the firm Airship Developments, Ltd. (another "AD") and acquired the liquidated assets of his former AD firm, including the AD500 design and the damaged airship, which was not rebuilt. Between 1979 and 1980, "new" AD built on "old" AD's previous work for Aerovision and developed ambitious plans for the following family of nonrigid airships:

- **AD15**: a small remotely piloted surveillance vehicle with an envelope volume of 150 m^3 (5,300 ft^3)
- **AD100**: a small utility blimp with an envelope volume of 1,000 m^3 (35,000 ft^3)
- **AD500**: a rebuilt version of the original AD500 prototype, which had an envelope volume 5,153 m^3 (182,000 ft^3)
- **AD600**: an enlarged AD500 with an envelope volume of 6,000 m^3 (210,000 ft^3)
- **AD5000**: an extremely large airship with an envelope volume of 50,000 m^3 (1,800,000 ft^3) and a payload capacity of over 20 metric tons (22 tons). Had it been built, this would have been the largest nonrigid airship in the world, with about 22% greater envelope volume than the U.S. Navy's Goodyear ZPG-3W that retired from service in 1962.

Munk's AD firms had been involved with the UK firm Mercantile Airship Transportation Limited (MAST) and its successor, Thermo-Skyships Limited (TSL), since about 1976. In May 1980, TSL acquired Munk's second "AD" firm for £1 million.

Airship Industries Ltd. (May 1980 – September 1990)

A goal for this acquisition was to form a single firm that was large enough to produce a large rigid airship and a smaller nonrigid airship. In July 1980, TSL changed the name of the newly merged firm to Airship Industries Limited (AI).

During the next two years, AI resources were divided between nonrigid and rigid airship projects. Roger Munk led the development of the Skyship 500 nonrigid airship, which was based on the AD500 and made its first flight on 18 September 1981.

Meanwhile, the AI rigid airship team, under Major Malcolm Wren, was developing designs for two quite different, large rigid airships:

- **R40 / R130** (two designations for the same airship): a conventional rigid airship with a metal framework hull and a fabric envelope enclosing lift gas cells at atmospheric pressure.
- **R150:** a metal-clad rigid airship with a metal framework hull.

While there was significant interest from FedEx and Redcoat Air Cargo, no contracts were placed for rigid airships.

Development of Wren's Thermo-Skyship hybrid thermal airship ended during this period. You'll find more information on this airship in my separate article on Thermo-Skyships Ltd. (TSL).

Airship Industries was in significant financial difficulty in 1982. While the firm worked to restructure its debt, it benefitted from investments from several sources. A 1983 United Nations Industrial Development Organization (UNIDO) report described AI's financial situation as follows:

> "The Royal Bank of Canada has invested in the company and Economic Regional Wallone (ERW), a Belgian regional development agency, has acquired 4% of the equity capital. Negotiations with ERW on a major £3 million investment, worth 39% of the present equity capital, are in progress, as are discussions with a number of other First World governments. In July 1982, the European Energy Commission awarded the company a grant of £313,000 for the demonstration of the fuel efficiency of the Skyship 500."

In late 1982, a "de-merger" was agreed, and the former TSL rigid airship technical and management team left AI to form Wren Skyships, Ltd. on the Isle of Man with, of course, Malcolm Wren serving as Managing Director. Their focus was on developing the

R.30 and the RS.1 metal-clad rigid airships. You'll find more information in my separate article on Wren Skyships Ltd.

The remainder of the AI staff continued under Roger Munk's leadership and focused on the development and sale of the nonrigid Skyship 500, 500HL and 600 airships. AI manufactured some Skyships at Cardington, while others were manufactured in Toronto, Tokyo and in the USA. A total of 16 Skyship airships were manufactured between 1980 – 1990. This team also developed design concepts for several other larger nonrigid airships.

Westinghouse–Airship Industries (WAI) (1985 – September 1990)

In early 1985, AI teamed with Westinghouse and formed Westinghouse–Airship Industries (WAI) to bid on a U.S. Navy contract to design and develop the giant Sentinel 5000 (military designation YEZ-2A) airborne early warning (AEW) airship. On 5 June 1987, the WAI team won the competition for the Sentinel 5000 and was awarded a $168.9 million contract to build a subscale Operational Development Model (ODM), which became known as the Sentinel 1000. On this team, AI was responsible for the airship and Westinghouse was responsible for the AEW systems and other mission systems. If the Sentinel 1000 ODM was successful, the team expected an order for 40 to 50 production Sentinel 5000 airships.

After successfully developing the military version, AI planned to develop a civilian passenger version known as the Skyship 5000.

The Sentinel 5000 project did not go smoothly. The Navy funded the program for only two years before funding was cut from the fiscal year 1989 defense budget. Congress later authorized continuing funding via the Defense Advanced Research Projects Agency (DARPA) to enable work on the Sentinel 1000 ODM to continue.

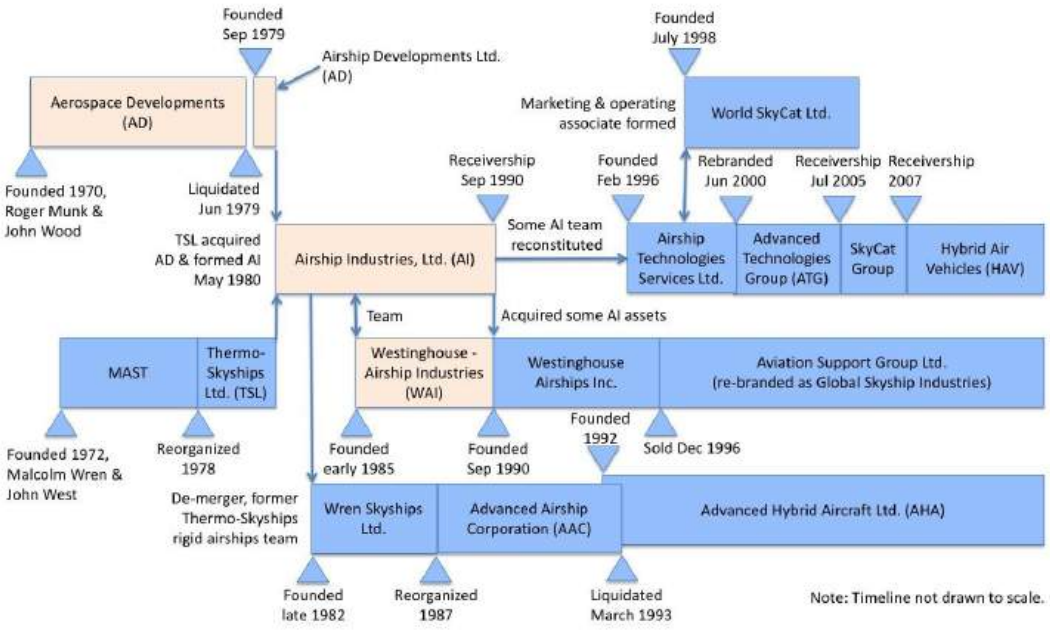
After three successive years of financial losses, Airship Industries ceased trading on the stock exchange in August 1990 and went into receivership in September 1990, resulting in the end of Airship Industries and the WAI partnership.

After the collapse of Airship Industries in 1990

Westinghouse regrouped, hired the former AI team members, and formed a new entity, Westinghouse Airships Inc. (also known as WAI), to execute the balance of the Sentinel contract and complete the Sentinel 1000 ODM airship. As part of the business settlement with Airship Industries, Westinghouse acquired rights to military variants of the Skyship airships.

UK firm Slingsby acquired rights to the civil versions of the Skyship 500, 500HL and 600, except in North America where Airship International held those rights as the appointed agent. The rights held by Airship International subsequently passed to the firm Airship Management Services (AMS). The 500HL and 600 type certificates held by Slingsby were acquired by Westinghouse in 1993.

When the U.S. Navy's Sentinel airship project was cancelled in late 1995, Roger Munk and former AI team members left Westinghouse Airships Inc. and formed Airship Technologies Services Ltd. in February 1996. This firm was rebranded in June 2000 as Advanced Technologies Group (ATG), which became well known primarily for two advanced airship projects: the SkyCat hybrid, heavy-lift airship and the StratSat stratospheric High Altitude Platform (HAP) for telecommunications. ATG also built and flew the small AT-10 high-technology blimp and developed the design concept for the Condor medium altitude surveillance airship derived from the SkyCat hybrid airship design.



Roadmap to airship firms managed or strongly influenced by M.W. Wren and Roger Munk, highlighting AD and Airship Industries.

This article is organized as follows:

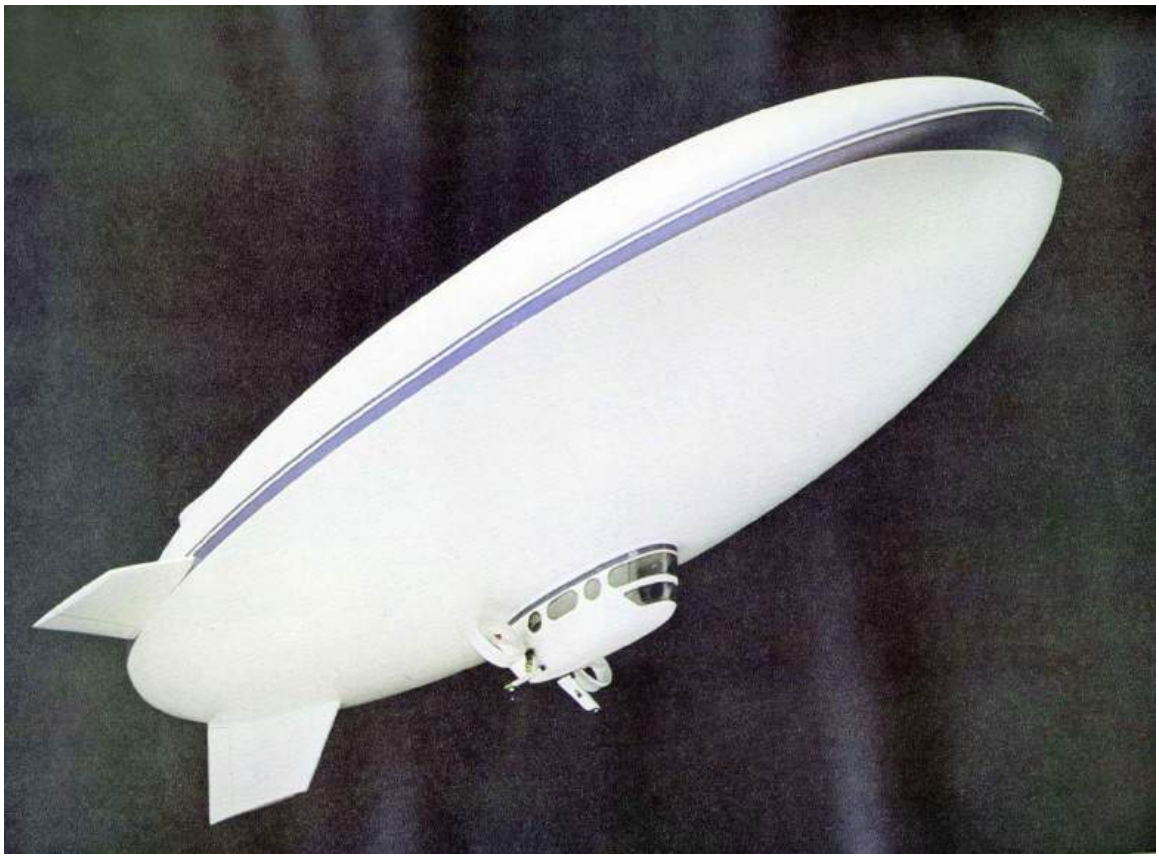
- Section 2: AD500 modern blimp prototype
- Section 3: R40 / R130 conventional rigid airship design concepts
- Section 4: R150 metal-clad rigid airship design concept
- Section 5: Series-produced Skyship 500, 500HL and 600 blimps
- Section 6: AI's larger Skyship design concepts
- Section 7: Westinghouse - Airship Industries (WAI) team for the U.S. Navy's Sentinel 1000 and 5000 (YEZ-2A) program thru 1990
- Section 8: AI's design concepts for derivatives of the U.S. Navy's Sentinel 5000

The conclusion of the U.S. Navy's Sentinel program, from 1990 to 1995, is covered in a separate article on the U.S. Navy's YEZ-2A program.

