

Navy - Maritime Patrol Airship study airships (1980)

Peter Lobner, 24 August 2021

1. Introduction

Almost 15 years after the Navy terminated its lighter-than-air (LTA) program in 1961 and retired the last of its post-WWII blimp fleet in 1962, the Navy and Coast Guard began reconsidering the merits of LTA patrol craft in the mid-1970s. Missions of interest included:

- Short-range aids to navigation
- Enforcement of laws and treaties
- Marine environmental protection
- Military operations / preparedness
- Marine science activities
- Port safety and security
- Search and rescue
- Ice operations

In 1980, the Naval Air Development Center (NADC) conducted the Maritime Patrol Airship Study. NADC defined updated mission requirements for a modern maritime patrol airship and penned their own design concept, designated NADC ZP-X, for use as a design baseline. By incorporating thrust vectoring propulsors, the ZP-X was a substantial departure from traditional naval blimp design.

NADC identified the following key performance capabilities for the modern maritime patrol airship:

- Hover capable (for logistics, boarding, rescue, observation, crew replacement, refueling)
- 90 knot maximum speed
- Vertical takeoff & landing (VTOL)
- Able to tow sensors & vessels
- Broad weather envelope
- Low power requirements

NADC contracted Goodyear Aerospace Corporation and Bell Aerospace Textron to independently develop concept designs for the same mission and performance requirements.

By the time this study was initiated, former Navy blimp facilities had stood disused for 15 years, leaving the Navy with few options for hosting a modern airship fleet. The study estimated the cost of modernizing the large airship facilities at Moffett Field, California and Lakehurst, New Jersey.

NADC determined that a best estimate of the unit cost for manufacturing 50 airships was \$5 million. In addition, pro-rated facility modernization costs and initial crew training costs added \$900,000 and \$500,000 per airship, respectively. This placed the acquisition cost at \$6.4 million per airship in 1977 dollars.

NADC noted that the largest component of operating cost was the cost of personnel. NADC estimated the airship crew requirements based on mission duration, varying from five crew for missions up to 10 hours, eight crew for missions between 10 – 20 hours, and 13 crew for longer missions. The upper limit for mission duration was 35.5 hours. For costing, NADC assumed that aircrews would be limited to flying 800 hours per year and airship utilization would be 2,400 hours per year, with three crews per airship.

The airship was assumed to have an operational lifetime of 12 years.

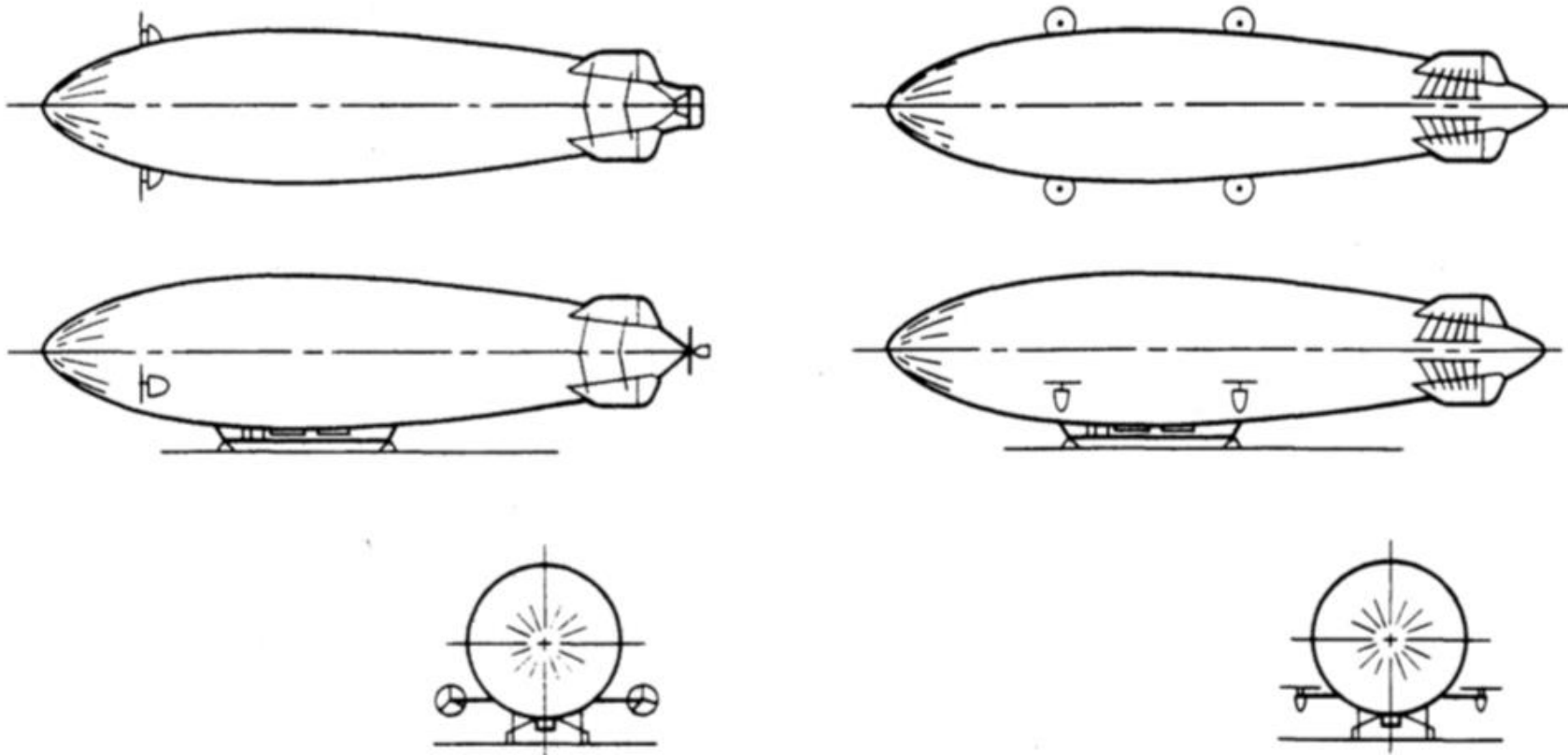
The Navy did not procure any new airships for the updated maritime patrol mission.

