

# **US Navy - YEZ-2A (Sentinel 1000 & 5000)**

Peter Lobner, updated 8 March 2022

## **1. Introduction**

On 21 June 1961, the Secretary of the Navy announced the termination of the Navy's lighter-than-air (LTA) program. Patrol Squadrons ZP-1 and ZP-3 were disestablished by the end of October 1961. Two N-class blimps that had been kept at Lakehurst for research were retired on 31 August 1962 after making a final ceremonial flight. It was the end of an era in naval aviation.

Thirteen years later, in 1975, the National Aeronautics and Space Administration (NASA) initiated a study called "Feasibility of Modern Airships – Phase I." The Navy joined Phase II of that study in 1976, and continued studying naval airship applications for a decade without launching an actual naval airship development program. These Navy studies were:

- Feasibility of Modern Airships – Phase II (1976 – 77)
- Advanced Navy Vehicle Concepts Evaluation (ANVCE, 1976 – 1977)
- Assessment of Selected LTA Vehicles for Mission Tasks of the US Coast Guard (1975 – 1978)
- Maritime Patrol Airship (MPA) Program (1980)

In 1982, Naval Air Systems Command initiated a study to reconsider the role of airships as airborne early warning (AEW) platforms for detecting low flying bombers and sea-skimming cruise missiles.

### **The YEZ-2A competition**

In February 1985, the Navy issued a request for proposal for a radar-carrying Battle Surveillance Airship System (BSAS). The primary competitors were Goodyear Aerospace, Westinghouse teamed with Airship Industries (AI) as Westinghouse–Airship Industries (WAI) and Boeing teamed with Wren Skyships.

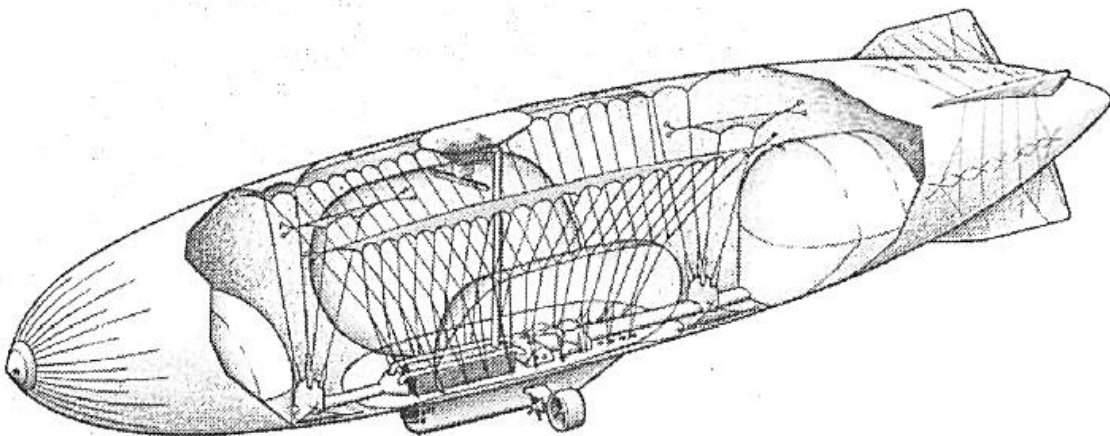
In mid-1985, the Naval Air Development Center (NADC) awarded three six-month contracts for further studies by the above teams. Before a winner was selected and a contract was awarded in 1987, this airship program was renamed three times:

- Naval Airship Surveillance Program (NASP),
- Organic Long Endurance Airborne Area Surveillance Airship System,
- Naval Airship Program (NAP)