2. The Aerospace Developments AD500

Design work on the nonrigid AD500 blimp started in 1976. This blimp generally is credited with being the first modern blimp because it introduced several important features that have become commonplace in modern airships:

- Vectored thrust propulsors
- Modern envelope materials (lightweight skin of polyester and polyurethane with an inner Mylar gasproof membrane)
- Lightweight composite material structures (gondola, nose cone, tail fins)
- Kevlar suspension cables supporting the gondola



AD500 concept drawing, circa 1976. The gondola windscreen and the shrouded propellers were considerably revised in the as-built airship.
Source: Airship Heritage Trust

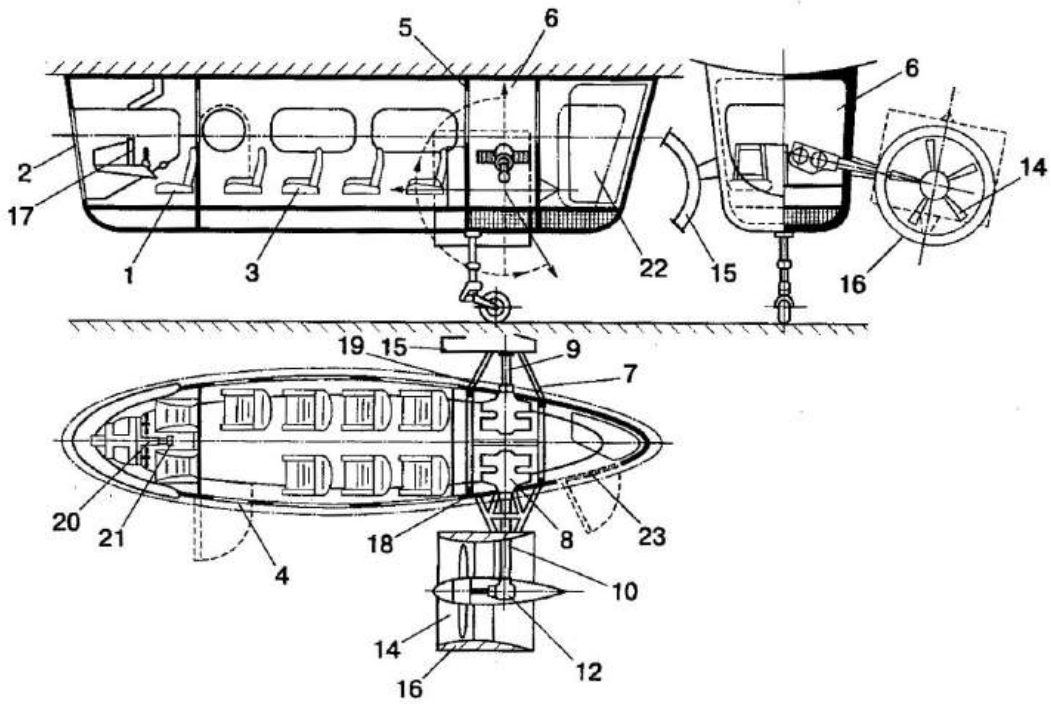
AD500 (G-BECE) on a mobile mast outside the Cardington sheds.

The ducted fans are supported from the gondola on fixed “stub wing” pylons. During cruise flight, the ducted fans are aligned horizontally (0◦) to provide forward propulsion. The ducted fans can be tilted up or down in the pitch plane, over a range from +90º (up) to -120º (down), to provide dynamic thrust while maneuvering during takeoff and landing, even while the airship is slightly light or heavy.

Source, both photos: Airship Heritage Trust

The 9.1 m (30 ft) long composite, monocoque gondola was manufactured by Vickers–Slingsby from molded Kevlar-reinforced plastic.

Source: Airship Heritage Trust



Legend: 1 - pilot's seat; 2 – windshield; 3 - passenger seats; 4 – cabin door; 5 - bulkhead-partition; 6 - engine compartment; 7 & 8 - engines; 9 & 10 - transmission shafts; 11 & 12 – reduction gear; 13 & 14 - five-bladed fans; 15 & 16 — fan shrouds (fairings); 17 - pilot's steering wheel, 18 & 19 - electric generators; 20 & 21 - engine controls; 22 - fuel tank; 23 – hatch to aft compartment

AD500 gondola configuration. Source: Boyko (2001)

General characteristics of the AD500 blimp

Parameter	AD500
Length, overall	52.0 m (170.6 ft)
Diameter, max.	14.0 m (45.9 ft)
Envelope volume	5,153 m^3 (182,000 ft^3)
Ballonet volume	1,280 m^3 (45,202 ft^3), 25% of envelope volume in two ballonets, fore & aft
Propulsion and maneuvering	2 x Porsche air-cooled engines rated @ 152 kW (204 shp), installed inside the gondola driving 2 x thrust vectoring (90° up, 120° down), shrouded 5-bladed, reversible propellers, attached via stub wings to the gondola.
Total aerostatic lift	5,160 kg (11,376 lb)
Disposable lift	1,930 kg (4,255 lb)
Gondola dimensions	9.1 L x 2.4 W meters (30.0 L x 7.9 W ft)
Accommodations	2 crew and 8 passengers
Speed, max	101 kph (63 mph)
Speed, cruise	87 kph (54 mph) @ half-power
Altitude, max	3,050 m (10,000 ft) pressure altitude
Range	870 km (540 miles), still air
Service life	8 years

AD500 1st flight. Source: Airship Heritage Trust

The AD500 was assembled in Hangar #1 at Cardington and, on 3 February 1979, G-BECE made its first flight with a vectored thrust takeoff at a steep angle.

A month later, after a test flight in windy conditions on 8 March 1979, the AD500 was severely damaged by sustained high winds while moored outside during a storm. The airship suffered damage to the nose cone and gondola and Roger Munk deflated the envelope by operating a previously untired “emergency rip” feature. The efforts to save the airship during the storm are described in detail on the Airship Heritage Trust website here: https://www.airshipsonline.com/airships/AD%20500/index.html

AD’s Venezuelan sponsor, Aerovision, subsequently withdrew its financial support. In spite of very promising performance during early flight testing of their airship, AD was forced into liquidation on 8 June 1979.

Recovering the AD500 gondola after the storm.
Source: Airship Heritage Trust

3. R40 / R130 conventional rigid airship design concept

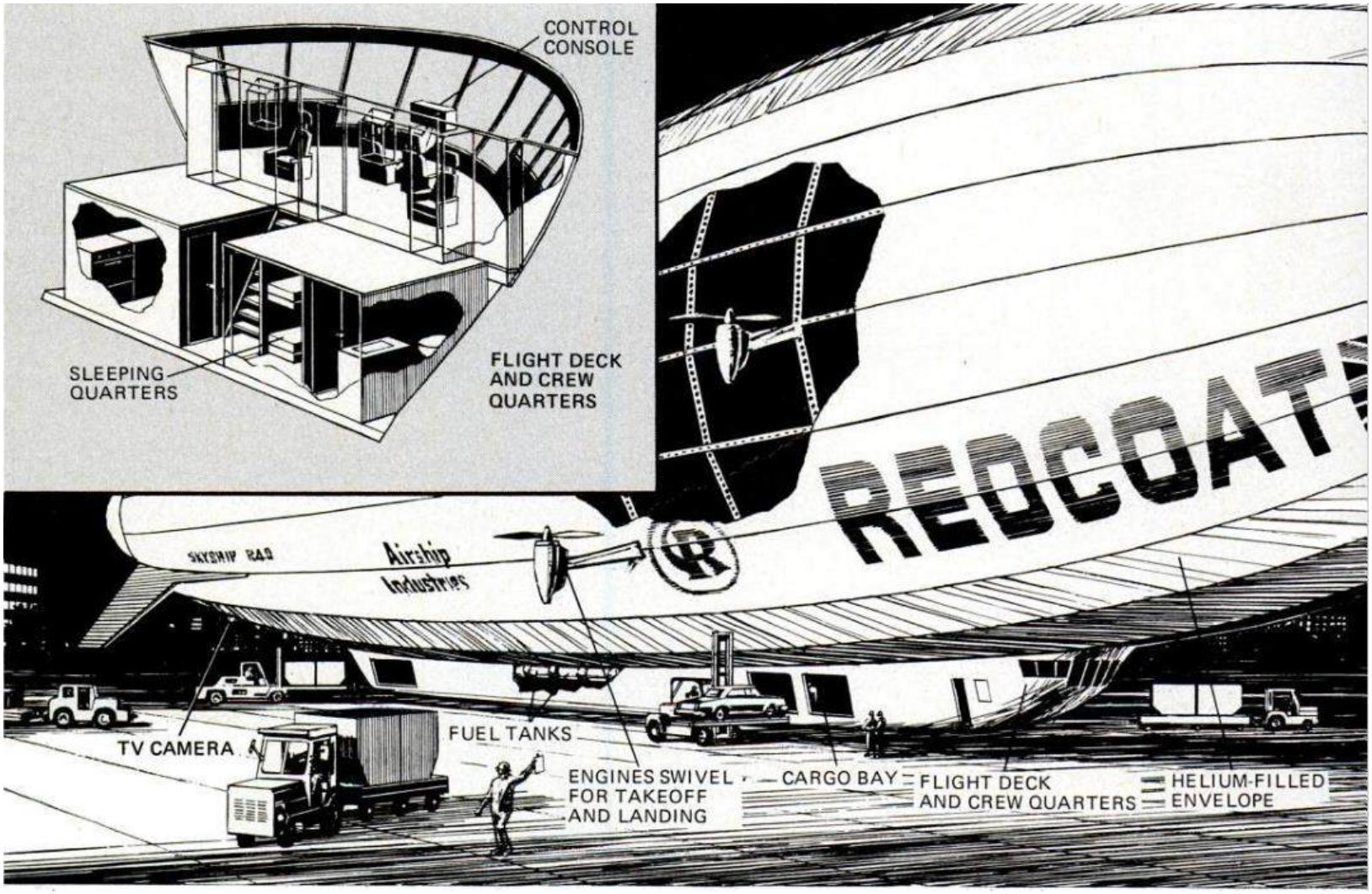
In July 1980, AI announced plans for the civilian freight-carrying R40 / R130 rigid airship (two different designations appear to have been used for the same airship). Redcoat Air Cargo, a small UK cargo carrier, proposed acquiring four R40 / R130 airships by 1984.
The R40 / R130 was a conventional rigid airship design with a metal framework hull structure and a fabric envelope enclosing lift gas cells at atmospheric pressure.

General characteristics of the R40 / R130 conventional rigid airship

Parameter	**R40 / R130**
Type	Conventional rigid, fabric envelope
Length, overall	183 m (600 ft)
Diameter, max	36.6 m (120 ft)
Hull volume	120,000 m^3 (4,200,000 ft^3)
Internal pressure	Atmospheric
Propulsion	4 x Pratt & Whitney Canada PT6-50 turboprop engines rated @ 846 kW (1,135 shp) each.
Cargo compartment volume	1,170 m^3 (41,318 ft^3)
Payload, max	58 metric tons (63.8 tons)
Speed, max	137 kph (85 mph)
Operating altitude	900 m (2,953 ft)
Range	• 800 km (497 miles) with max. payload • 3,200 km (1,988 miles) with a 45 metric ton (49.5 ton) payload

Redcoat Air Cargo switched their acquisition plans from the R40 / R130 to the R150 metal-clad rigid airship.