This article provides an overview of the Goodyear ZP3G and the Bell MPA patrol airship concepts. Both were non-rigid, pressurized blimps with catenary curtains that supported the control car (gondola) and other loads. Both Goodyear and Bell offered designs that were substantially different from previous Navy blimps. The Bell solution was a more powerful hybrid blimp that, in some respects, resembled the Goodyear Aerospace VTOL Dynastat concept developed in the 1970s.

Comparison of maritime patrol airship general characteristics

Parameter	NADC ZP-X	Goodyear ZP3G	Bell MPA
Length	305 ft (93 m)	324 ft (98.8 m)	326 ft (99.4 m)
Diameter	69.3 ft (21.1 m)	73.4 ft (22.4 m)	72.4 ft (22.7 m)
Envelope volume	783,696 ft ³ (21,192 m ³)	875,000 ft ³ (24,777 m ³)	857,437 ft ³ (24,280 m ³)
Ballonets # / volume		4 / 216,250 ft ³ (6,124 m ³)	2 / 223,194 ft ³ (6,320 m ³)
Static lift @ 2,000 ft.	44,243 lb (20,068 kg)	52,164 lb (23,661 kg)	44,658 lb (20,257 kg)
Dynamic lift	7,638 lb (3,465 kg)	8,500 lb (3,856 kg)	17,917 lb (8,127 kg)
Propulsion	3 x turboprop engines driving thrust vectoring propellers, some reverse thrust for landing	3 x turboshaft engines driving thrust vectoring propellers, some reverse thrust for landing	4 x turboprop engines driving thrust vectoring prop/rotors with collective control
Installed power, total	1,927 shp (1,437 kW)	2,400 shp (1,790 kW)	4,306 shp (3,211 kW)
Gross weight	54,554 lb (24,745 kg)	60,664 lb (27,517 kg)	65,274 lb (29,608 kg)
Empty weight	27,674 lb (12,553 kg)	33,740 lb (15,304 kg)	33,019 lb (14,977 kg)
Useful load	26,880 lb (12,193 kg)	22,504 lb (10,207 kg)	32,256 lb (14,631 kg)
Buoyancy ratio *	0.86	0.86	0.73
Operating altitude	1,000 - 5,000 ft (305 – 1,524 m)	5,000 ft (1,524 m)	5,000 ft (1,524 m)
Maximum altitude	10,000 ft (3,048 m)	9,700 ft (2,957 m)	10,000 ft (3,048 m)
Maximum speed	90 knots	97 knots	104 knots
Endurance	35.5 hours	101 hrs @ 25 knots	
* buoyancy ratio = beta factor = aerostatic lift / total lift			

Source: adapted from NADC-80149-60 (1980)



*Comparison of the general arrangements of the Goodyear ZP3G (left) and the Bell MPA (right).
Source: NASA Tech Memo 86672 (1984)*

2. Goodyear Aerospace Corporation ZP3G

The Goodyear ZP3G design had a non-rigid, pressurized envelope with a single lift gas volume and four ballonets: forward, aft and two saddle ballonets amidships.