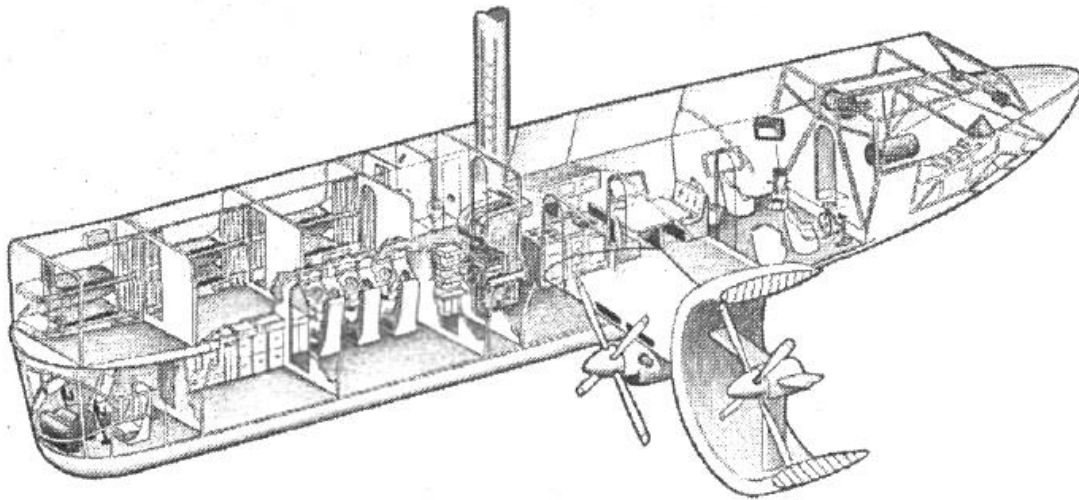
On 5 June 1987, the Westinghouse–Airship Industries (WAI) team was selected as the winner of the YEZ-2A competition.

### **The losing bidders: Goodyear and Boeing / Wren Skyships**

Goodyear proposed a modernized variant of their ZPG-3W AEW blimp, which was retired from Navy service in 1961. At that time, it was the largest nonrigid airship ever built and it still held that honor at the time of the YEZ-2A competition in 1987. The general layout of the airship proposed by Goodyear is shown in the following diagrams.



*General arrangement of Goodyear's YEZ-2A proposal.  
Source: SecretProjects.co.uk*



*Gondola arrangement of Goodyear's YEZ-2A proposal.*

*Source: SecretProjects.co.uk*

Details on the Boeing – Wren Skyships bid are not available. The large metal-clad rigid airships Wren Skyships had been developing (the R.30 and RS.1) would not have been suitable platforms for a large, internally-mounted radar antenna. It is possible that Wren offered a large nonrigid airship using technologies later incorporated into their Advanced Non-Rigid (ANR) airship.

## **2. The winning team: WAI**

On 5 June 1987, the WAI team won the competition for the Sentinel 5000 (YEZ-2A) radar surveillance airship and was awarded a \$168.9 million contract to build a subscale Operational Development Model (ODM), which became known as the Sentinel 1000. The contract also included options for up to five Sentinel 5000s. On this team, AI was responsible for the airships and Westinghouse was responsible for the AEW system and other mission system. If the Sentinel 1000 ODM was successful, the team expected an order for 40 to 50 production Sentinel 5000 AEW 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 went into receivership in September 1990, resulting in the end of the WAI partnership. Westinghouse regrouped, hired the former AI team members, and formed a new entity, Westinghouse Airships Inc., 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.

The Sentinel 1000 was completed and flew for the first time in June 1991 at the Westinghouse facility at Weeksville, North Carolina. Unfortunately, it was destroyed in a hangar fire on 3 August 1995. DARPA terminated the program later in 1995.