Rendering of Airship Industries R40 conventional rigid airship. Source: Abbot & Walmsley (1998)



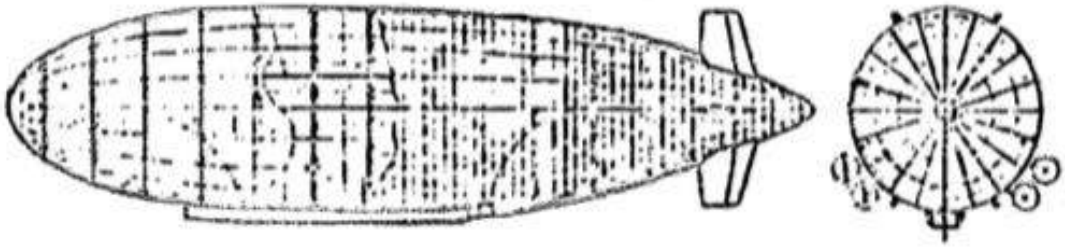
Airship Industries R40 conventional rigid airship in Redcoat Air Cargo livery.
Source: Popular Mechanics, May 1981

4. R150 metal-clad rigid airship design concept

The R150 design was initiated in the early 1980s. This was a design concept for a large, metal-clad, rigid airship for civilian cargo applications and military applications such as strategic airlift, anti-submarine warfare (ASW), surveillance and patrol. It was similar in concept to the successful U.S. Navy ZMC-2 metal-clad rigid airship built and first flown in 1929 and operated until 1939.

In a metal-clad airship, the sheet metal envelope is part of the monocoque load bearing structure that also serves as the gas-tight container for the helium lifting gas. There are no soft fabric or synthetic lift gas cells, as found in a conventional rigid airship. A slight internal helium pressure places the metal hull in tension, enabling it to carry greater bending and shear loads during flight.

Areas of the hull carrying concentrated loads (i.e., engines and cargo) are reinforced with frames that distribute the loads and maintain the circular hull cross-section. Longerons (longitudinal structural components) maintain the hull's structural integrity when the interior is at atmospheric pressure.



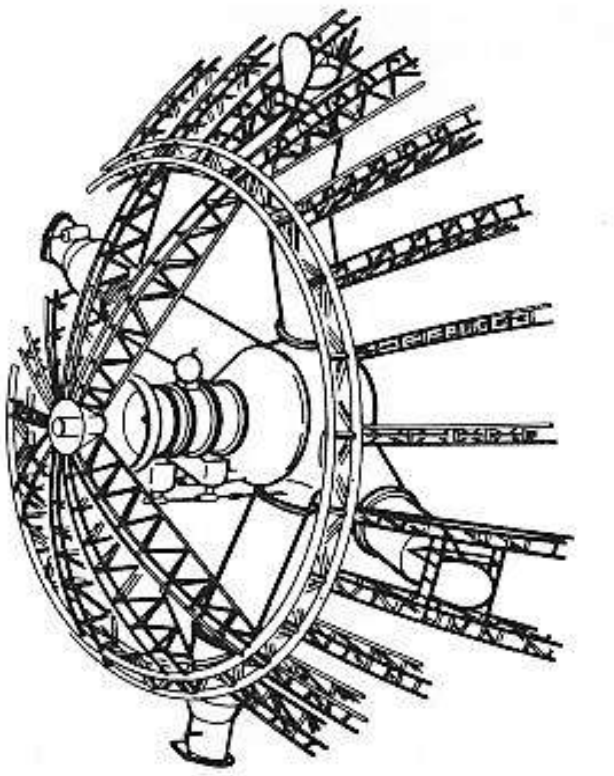
R150 metal-clad rigid airship general arrangement.
Source: adapted from UNIDO (1983)

Work on the R150 was initiated by the Airship Industries rigid airship team headed by Major Malcolm Wren in response to requirements laid out by Redcoat Air Cargo. A 1983 UNIDO report described these requirements:

> "Redcoat's requirements specified that the airship should be able to carry a payload up to 75 (metric) tons over 1,000

nautical miles, or 46 (metric) tons over 4,000 nautical miles for service to West Africa, the Middle East and Central America. The cruising speed should be variable between 63 – 85 knots – twice as fast as the fastest ocean freighters – depending on the range and application. The cargo to be carried was to range from machine parts to day-old chicks and low density cargos. The requirement also specified that the airship should be able to operate from relatively simple landing sites."

R150 main propulsion was provided by four turboprop engines installed on vectoring stub wings extending from the hull and driving 5.5 m (18 ft) diameter feathering and reversing propellers. The vectoring stub wings and engines were in a horizontal position during cruise and could be pivoted to a vertical position for takeoff and landing. A natural gas (NG) fuel option was considered, with two NG cells inside the hull envelope. This reduced fuel cost, but also reduced maximum payload.



Five-port bow thrusters.
Source: Airship Heritage Trust

During cruise, flight control would be provided by elevators and rudders on the six tail fins. At airspeeds below 20 knots, flight control was aided by bow and stern thrusters, which each have five outlets to direct thrust up or down for pitch control, port or starboard for yaw control, and fore (bow thruster) / aft (stern thruster) along the longitudinal axis. The accompanying diagram shows a similar thruster configuration designed for the Wren Skyship RS.1.

General characteristics of the R150 metal-clad rigid airship

Parameter	R150
Type	Rigid, aluminum alloy frame with aluminum alloy envelope
Length, overall	173.9 m (570.4 ft)
Diameter, max.	40.9 m (134.2 ft)
Hull volume	132,000 to 152,832 m^3 (5,397,215 ft^3)
Internal pressure	About 2 kilopascals (0.29 psi)
Lift gas volume, max	150,519 m^3 (5,316,526 ft^3)
Ballonet volume, max	21,238 m^3 (750,000 ft^3)
Propulsion and maneuvering	• 4 x Garrett TPE 331-5 turboprop engines rated @ 1,227 kW (1,645 shp) each, driving vectoring, 5.5 m (18 ft) diameter reversible propellers Total installed power: 4,908 kW (6,580 shp) • 1 x Allison 250-B28 turboshaft engine rated @ 373 kW (500 shp) driving an air compressor supplying the bow and stern 5-port thrusters
Weight, max takeoff	141,855 kg / 142 metric tons (312,736 lb / 156 tons)
Weight, disposable load	85,275 kg / 85.3 metric tons (188,000 lb / 94 tons)
Payload	44,452 kg / 44.5 metric tons (98,000 lb / 49 tons)
Weight, empty	56,307 kg (124,136 lb)
Speed, max	171 kph (92.3 knots)
Speed, cruise	164 kph (88.5 knots)
Range	Up to 21,773 km (13,529 mile)
Endurance	5 to 20 hours typical mission, 245 hours maximum

Redcoat Air Cargo and Federal Express were two potential customers for the R150. Fed Ex had discussed acquiring a “training airship” and four R150s, with an option for 10 more. Redcoat estimated that the R150 could have cut their fuel costs by about one-third.

Fed Ex shelved their airship plans in late 1981. Redcoat went into voluntary liquidation in mid-1982 due to cash flow problems. This left AI without a customer for their rigid airship designs.

When the de-merger occurred in late-1982, the R150 project was abandoned along with preliminary plans for a larger rigid airship capable of carrying a 150 metric ton (165 ton) payload. Had it been built, the R150 would have been the largest airship since the 1930s, but still 25% smaller (by volume) than the LZ-129 Hindenburg.

The newly formed firm Wren Skyships Ltd. subsequently developed designs for two smaller metal-clad rigid airships, the R.30 and the RS.1, based on the R150.

5. Series-produced Skyship 500, 500HL and 600 blimps

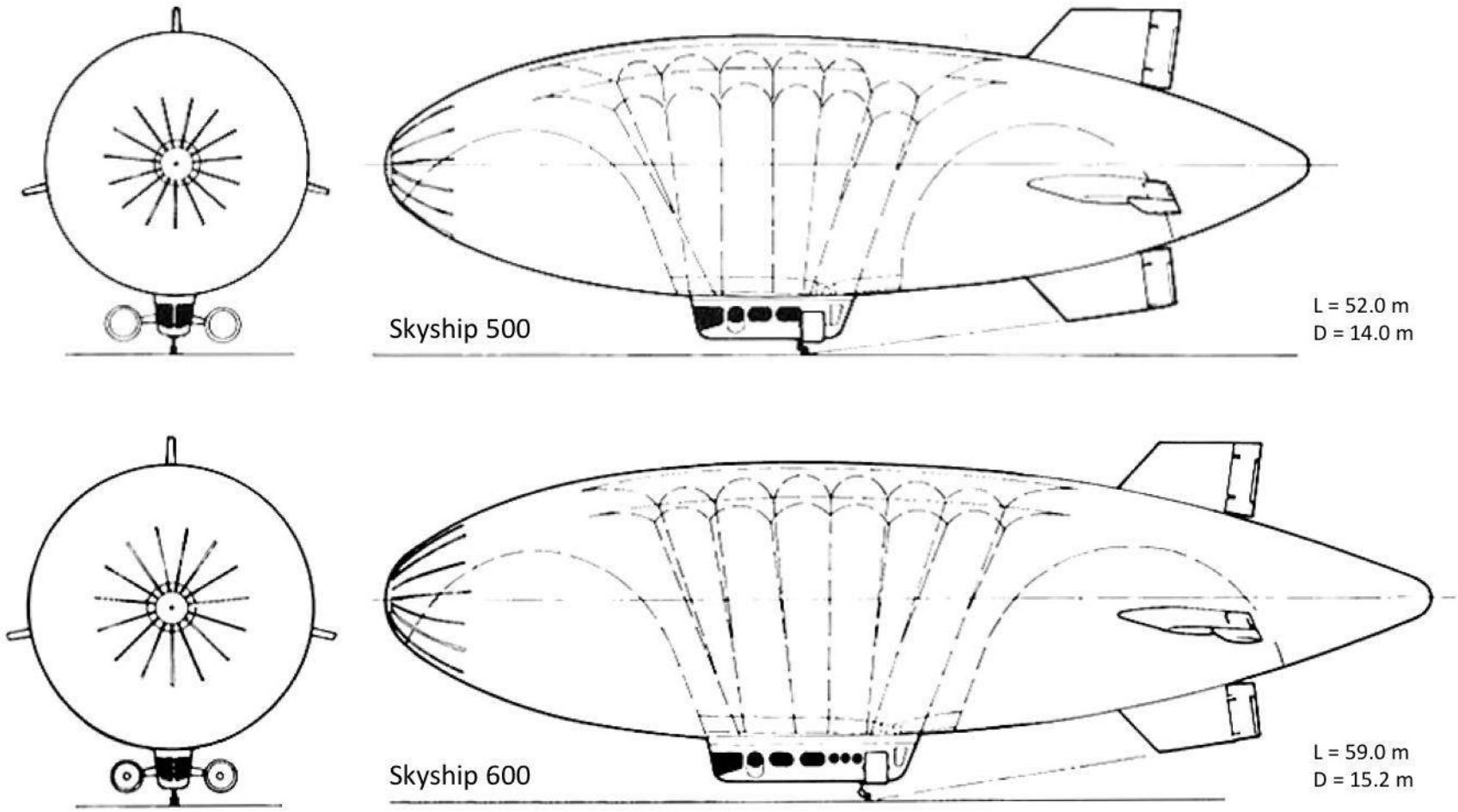
Starting in 1980, the Airship Industries nonrigid airship team, led by Roger Munk, used the AD500 prototype design as the basis for their Skyship 500 series, which was scaled up later to produce the Skyship 600 series. A total of 16 Skyship airships were manufactured between 1980 – 1990: six Skyship 500s (two were later converted to 500 HLs), one original Skyship 500 HL, and nine Skyship 600s.