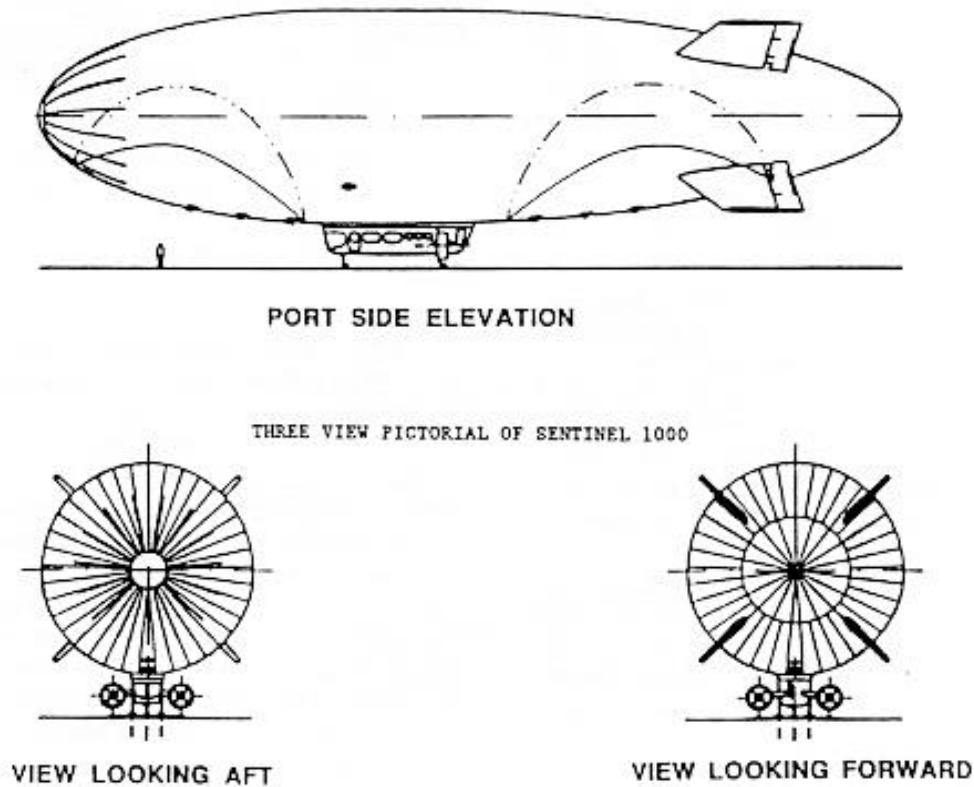
Roger Munk and former AI team members left Westinghouse Airships Inc. and formed the UK firm Airship Technologies Services Ltd. in February 1996.

The two Westinghouse firms involved in the Sentinel program, Westinghouse Airships Inc. and Westinghouse Surveillance Systems Ltd., were sold to Aviation Support Group Ltd. on 12 December 1996. The firms were reorganized and rebranded as Global Skyship Industries, in the Kissimee, FL. This firm currently holds the FAA Type Certificates of the Skyship 500HL and 600 airships in addition to a large body of airship project documentation. As of mid-2021, it appears that Global Skyship Industries is not a going concern. Their former web domain, [globalskyships.com](http://globalskyships.com), is inactive and up for sale.

The balance of this article describes the designs of WAI's Sentinel 1000 and -5000 airships.

### 3. The Sentinel 1000 subscale ODM

The Sentinel 1000 was a half-scale version of the Sentinel 5000.



*Sentinel 1000 general arrangement. Source: Airship Heritage Trust*

Design features of the Sentinel 1000 included:

- Modified Airship Industries Skyship 600 gondola
- Tricycle landing gear for better stability than the single gear on the Skyship 600
- 50% larger envelope volume than the Skyship 600: 10,000 m<sup>3</sup> (350,000 ft<sup>3</sup>)
- X-tail empennage to provide better clearance on take-off when the nose of the ship is pulled up.
- Different envelope material that eliminated the need for routine hangaring for service
- Ground-handling system that required a comparatively small ground crew of eight
- Fly-by-light flight control system (FCS) (not installed until 1992)

## Sentinel 1000 and 5000 general characteristics

Parameter	Sentinel 1000	Sentinel 5000 (YEZ-2A)
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 <sup>3</sup> (353,146 ft <sup>3</sup> )	70,792 m <sup>3</sup> (2,500,000 ft <sup>3</sup> )
Max operating weight	9,200 kg (20,240 lb)	
Max disposable load	2,704 kg (5,962 lb)	
Propulsion	<ul style="list-style-type: none"> <li>2 x turbocharged 6-cylinder Porsche 930/67 engines @ 255 hp (190 kW) each, with ducted propellers similar to Skyship 600, vectoring +110° to -80°</li> <li>Total installed power: 510 shp (380 kW)</li> </ul>	<ul style="list-style-type: none"> <li>2 x turbo-charged PPB marine diesels @ 1,800 bhp (1,342 kW) each.</li> <li>1 x GE T700 turboprop @ 1,700 shp (1,268 kW) in a pusher configuration for “sprint” operations</li> <li>Total installed power: 5,300 shp (3,952 kW)</li> </ul>
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	50 knots	90 knot “sprint,” all engines
Speed, cruise	45 knots	45 knots
Ceiling, operating	305 – 1,524 m (1,000 – 5,000 ft)	up to 3,050 m (10,000 ft)
Ceiling, max (pressure altitude)	8,000 ft (2,438 m)	4,270 m (14,000 ft)
Endurance		<ul style="list-style-type: none"> <li>2 - 3 days on station @ 45 knots, no refueling</li> <li>up to 30 days with refueling &amp; replenishment from surface ships</li> </ul>



*Sentinel 1000 in flight at Weeksville. Source: Airship Heritage Trust*



*Sentinel 1000. Source:*  
<https://rochesteravionicarchives.co.uk/platforms/sentinel-airship>

The Sentinel 1000 airship was assembled in the Airdock #2 hangar at WAI's Weeksville facility at a former blimp base near Elizabeth City, North Carolina. This hangar was built in 1942 and was the largest wood construction building in the world, measuring 900 ft long by 298 ft wide by 192 ft high (274 x 91 x 58.5 m) with 180 ton doors mounted on railroad tracks.

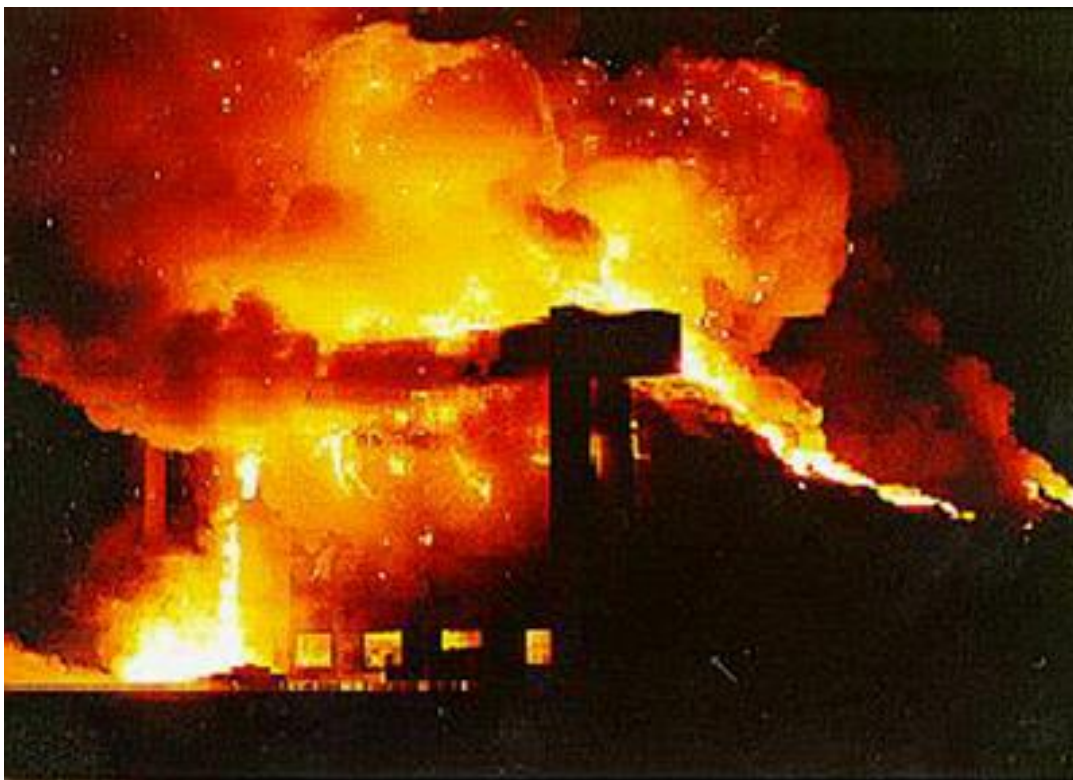
First flight of the Sentinel 1000 occurred on 26 June 1991. By this time, Westinghouse Airships Inc. was managing the program, and DARPA was providing the funding.