First Skyship 500, G-BIHN, at Cardington. Source: Airships Online

First Skyship 600, G-SKSC, at Cardington. Source: Airships Online

General characteristics of the Skyship 500 and 600

Parameter	Skyship 500	Skyship 600
Length	52 m (170.7 ft)	59 m (193.6 ft)
Diameter, max	14 m (45.9 ft)	15.2 m (49.4 ft)
Height, overall	18.7 m (61.2 ft	20.3 m (66.6 ft)
Envelope volume	5,153 m^3 (182,000 ft^3)	6,666 m^3 (235,400 ft^3). 3% larger replacement envelopes from TCOM.
Envelope material	Polyester load carrier spray coated externally with titanium oxide impregnated polyurethane & sealed internally with polyurethane bonded Mylar gas retention film	Same as Skyship 500.
Ballonet volume	26% gross volume: 1,334 m^3 (47,110 ft^3)	26% gross volume, 1,800 m^3 (53,566 ft^3)
Max gross lift	4,500 kg (9,9901 lb)	5,900 kg (13,007 lb)
Maximum takeoff weight	4,430 kg (9,766 lb)	6,650 kg (14,661 lb)
Empty weight	3,185 kg (7,022 lb)	3,650 kg (8,047 lb)
Payload	2,000 kg (4,409 lb)	3,000 kg (6,614 lb)
Propulsion	2 x normally aspirated 6-cylinder Porsche 930/01/A1/3 engines rated @ 152 kW (204 hp) each, installed in the gondola, driving pylon-mounted, shrouded, 5-bladed Hoffmann reversible pitch propellers 1.4 m (4.5 ft) in diameter, vectorable 90° up to 120° down	2 x turbocharged 6-cylinder Porsche 930/67/AI/3 engines rated @ 190 kW (255 hp) each, with ducted propeller configuration similar to Skybus 500, vectorable 85° up to 110° down
Gondola dimensions	9.2 L x 2.4 W meters (30.3 L x 7.9 W feet)	11.7 L x 2.56 W meters (38.3 L x 8.4 W feet)
Accommodations	2 crew + 8 passengers	2 crew + 13 passengers
Speed, max	93 kph (58 mph)	92.5 kph (57.5 mph)
Speed, cruise	56 kph (35 mph)	55.5 kph (34.5 mph)
Range	870 km (540 m) @ 74 kph (46 mph)	1,020 km (630 mi) @ 74 kph (46 mph)
Ceiling, max (pressure altitude)	2,980 m (9,770 ft)	3,050 m (10,010 ft)
Endurance	12 hours	



Skyship 500 & 600 scale comparison. Source: Adapted from R.L. Rimell, "Skyship!"

1st Skyship 500 (G-BIHN, foreground) & 1st Skyship 600 (G-SKSC) flying over London.
Source: Airship Heritage Trust video "Skyship Stories Episode 1"

Skyship 500

Airship Industries used the AD500 prototype design as the starting point for the Skyship 500. Both airships have the same size envelope and gondola and very similar design features. Improvements made in the Skyship 500 included bow stiffening, simpler ballonet gas valves, flight control refinement, honeycomb sandwich tail fins with Kevlar leading edges, and an envelope design with longitudinal rather than transverse panels, reducing the number of panels needed to manufacture the envelope. A Skyship 500 weighs about 140 kg (310 lb) less than the AD500.

The only metal used in the gondola is in the fire-proof bulkhead separating the engine compartment from the cabin, and the steel outriggers supporting the ducted fan propulsors. The only metal used in the envelope is in the pulleys that secure the gondola's Kevlar suspension cables. As a result, the Skyship 500 has a very low radar cross-section.

The 1st Skyship 500, G-BIHN at a mobile mooring mast.
Source: Mike Freer via Wikipedia

A Skyship 500 flying in 1983 U.S. Naval Air Development Center test of airship flying qualities, performance, and radar cross-section. Source: Wikipedia

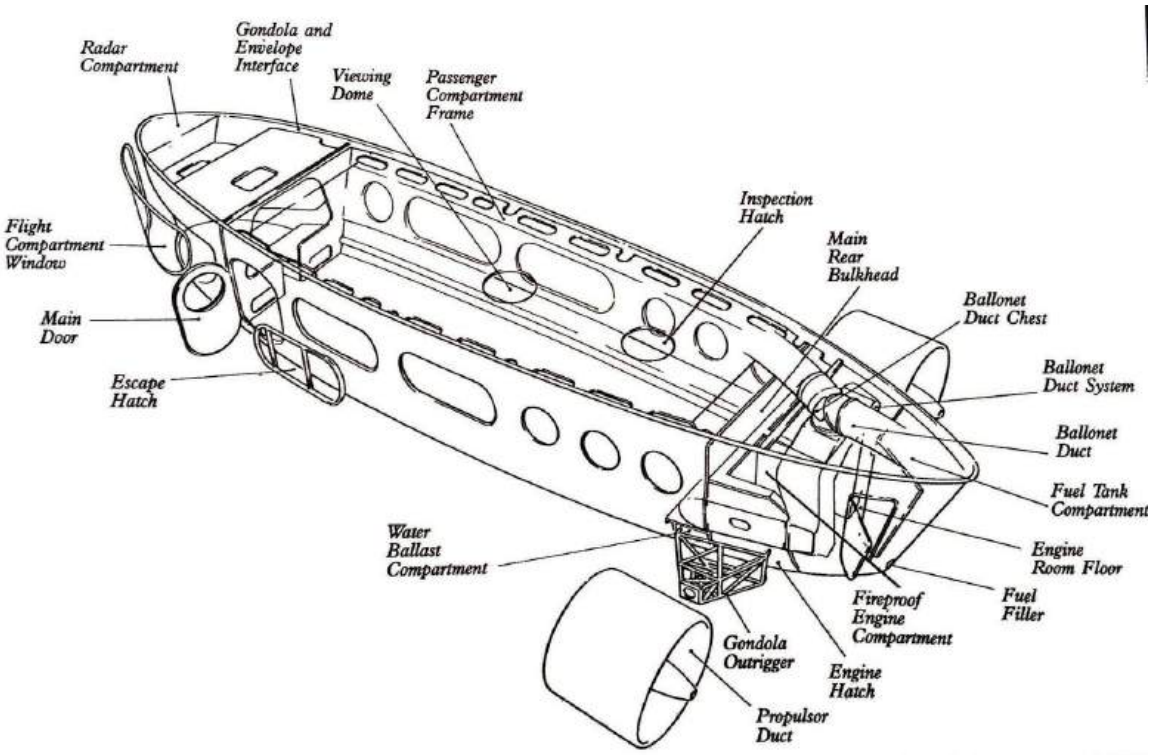
Two and a half years after the AD500 first flight, the first Skyship 500, G-BIHN, made its first flight at Cardington on 28 September 1981. The Skyship 500 received its Certificate of Airworthiness from the UK Civil Aviation Administration on 3 September 1983. Six Skyship 500s were built, two later being converted to 500 HLs.

Skyship 600

The Skyship 600 is a stretched version of the Skyship 500, with a 30% increase in envelope volume and a 50% increase in disposable load. With turbocharged Porsche engines, the Skyship 600 matches the performance of the Skyship 500 with normally-aspirated engines. The airship has a larger gondola that can accommodate a crew of two and 13 passengers. The first Skyship 600 (registration G-SKSC) made its first flight in March 1984. Nine Skyship 600s were built.

Skyship 600-04 made the first ever flight of an aircraft with a fly-by-light fiber optic flight control system, with no manual backup, on 23 October 1988 at the Airship Industries U.S. operations center at the former Weeksville Naval Air Station (NAS) near Elizabeth City, North Carolina. The system was developed by GEC. You can watch a short video on this historic flight here.

Skyship 600 being moved from a hangar on a mobile mooring mast.
Source: Screenshots from video (2013)



Skyship 600 gondola and system layout. Source: Airship Heritage Trust

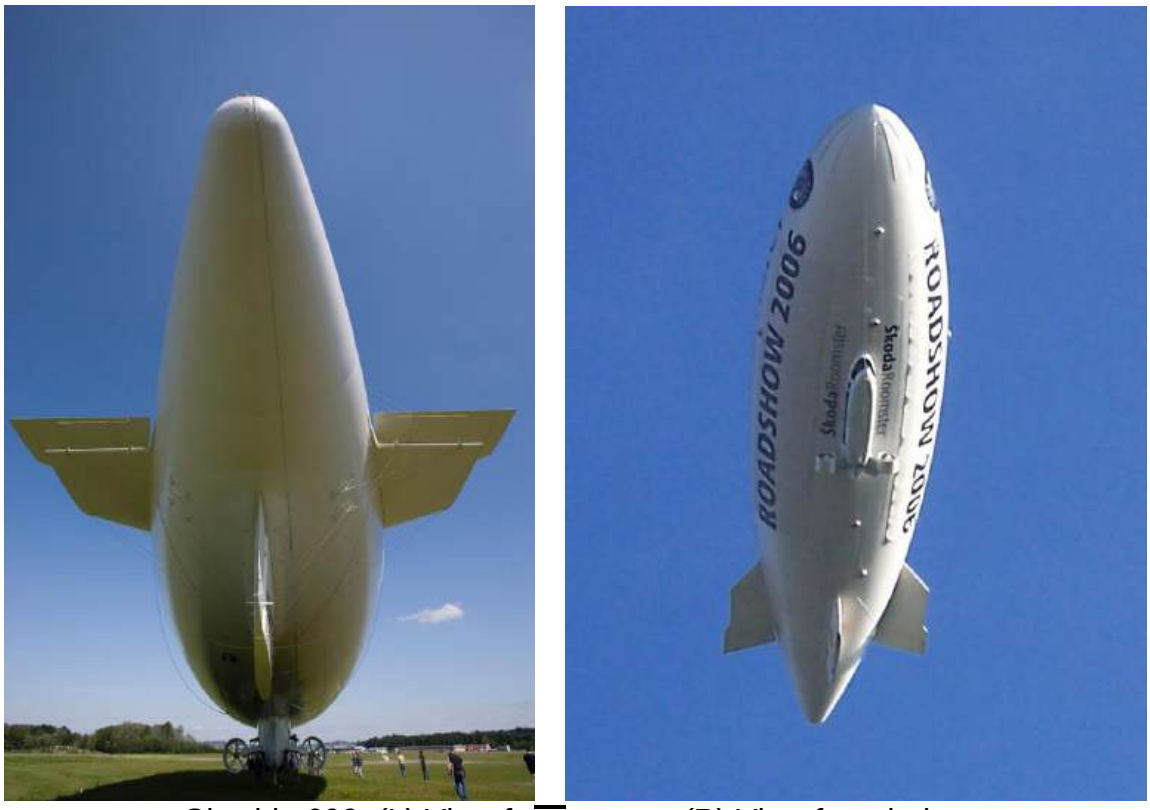
Skyship 600 gondola details, circa 2006.
Source: Thierry Detable via Airport-Data.com

The Skyship 600 was promoted as a naval patrol airship with a motorized, inflatable patrol boat that was deployable in flight from a stowed location under the gondola. A crew entry door in the bottom of the gondola provided inflight access to the boat. A twin winch system deployed or recovered the boat while the airship hovered above with the propulsors vectored down for added dynamic lift. Fins on the stern of the raft improved stability during the lift.

In 1983, the U.S. Navy, Coast Guard and Department of Defense collaborated in a test of a similarly-configured Skyship 500 in the Patrol Airship Concept Evaluation (PACE) Trials at the former Weeksville Naval Air Station (NAS) in North Carolina. You can watch a short video of the trials here.

These photos show a French test in the English Channel demonstrating deployment of the inflatable patrol boat from a Skyship 600.
Source, both photos: Hybrid Pilot Services, Ltd.

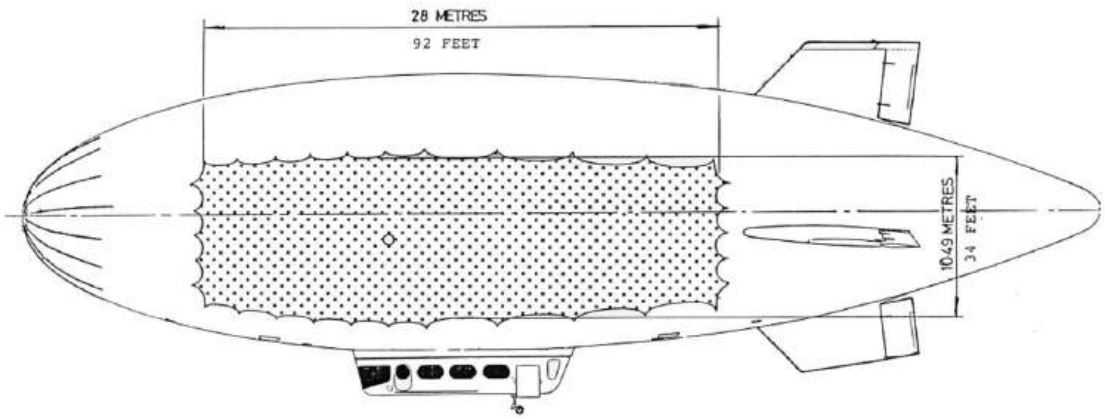
Skyship 600 sits on the flight line at Naval Air Station Key West, FL where it was being tested by the U.S. Coast Guard as an environmentally friendly surveillance aircraft. Source: Defense Visual Information Distribution Service (2 July 2008)



Skyship 600: (L) View from astern, (R) View from below.
Source, both graphics: Skyship Cruise AG

Two Skyship 600 airships operated by Skycruise Switzerland were leased to aid security and surveillance efforts during the 2004 Athens Olympics. Source: Flying Magazine (2004)

Skycruise Skyship 600s in Athens for the Olympics. Source: Hybrid Pilot Services Ltd. (2004)



Skyship 600 lighted display panel installation.
Source, both graphics: Skyship Cruise AG

Skyship 500HL

AI built one high-payload Skyship 500HL from scratch, using a Skyship 500 gondola with a larger Skyship 600 envelope. In addition, two Skyship 500s (UK registration G-BIHN and U.S. registration N501LP) were converted to the 500HL configuration.

The Skyship 500HL received U.S. Type Certificate is AS2EU, Rev 5., which, since 23 April 2012, had been held by Skyship Services.

Skyship 500HL & details of gondola layout.
Source, both graphics: Airship Heritage Trust

6. Airship Industry's larger Skyship design concepts

In the early 1980s, AI prepared design concepts for at least two much larger nonrigid airships. The 1983 UNIDO report explains:

> "Airship Industries has prepared concept designs for two much larger non-rigids, the Skyship 2000 and the Skyship 5000, of 20,000 m^3 (796,300 ft^3) and 50,000 m^3 (1,765,700 ft^3). Both are conceived for long endurance maritime patrol and advanced early warning.
>
> The Skyship 5000 will be 108 m (354.3 ft) long and 30 m (98.4 ft) in diameter and able to lift a disposable load of 28 tons. It would be capable of carrying a three shift crew of 19 on week-long missions.
>
> The Skyship 2000, designated *Coastguarder*, is a vessel 80 m (262.5 ft) long with a 10 ton lift capability.
>
> Although conceived for maritime patrol and AEW, both the 2000 and 5000 could be configured for the transport of passengers. The 2000 could carry up to 60 passengers while the 5000 could accommodate up to 200."

While AI did not develop either of these large airship concepts in the 1980s, the exercise prepared them for bidding on the U.S. Navy's Sentinel 5000 airborne early warning (AEW) airship program several years later and for continuing developing of the Skyship 5000 civil passenger derivative.

7. Westinghouse - Airship Industries (WAI) team for the U.S. Navy's Sentinel 1000 and 5000 (YEZ-2A) program thru 1990

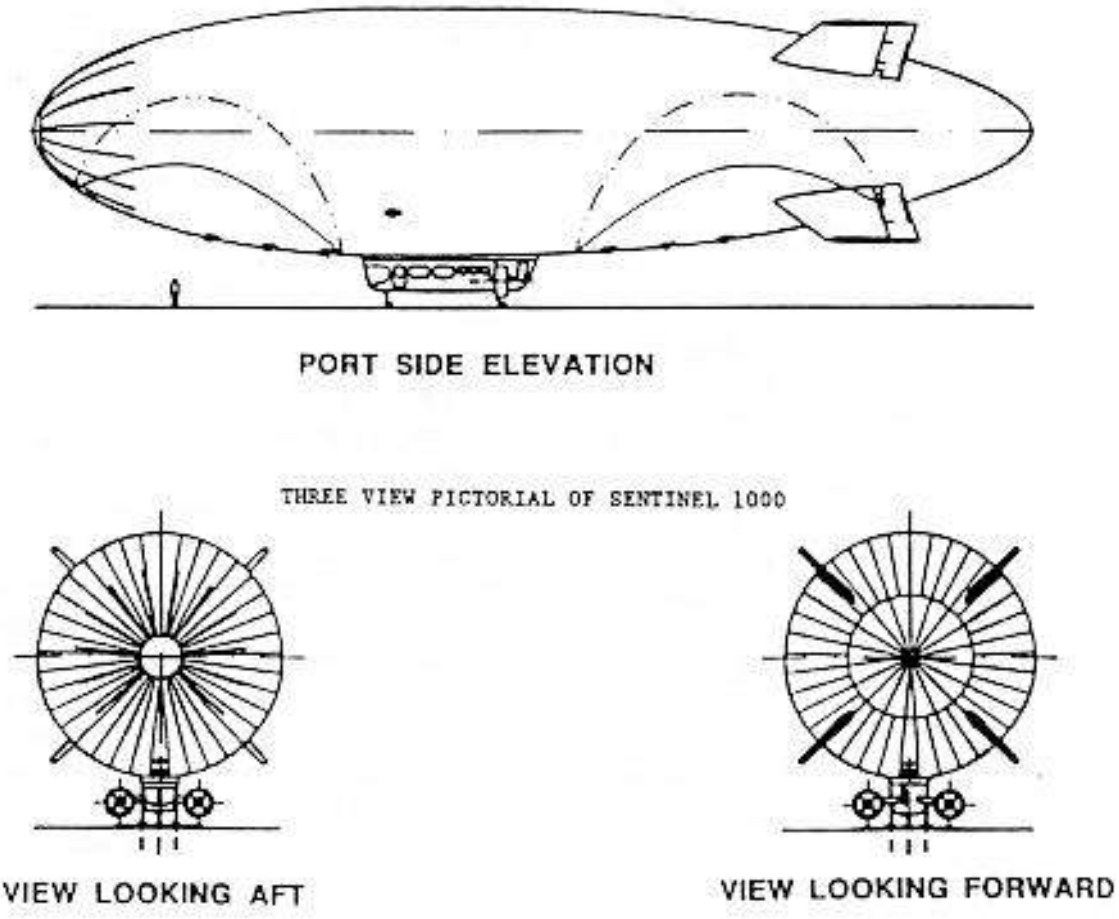
On 5 June 1987, the Westinghouse–Airship Industries (WAI) team won the competition for the Sentinel 5000 (YEZ-2A) radar surveillance and airborne early warning airship and was awarded a $168.9 million contract to build a subscale Operational Development Model (ODM), which became known as the Sentinel 1000.

Sentinel 1000 and 5000 general characteristics

Parameter	Sentinel 1000	Sentinel 5000 (YEZ-2A)
Type	Non-rigid	Non-rigid
Length	67.7 m (222 ft)	129.5 m (425 ft)
Diameter, max	16.7 m (54.7 ft)	32.0 m (105 ft)
Height, overall		46.3 m (152 ft)
Volume	10,000 m^3 (353,146 ft^3), single helium gas volume	70,792 m^3 (2,500,000 ft^3), single helium gas volume
Ballonet	Two, fore and aft	Two, fore and aft
Max op. weight	9,200 kg (20,240 lb)	
Max disposable load	2,704 kg (5,962 lb)	
Propulsion	• 2 x turbocharged 6-cylinder Porsche 930/67 engines rated @ 190 kW (255 shp) each, with ducted propellers similar to Skyship 600, vectoring +110º to -80º • Total installed power: 380 kW (510 shp)	• 2 x turbo-charged PPB marine diesels rated @ 1,342 kW (1,800 shp) each. • 1 x GE T700 turboprop @ 1,268 kW (1,700 shp) in a pusher configuration for "sprint" operations • Total installed power: 5,300 shp (3,952 kW)
Gondola dimensions	Similar to Skyship 600: L = 11.7 m (38.3 ft) W = 2.56 m (8.4 ft)	L = 25.9 m (85 ft) W = 5.1 m (16.3 ft) H = 7.3 m (23 ft)
Accommodations	1 x pilot and 10 passengers	10 – 15 in a partly pressurized, 3-level gondola
Speed, max	92.6 kph (50 knots)	167 kph (90 knots) "sprint," all engines
Speed, cruise	83.3 kph (45 knots)	83.3 kph (45 knots)
Ceiling, operating	305 – 1,524 m (1,000 – 5,000 ft)	up to 3,050 m (10,000 ft)
Pressure altitude	8,000 ft (2,438 m)	4,270 m (14,000 ft)
Endurance		• 2 - 3 days on station @ 45 knots, no refueling • up to 30 days with refueling & replenishment from surface ships

Sentinel 1000

The Sentinel 1000 was a nonrigid airship that resembled a further scale-up of the Skyship 600. It featured a modified Skyship 600 gondola with tricycle landing gear for better stability than the original single landing gear. It had a 50% larger envelope volume than the Skyship 600, with an X-tail configuration in place of the cruciform tail to permit a steeper departure angle on takeoff.

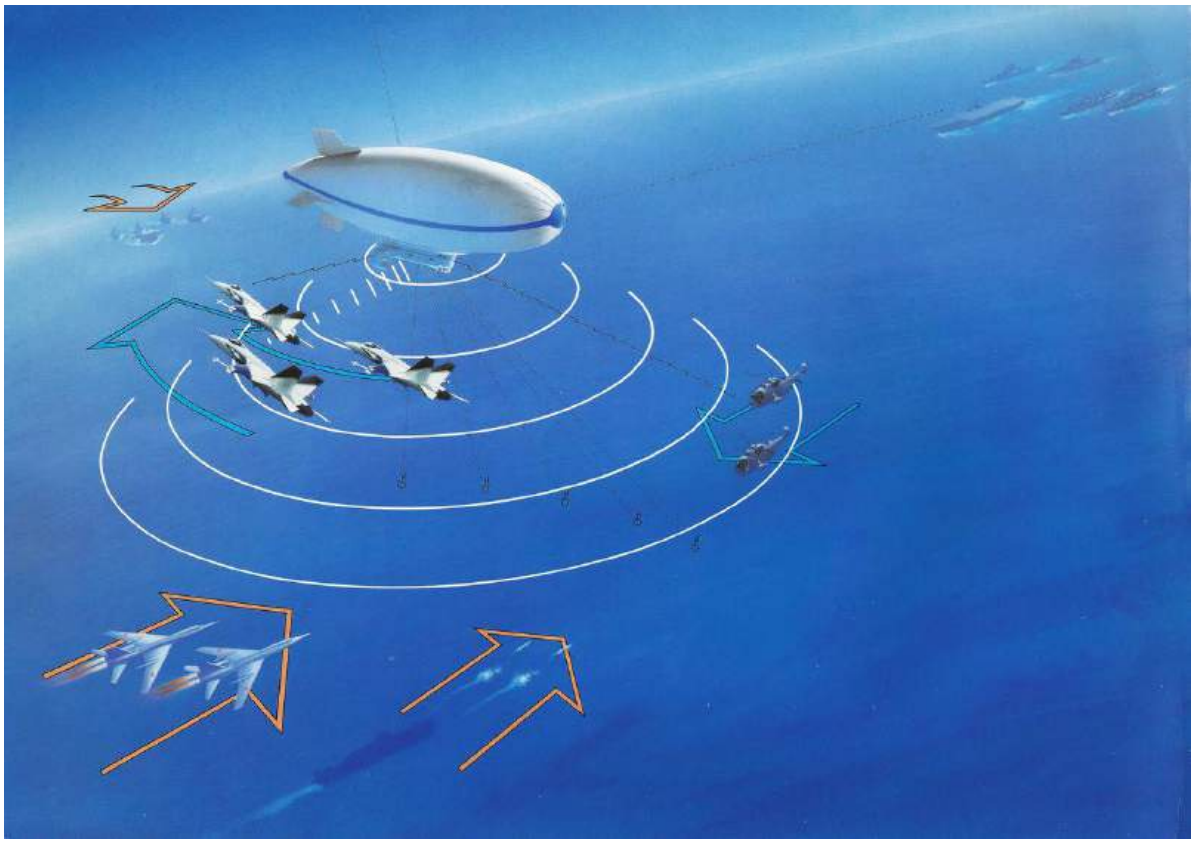


Sentinel 1000 general arrangement. Source: Airship Heritage Trust

The airship was assembled in the Airdock #2 hangar at WAI's Weeksville facility at a former blimp base near Elizabeth City, North Carolina. At the time of AI's insolvency in September 1990, the Sentinel 1000 was still being assembled and was nine months from its first flight in June 1991.