It wasn't until May 1992 that the Sentinel 1000 airship made its first flight with the GEC Avionics fly-by-light flight control system (FCS). This was the first flight of a production-standard FCS and also the first of an airship FCS incorporating auto-stabilizer and autopilot functions to reduce the workload of piloting the airship on lengthy missions. The system uses fiber optic cables rather than traditional electrical wiring, making it highly resistant to electromagnetic interference (EMI) and lightning strikes. A prototype system was previously installed and tested on an Airship Industries Skyship 600.

The Sentinel 1000 received US Type Certificate TS00002AT, which originally was issued to Westinghouse Airship, Inc. on 22 October 1993.

The Sentinel 1000 was severely damaged in a hangar fire that destroyed Airdock #2 at Weeksville on 3 August 1995. The fire was reported just after midnight and burned for more than eight hours. The 300,000 ft<sup>2</sup> structure was burned to the ground, except for the concrete supports for the hangar doors. The entire project was terminated later in 1995.





*Airdock #2 engulfed in flames, 3 August 1995.*



*Remains of the Sentinel 1000. Source, both photos: Legeros Fire Blog Archives 2006 – 2015 – Blimps, Hangars, Weeksville*



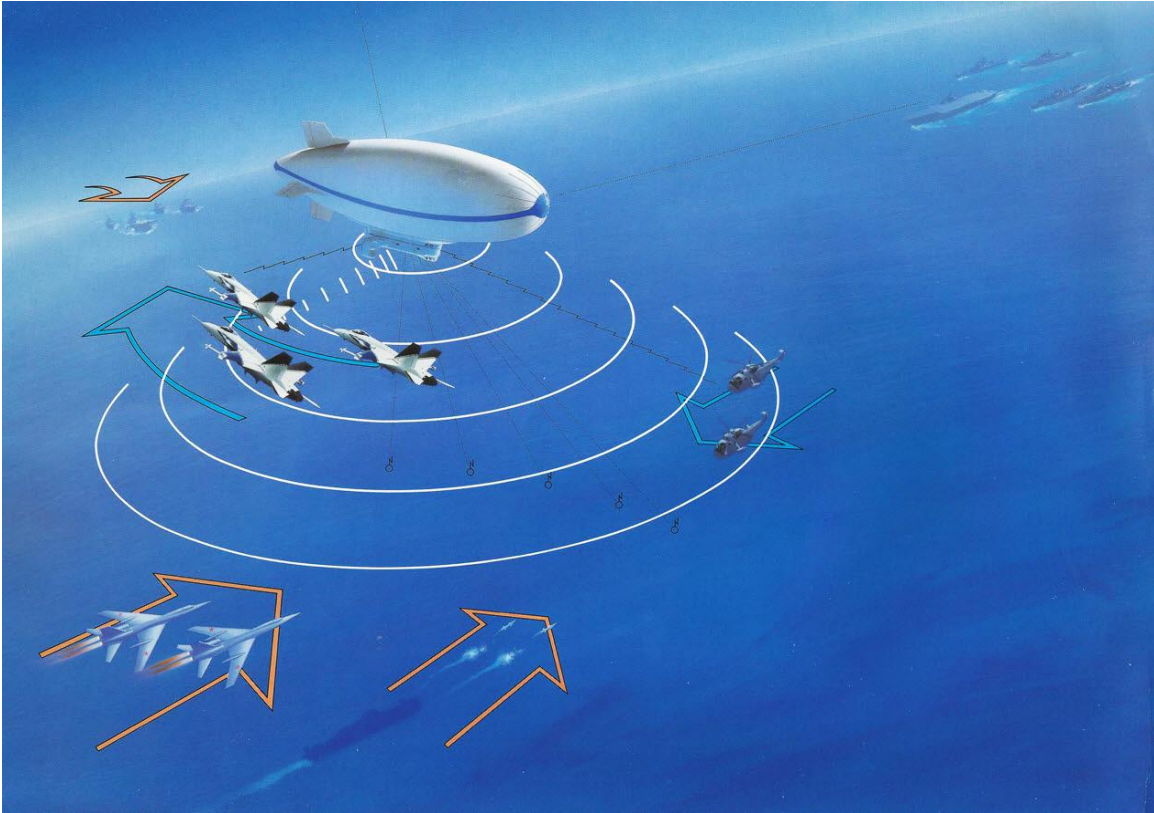
*Aerial view looking north at the remains of Airdock #2, circa 1995-99.  
Source: Paul Freeman, Abandoned & Little-Known Airfields*