Sentinel 5000 (YEZ-2A)

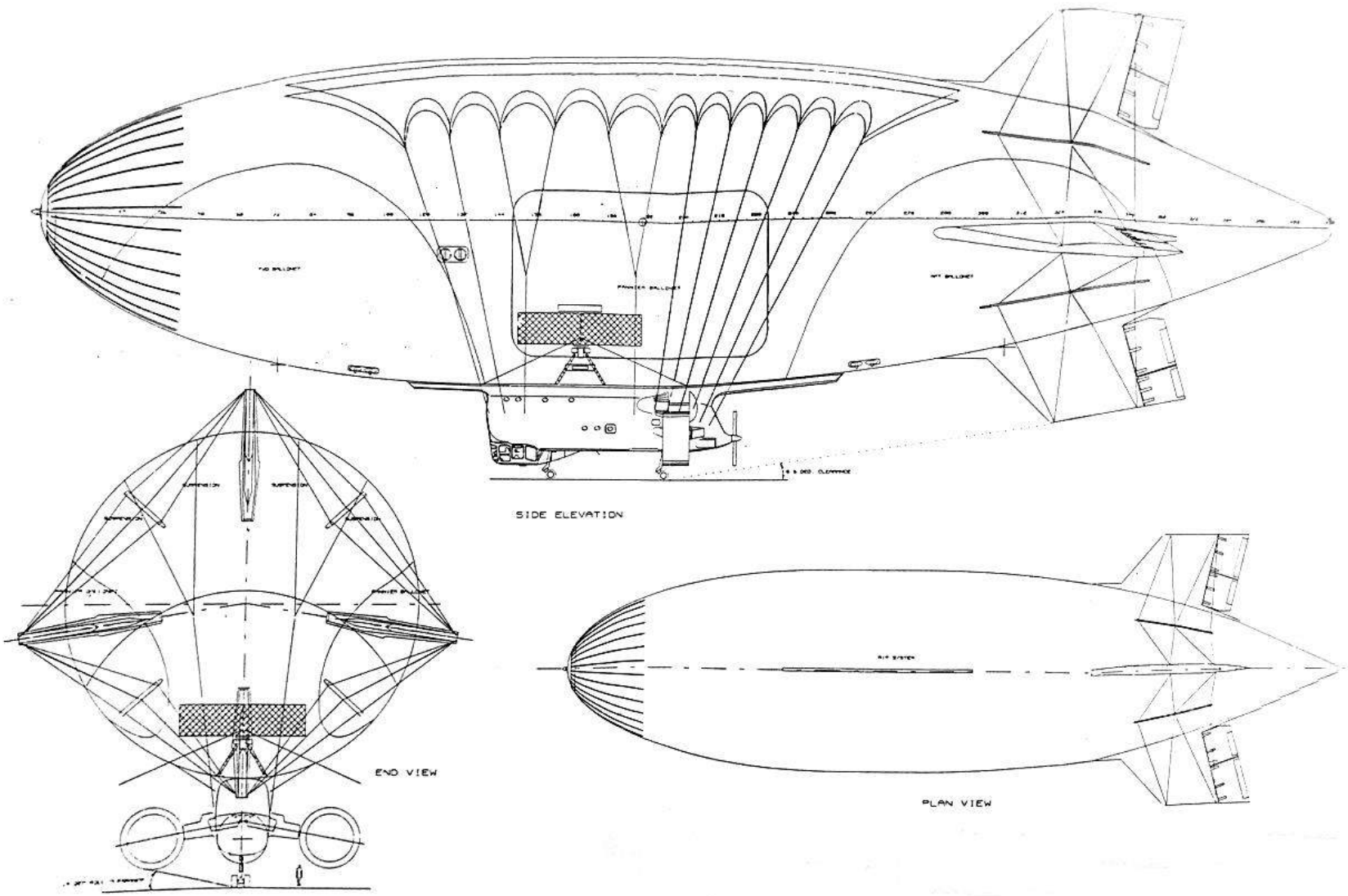
The Navy's original mission for the Sentinel 5000 called for an independent AEW system capable of operating with naval surface attack groups anywhere in the world, serving as a radar picket to protect fleet assets from attack by bombers and low-flying cruise missiles and helping direct a response force to defend against the attack. This concept of operations is illustrated in the following diagram.



Sentinel 5000 concept of operation: Airship detects incoming bombers and cruise missiles and directs fighters and ASW helicopters to engage. Source: airshiponline.com

The Sentinel 5000 would have been the largest nonrigid blimp ever built, with a gas envelope about 67% larger than the envelope on the Navy's Goodyear ZPG-3W AEW blimp, which retired from active service in 1961.

Airship Industries summarized the business case for the Sentinel 5000 in a short video here.

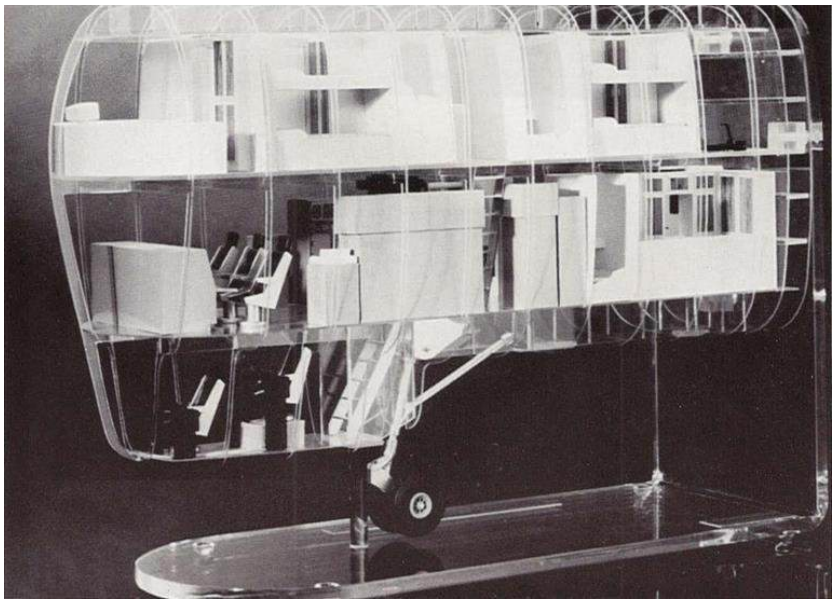


Sentinel 5000 three-view general arrangement drawing showing the location of the large radar antenna inside the gas envelope. Source: Adapted from Airship Heritage Trust

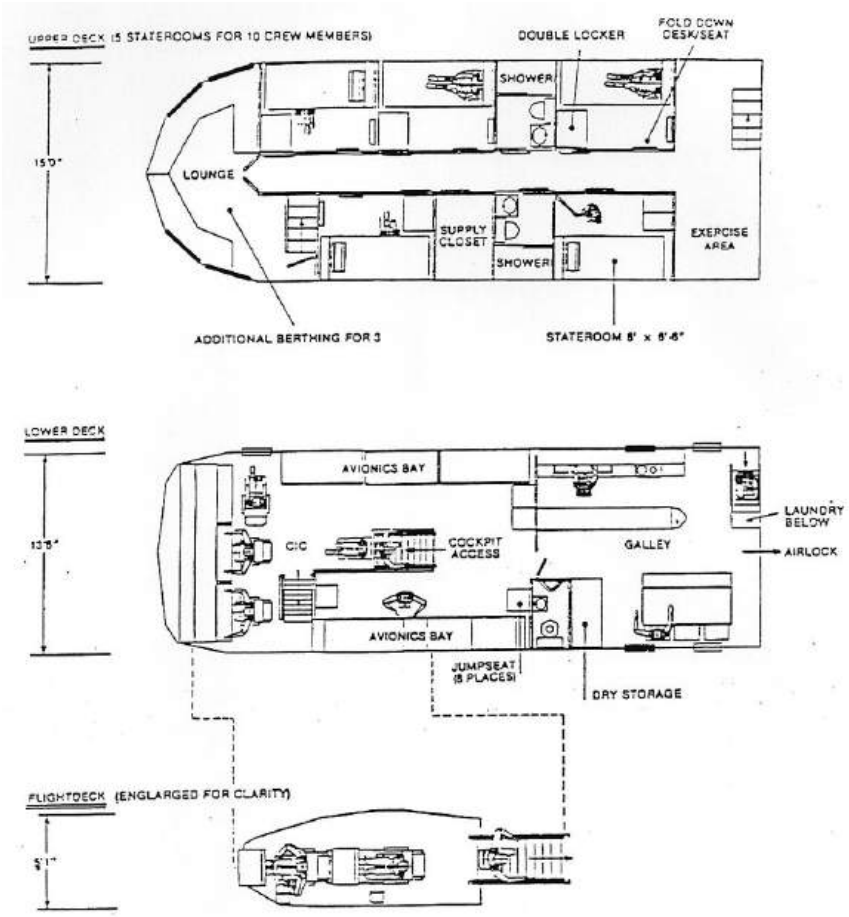
WAI brochure cover for Sentinel airship series.
Source: Airship Heritage Trust

The WAI design included the following key features:

- Pressurized gondola
- Fly-by-light controls
- Incorporated the Navy E-2C Hawkeye's radar (APS-125 or later APS-139), with an enlarged 12.2 m (40 ft) rotating antenna inside the envelope, installed above the gondola. Later use of a larger phased array radar was considered.
- Composite material gondola construction and composite envelope provide low radar cross-section.
- Engines were installed inside the gondola and thermally shielded to reduce their infra-red signature. The engines also were shielded with radar absorbent material.
- The airship carried means to defend itself from missile attack [i.e., electronic countermeasures (ECM) suite and decoys].



Model of three-level gondola forward section. Berthing / living area on the top deck, AEW operations on the mid deck, and flight controls on the lowest deck at the nose. Source: R.L. Rimell, Sentinel!



Gondola floor plan. Source: Airship Heritage Trust

Full-scale mockup of the Sentinel 5000 / YEZ-2A gondola at Naval Air Station Lakehurst, NJ. Source: Secret Projects

You'll find a short video of Roger Munk giving U.S. Navy officials a tour of the Sentinel 5000 mockup here.

At the time of AI's insolvency in September 1990, the Sentinel 5000 full-scale mockup had been completed. Final design work on the project continued without AI, under the reorganized firm known as Westinghouse Airships Inc. (still known by the acronym "WAI").

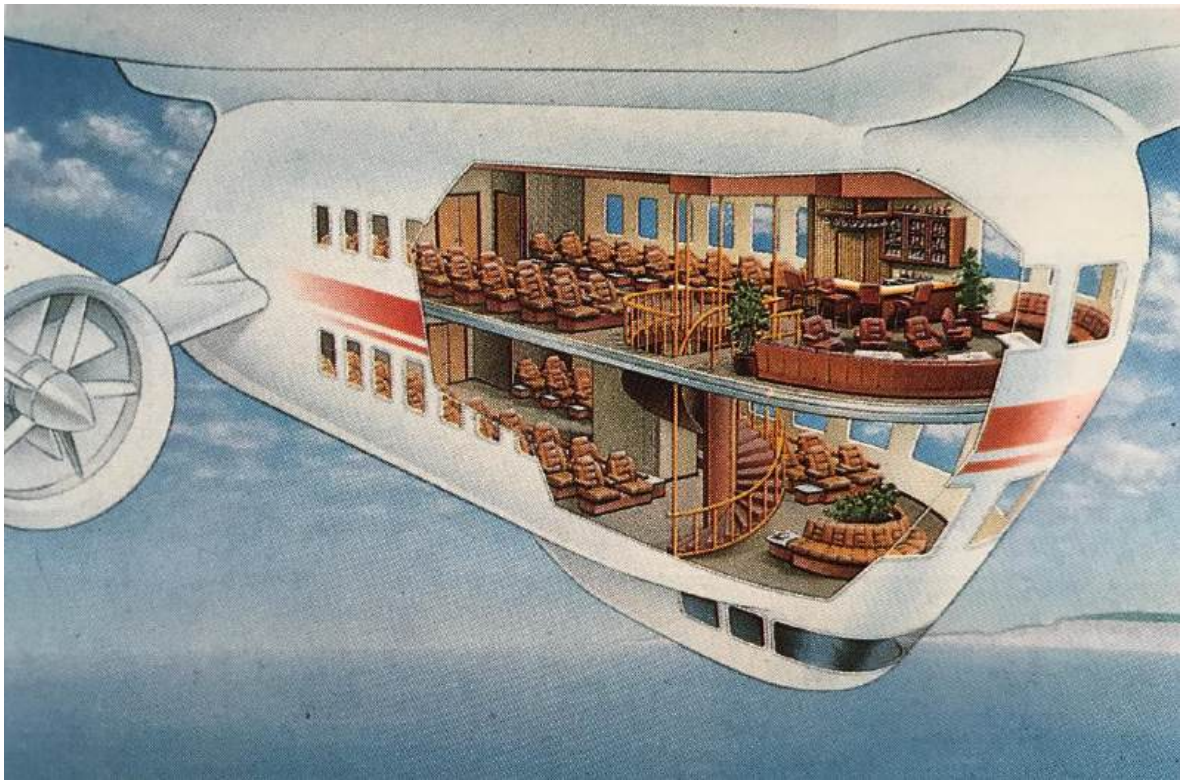
For more information on the Sentinel 1000 and 5000 airships, see my separate article on the U.S. Navy's YEZ-2A program.

8. Al's design concepts for derivatives of the U.S. Navy's Sentinel 5000

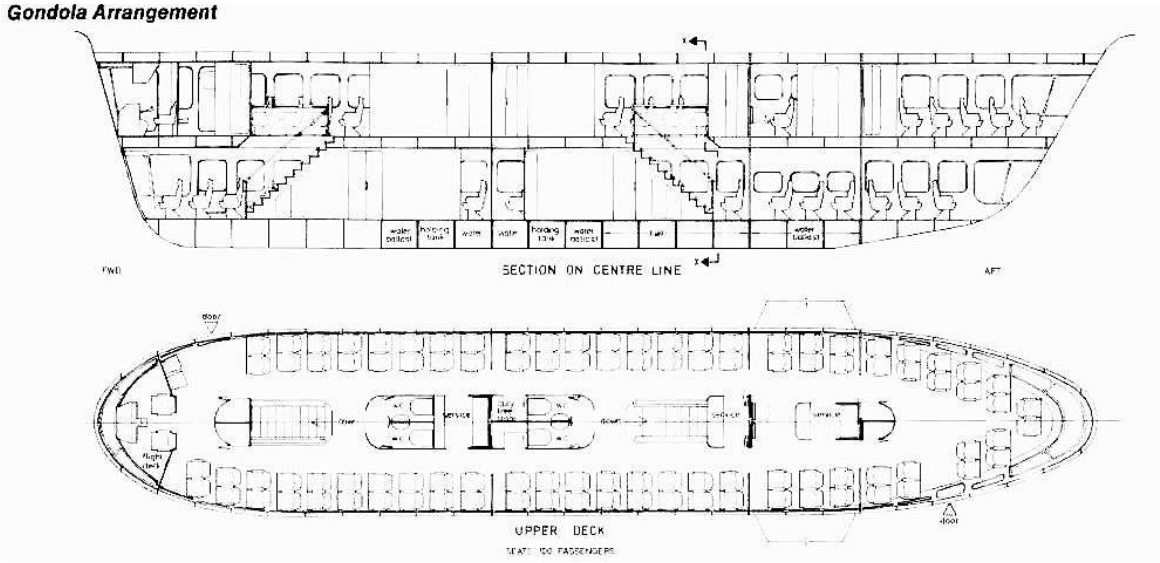
Civilian Skyship 5000

Airship Industry's Skyship 5000 civil passenger airship design concept originally was conceived in the early 1980s and was updated as a potential derivative of the Sentinel 5000 airship being developed by the WAI team for the U.S. Navy.

Launch of the civilian Skyship 5000 program depended on the success of the Sentinel 5000 program. That business opportunity ended when AI became insolvent and failed in September 1990.



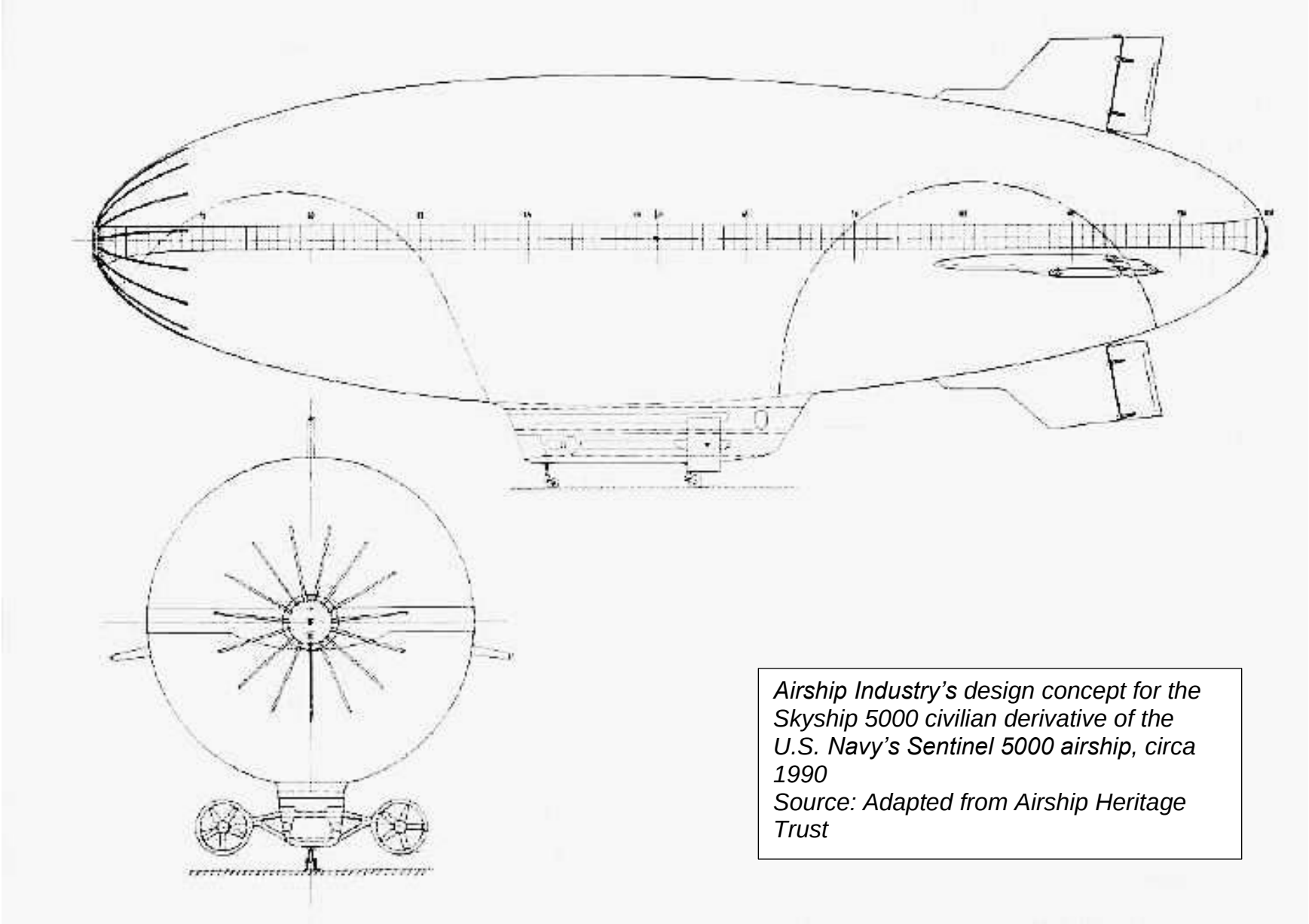
Skyship 5000 gondola configuration for passenger service.
Source: Airship Heritage Trust



Skyship 5000 gondola plan and elevation layout drawings for passenger service. Source: Airship Heritage Trust

General characteristics of the Skyship 5000 blimp

Parameter	**Skyship 5000**
Length, overall	108.0 m (354.3 ft)
Diameter, max.	30.0 m (98.4 ft)
Width overall (tail span)	36.5 m (120 ft)
Height, overall	41.0 m (134.5 ft)
Envelope volume	60,000 m^3 (1,760,000 ft^3)
Ballonet volume	19,200 m^3 (563,200 ft^3), 32% of envelope gross volume in two ballonets, fore & aft
Propulsion and maneuvering	2 x shrouded propellers, attached via stub wings to the gondola.
Weight, empty	20,172 kg (44,471 lb)
Weight, maximum	50,000 kg (110,231 lb)
Disposable load, nominal	30,000 kg (66,139 lb)
Accommodations	• 2 x cockpit crew + flight attendants • Seating for about 140 passengers in the two-deck gondola



Airship Industry's design concept for the Skyship 5000 civilian derivative of the U.S. Navy's Sentinel 5000 airship, circa 1990
Source: Adapted from Airship Heritage Trust

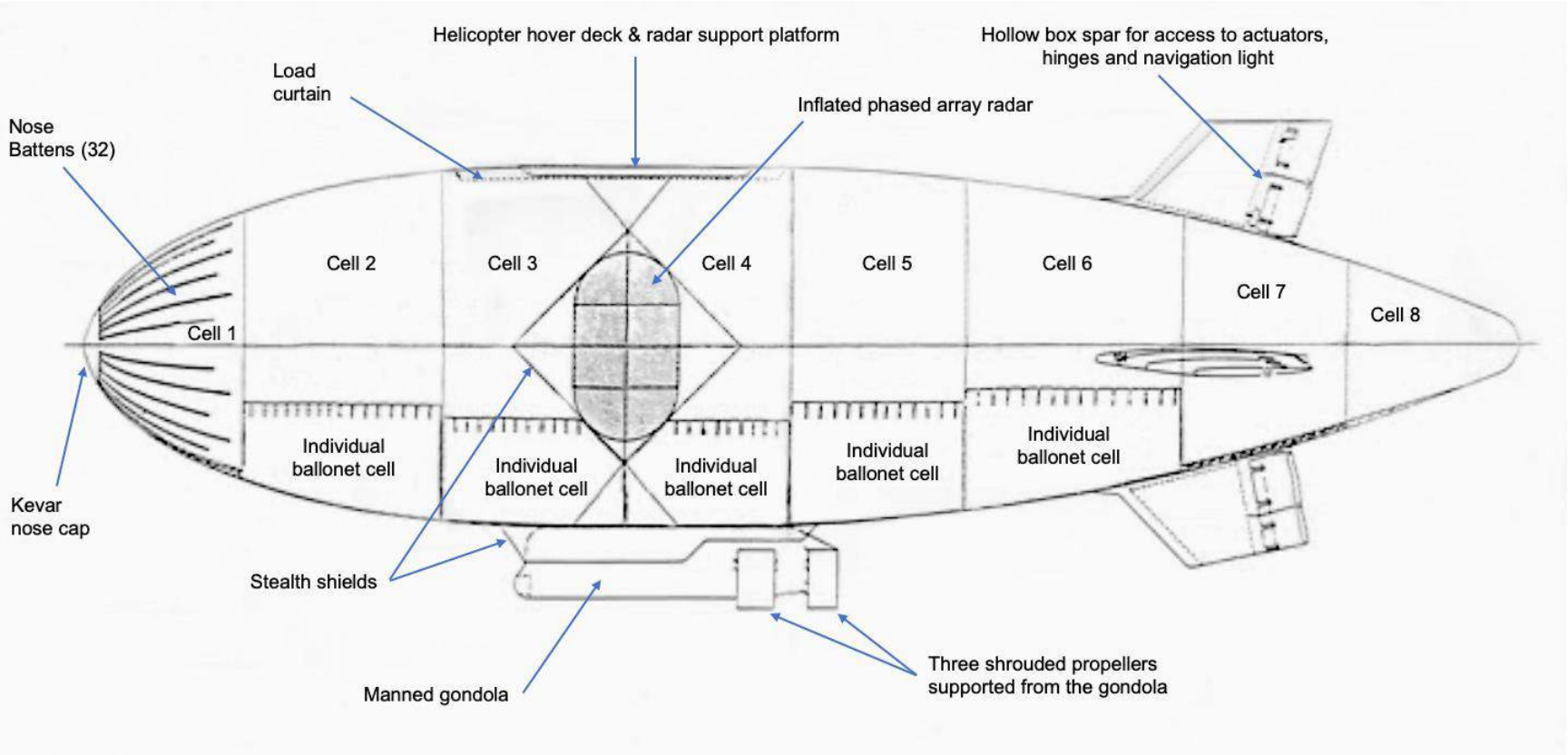
Australian maritime patrol and monitoring airship – Sentinel 9000

Airship Heritage Trust reported on another derivative of the basic Sentinel 5000 design, this one for a proposed large maritime patrol and monitoring airship for the Australian government. Known as the Sentinel 9000, this long-endurance airship was intended for maritime patrol along the north coast of Australia, including monitoring for illegal immigration activities in the region. The airship could characterize and engage a suspected vessel, relay information to Australian Coast Guard and Navy surface vessels, and coordinate interdiction. The Australian government did not proceed with Sentinel 9000 development

The Sentinel 9000 non-rigid airship design concept has a profile similar to the Sentinel 5000, with cruciform tail fins and aerodynamic control surfaces, three shrouded propulsors at the aft end of the gondola, and a conventional nose structure (Kevlar nose cap, battens to stiffen the non-rigid nose and distribute loads). Internally the Sentinel 9000 had a "load curtain," which likely refers to a typical catenary curtain structure that supports the weight of the gondola.