#### **4. The Sentinel 5000 airship (YEZ-2A)**

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

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 Sentinel 5000 airship concept of operations is illustrated in the following diagram.

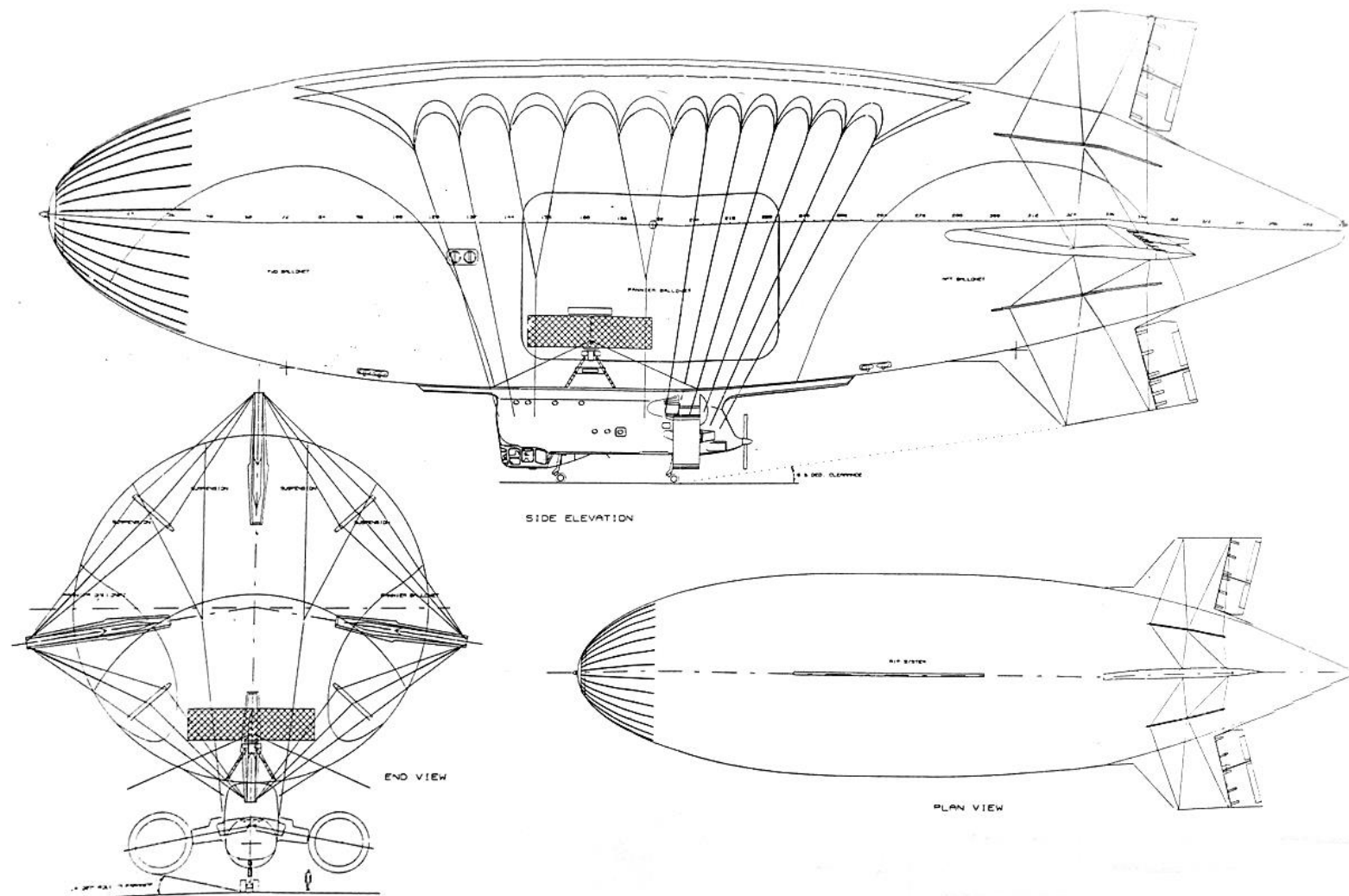


*Sentinel 5000 concept of operation: Airship detects incoming bombers and cruise missiles and directs fighters and ASW helicopters to engage. Source: airshiponline.com*

The WAI design included the following key features:

- Pressurized gondola
- Fly-by-light controls
- Multiple lifting gas compartments
- Incorporated the Navy E-2C Hawkeye's radar (APS-125 or later APS-139), with an enlarged 40 ft (12.2 m) 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 shielded with radar absorbent material.
- Engines were installed inside the gondola and thermally shielded to reduce their infra-red signature.
- The airship carried means to defend itself from missile attack (i.e., ECM suite and decoys).

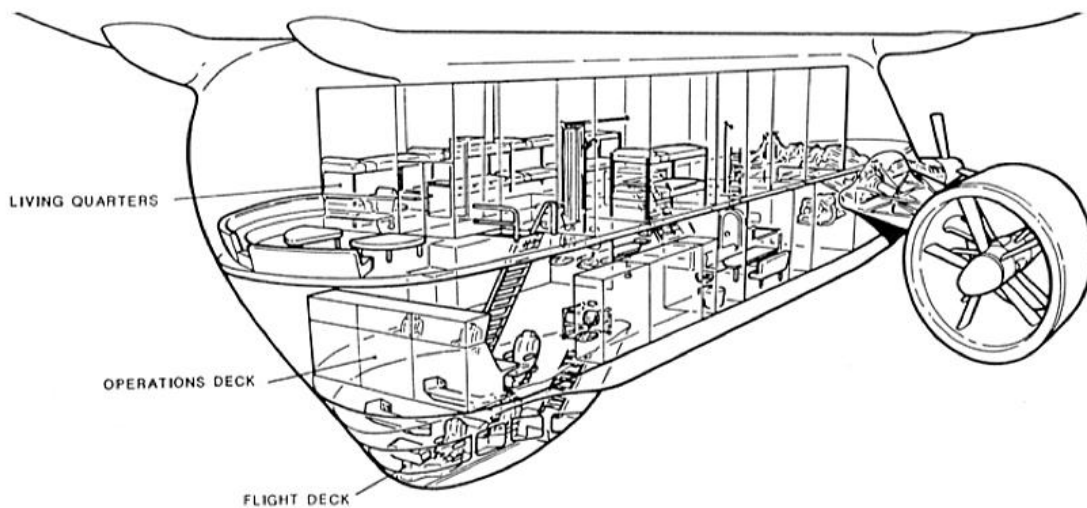




*Sentinel 5000 general arrangement. Source: Adapted from Airship Heritage Trust*



*Sentinel 5000 interior details, including placement of the search radar antenna.  
Source: R. Hochstetler, et al., (2016)*



*Cutaway view of the three-level gondola. Berthing / living area is on the top deck, AEW operations on the mid-deck, and flight controls are on the lowest deck at the nose. Source: NAA Noon Balloon #120*



*Full-scale mockup of the Sentinel 5000 / YEZ-2A gondola.  
Source: Secret Projects*

The National Aeronautics and Space Administration (NASA) supported the Sentinel 5000 development program, as reported by Ron Hochstetler:

“In 1994 the US Navy contracted with ARC (NASA Ames Research Center) to conduct a human-in-the-loop evaluation of the handling qualities of the YEZ-2A Air Early Warning (AEW) concept airship..... ARC investigated the ability of the airship to conduct refueling and resupply operations from a simulated surface ship under visual flight rules (VFR) conditions at a number of airspeeds and static heaviness conditions. This program resulted in the construction of a full 6 DOF (Degrees-Of-Freedom) non-linear flight dynamics simulation model for the YEZ-2A airship..... ARC used this research to obtain a catalogue of vehicle responses to both aerodynamic and power control inputs as well as longitudinal handling qualities.”