The Sentinel 9000 also included some interesting features that were not part of the original Sentinel 5000 design.

- **Multiple lifting gas cells and ballonets:** There are eight lifting gas cells and five ballonets within the outer non-rigid envelope. This design feature apparently follows some of the early concept designs for the Sentinel Series and the Skyship 5000.
- **Strengthened deck at the top of the envelope:** This feature is identified in the design drawing as a "helicopter hover deck and radar support platform."
- **Inflated phased array radar within the envelope**: The radar array is placed between two lifting gas cells within a feature identified as a "stealth shield," all supported from the upper support platform.
- **Single-level gondola:** The compact gondola may be pressurized to enable high-altitude operation.



Airship Industry's Sentinel 9000 maritime patrol and monitoring airship design concept for the Australian government, circa 1990. Source: Adapted from Airship Heritage Trust

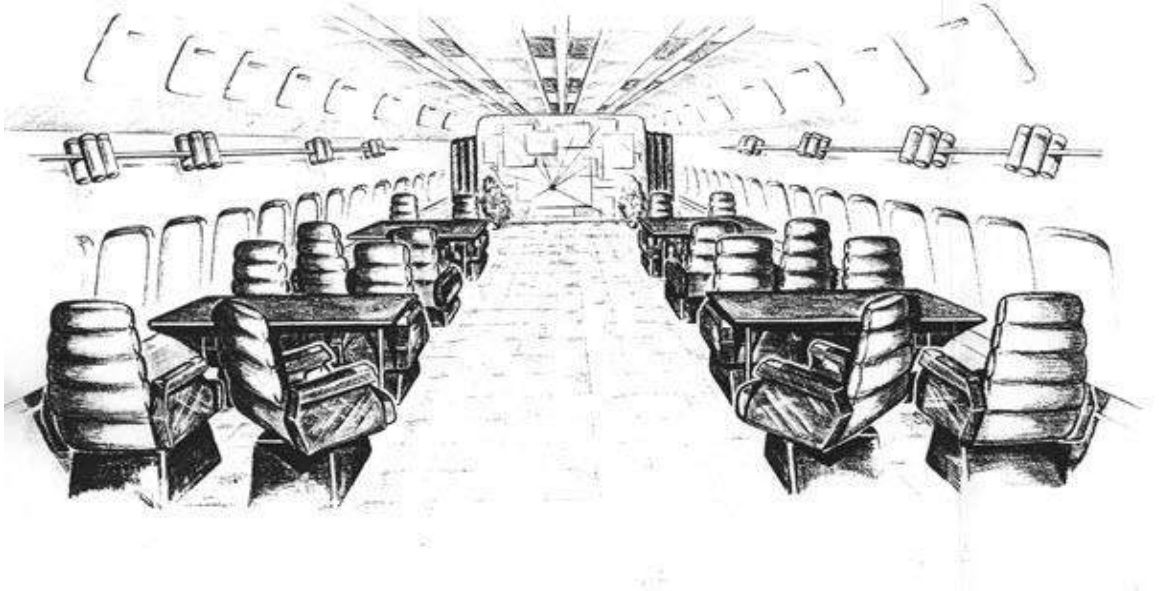
The elevation drawing of the Sentinel 9000 does not show access paths to the radar or to the support platform on top of the envelope.

General characteristics of the Sentinel 9000 / Skyship 9000 blimp

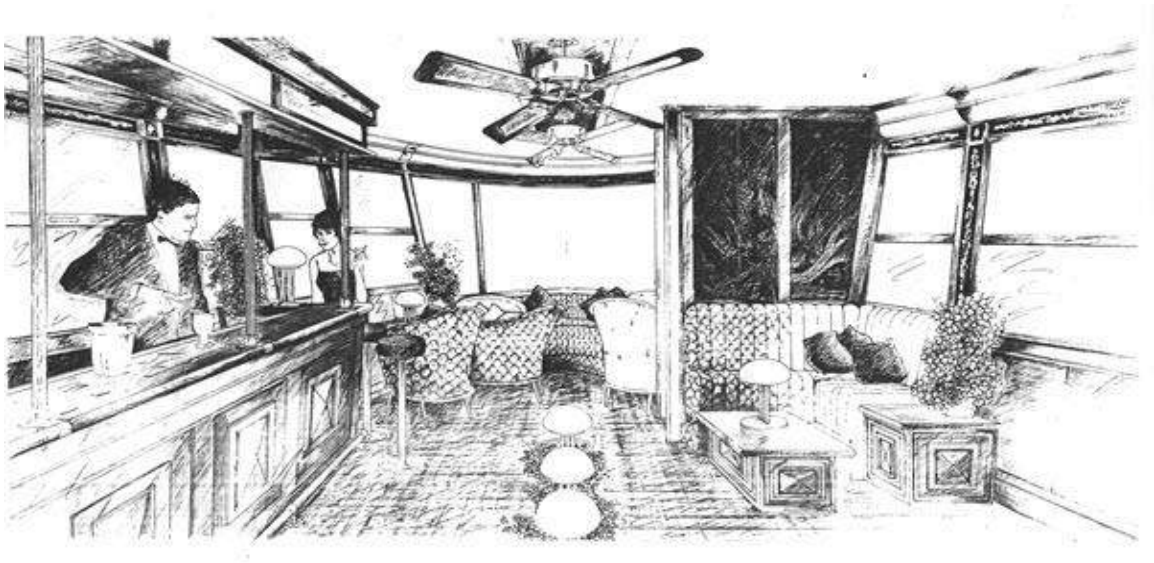
Parameter	Sentinel 9000 / Skyship 9000
Length, overall	130.0 m (423 ft)
Diameter, max.	32.0 m (105 ft)
Height, overall	45.7 m (150 ft)
Envelope volume	70,800 m^3 (2,500,000 ft^3)
Propulsion and maneuvering	3 x shrouded propellers, supported from the gondola.
Speed	61 knots (70 mph) (est.)

Civilian variant of the Sentinel 9000 proposed to the Australian government

Like the Sentinel 5000 / Skyship 5000, Airship Industries' plans included a civilian derivative of the large Sentinel 9000 airship. The following two diagrams show civilian interior design concepts.



Civil Skyship 9000 interior concept. Source: Airship Heritage Trust



Civil Skyship 9000 interior concept. Source: Airship Heritage Trust

9. For more information

From Airship Heritage Trust

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- "Airship Industries Skyship 500," Airship Heritage Trust: https://www.airshipsonline.com/airships/ss500/index.html
- "Skyship 500 HL (Heavy Lift)," Airship Heritage Trust: https://www.airshipsonline.com/airships/SS500HL/index.html
- "Airship Industries Skyship 600," Airship Heritage Trust: https://www.airshipsonline.com/airships/ss600/index.html
- "Sentinel 1000," Airship Heritage Trust: https://www.airshipsonline.com/airships/Sentinel_1000/Index.htm
- "Skyship 5000 / Sentinel 5000," Airship Heritage Trust: https://www.airshipsonline.com/airships/Sentinel_5000/index.html
- "Skyship 9000 / Sentinel 9000 proposal," Airship Heritage Trust: https://www.airshipsonline.com/airships/Sentinel_9000/index.html

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    - Skyship Stories, Episode 3, “The Great Blimp Race,” (8:59 min), 6 October 2022: https://www.youtube.com/watch?v=wjE_bjnSCeg&t=451s
    - Skyship Stories, Episode 4, “Flying Skyships,” (9:56 min), Airship Heritage Trust, 13 October 2022: https://www.youtube.com/watch?v=0u1N_AOdvYw&t=334s
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    - Skyship Stories, Episode 8, “Skyships in the snow,” (13:17 min), Airship Heritage Trust, 6 December 2022: https://www.youtube.com/watch?v=t3mfM32nkjU&t=55s

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Videos

- “Airship Industries promo video from 1983, edited with Videoshop,” (12:48 min), posted by Paul Bleakley, 13 March 2014: https://www.youtube.com/watch?v=yMV8vSqff_g&list=PLKPNYyj44DuoCvlT8JeX66cnAFDnWhPkh&index=10
- “Patrol Airship Concept Evaluation (PACE) Trials, Airship Industries, Weeksville, (1983)” (8:50 min, Skyship 500 trials), posted by Ben Lovegrove, 4 March 2018: https://www.youtube.com/watch?v=1jBiLn1D42w
- “Airship Industries Skyship 600 maiden flight (1984),” (5:57 min), posted by Paul Bleakley, 17 March 2014: https://www.youtube.com/watch?v=bwkJIU-zLJE&list=PLKPNYyj44DuoCvlT8JeX66cnAFDnWhPkh&index=9
- “Airship Industries. Paris Air Show. Deploying the boat! Skyship 600 (1985),” (11:54 min), posted by Paul Bleakley, 17 February 2014: https://www.youtube.com/watch?v=mMBeyPwtYCc&list=PLKPNYyj44DuoCvlT8JeX66cnAFDnWhPkh&index=11
- “Airship Industries, 007 Skyship 500 in ‘A View to a Kill’ (1985),” (13:24 min), posted by Paul Bleakley, 20 February 2014: https://www.youtube.com/watch?v=Gc21BsnF5Mg&list=PLKPNYyj44DuoCvlT8JeX66cnAFDnWhPkh&index=14
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- “Swan lager Skyship 600,” (1:21 min, airship walkaround in a hangar), posted by Paul Bleakley, 24 October 2015: https://www.youtube.com/watch?v=Xup9LVzjiHg&list=PLKPNYyj44DuoCvlT8JeX66cnAFDnWhPkh&index=1
- “Airship Industries Fuji Skyship 500,” (1:56 min), posted by Paul Bleakley, 17 March 2014: https://www.youtube.com/watch?v=20AL4smTeqI&list=PLKPNYyj44DuoCvlT8JeX66cnAFDnWhPkh&index=7
- “Comment C'est Fait - Les Aérostats Dirigeables,” (In French), (4:57 min, Skyship 600 maintenance), posted by Qualid Hendi, 12 February 2013: https://www.youtube.com/watch?v=D2tZp-X5NV8
- “Airships of the 1990s,” (7:23 min, includes Skyship 600, 500HL & Sentinel 1000), posted by zrsthemovie.com, 27 April 2020: https://www.youtube.com/watch?v=9hqAKZGYZRc
- “Build and Fly Skyship 600 (the FujiFilm blimp, 1995),” (8:57 minutes), posted by zrsthemovie.com, 28 August 2020: https://www.youtube.com/watch?v=8Zs17ktnTkk

Modern Airships **articles**

- *Modern Airships - Part 1*: https://lynceans.org/all-posts/modern-airships-part-1/
    - Advanced Technology Group (ATG)
    - US Navy YEZ-2A (Sentinel 1000 & 5000)
    - Wren Skyships Ltd. / Advanced Airship Corporation (AAC)
- *Modern Airships - Part 2*: https://lynceans.org/all-posts/modern-airships-part-2/
    - Thermo-Skyships Ltd. (TSL) hybrid thermal airships
- *Modern Airships - Part 3*: https://lynceans.org/all-posts/modern-airships-part-3/