At the time the program was defunded and terminated in 1995, a major redesign of the gondola and propulsion system was in progress, with the goal of reducing development costs by about \$45 million.

## 5. For more information

- “Skyship 5000 / Sentinel 5000,” Airship Heritage Trust: [https://www.airshipsonline.com/airships/Sentinel\\_5000/index.html](https://www.airshipsonline.com/airships/Sentinel_5000/index.html)
- “Sentinel 1000,” Airship Heritage Trust: [https://www.airshipsonline.com/airships/Sentinel\\_1000/Index.htm](https://www.airshipsonline.com/airships/Sentinel_1000/Index.htm)
- “Westinghouse Airship to Build Military Blimp,” The Washington Post, 8 June 1987: <https://www.washingtonpost.com/archive/business/1987/06/08/westinghouse-airship-to-build-military-blimp/12c2590c-bb09-4202-8311-95322c138f7d/>
- Roland Escher, “Westinghouse Airships Inc.,” Airship and Blimp Resources, 2003: <http://www.myairship.com/database/wai.html>
- “Westinghouse Airship Industries SkyShip 5000 and Sentinel 5000,” Secret Projects:

<https://www.secretprojects.co.uk/threads/westinghouse-airship-industries-skyship-5000-and-sentinel-5000.7391/>

- R. Hochstetler, et al., “Modeling and Simulation Tools for Heavy Lift Airships,” Paper 39, delivered at MODSIM World 2016: [http://www.modsimworld.org/papers/2016/Modeling\\_and\\_Simulation\\_Tools\\_for\\_Heavy\\_Lift\\_Airships.pdf](http://www.modsimworld.org/papers/2016/Modeling_and_Simulation_Tools_for_Heavy_Lift_Airships.pdf)
- “United States Navy YEZ-2A Airship Program Collection,” Smithsonian National Air and Space Museum: <https://airandspace.si.edu/collection-archive/united-states-navy-yez-2a-airship-program-collection/sova-nasm-2018-0048>
- “Type Certificate Data Sheet No. TS00002AT,” Rev 2., S1000 (Sentinel 1000), assigned to Skyship Services, Inc., 23 April 2012, search on the FAA Type Certificate website here: [https://rgl.faa.gov/Regulatory\\_and\\_Guidance\\_Library/rgMakeModel.nsf/MainFrame?OpenFrameSet](https://rgl.faa.gov/Regulatory_and_Guidance_Library/rgMakeModel.nsf/MainFrame?OpenFrameSet)
- Legeros Fire Blog Archives 2006 – 2015 – Blimps, Hangars, Weeksville, 10 February 2010: <https://legeros.com/ralwake/photos/weblog/pivot/entry.php?id=3705>
- Paul Freeman, “Abandoned & Little-Known Airfields, Northeastern North Carolina,” [http://www.airfields-freeman.com/NC/Airfields\\_NC\\_NE.htm](http://www.airfields-freeman.com/NC/Airfields_NC_NE.htm)

### **Other Modern Airships articles**

- *Modern Airships - Part 1:* <https://lynceans.org/all-posts/modern-airships-part-1/>
  - Airship Industries Ltd. airships
  - Goodyear - N-Class blimps
  - Navy ANVCE program airships (1976 – 1979)
  - Navy Maritime Patrol Airship (MPA) study airships (1980)
  - Wren Skyships Ltd. / Advanced Airship Corporation (AAC)
- *Modern Airships - Part 2:* <https://lynceans.org/all-posts/modern-airships-part-2/>
- *Modern Airships - Part 3:* <https://lynceans.org/all-posts/modern-airships-part-3/>