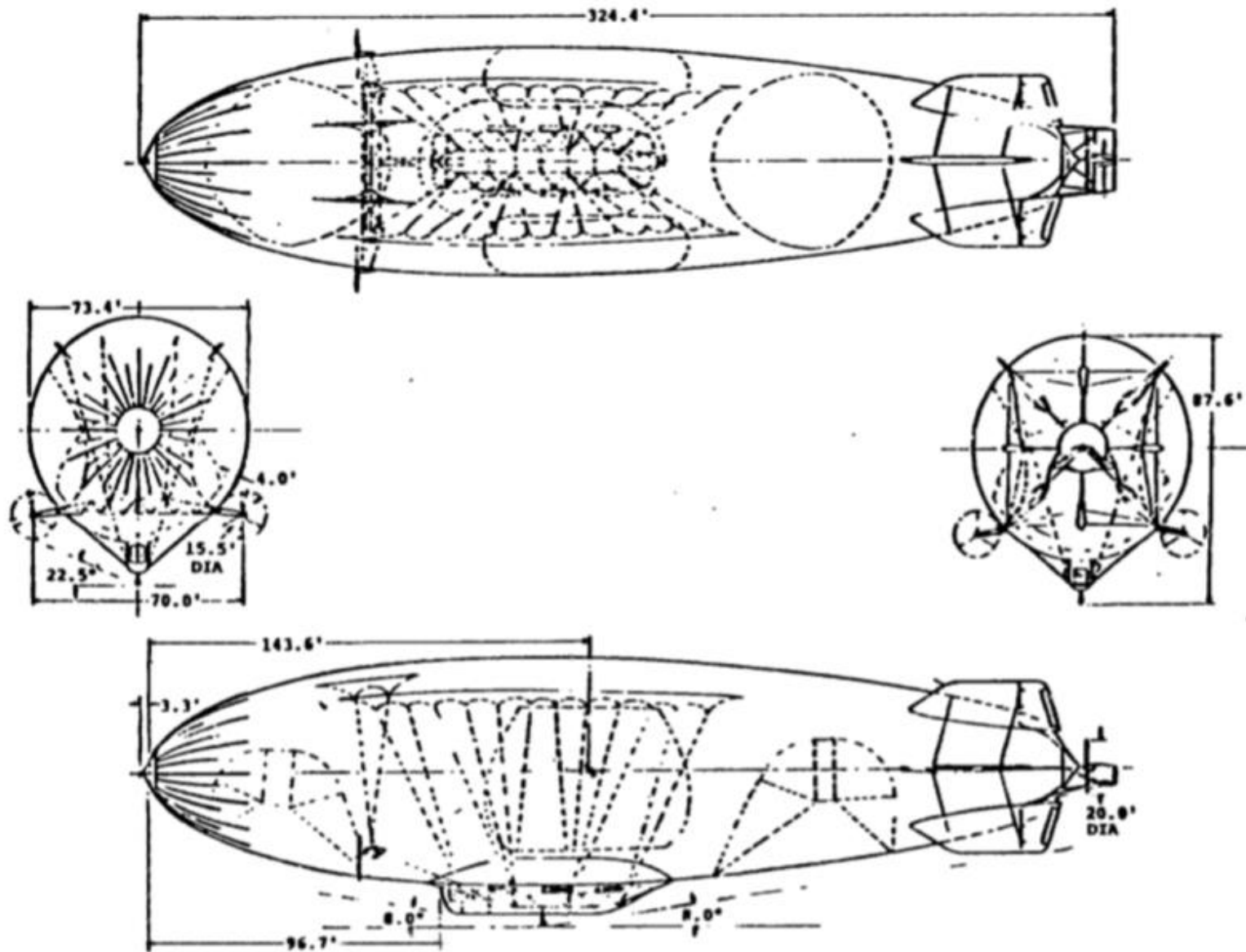
The propulsion system was comprised of three Allison GMA-500 turboshaft engines rated at 800 shp (596.6 kW) each.

- Two flank-mounted propulsors could vector from $+90^\circ$ to -90° .
 - Attached to reinforced areas of the envelope, ahead and above the gondola, and are supported by a separate catenary system that distributes engine weight and thrust loads through the upper part of the envelope.
 - Cross-shafted to permit both propellers to be driven by a single engine.
 - Engines installed horizontally, in a fixed position. The propeller gearbox and “rotating thrust axis mechanism” are mounted outboard of the engine.
- One stern mounted propulsor could vector from horizontal (0°) to $+90^\circ$ for VTOL operations.
 - Attached via reinforcements at the tail of the envelope.
 - This propulsion unit is mounted on a “Vee” tail that moves with the vectoring propeller.
 - “Ruddervators” in the propeller slipstream improve control effectiveness in hover and low speed flight.

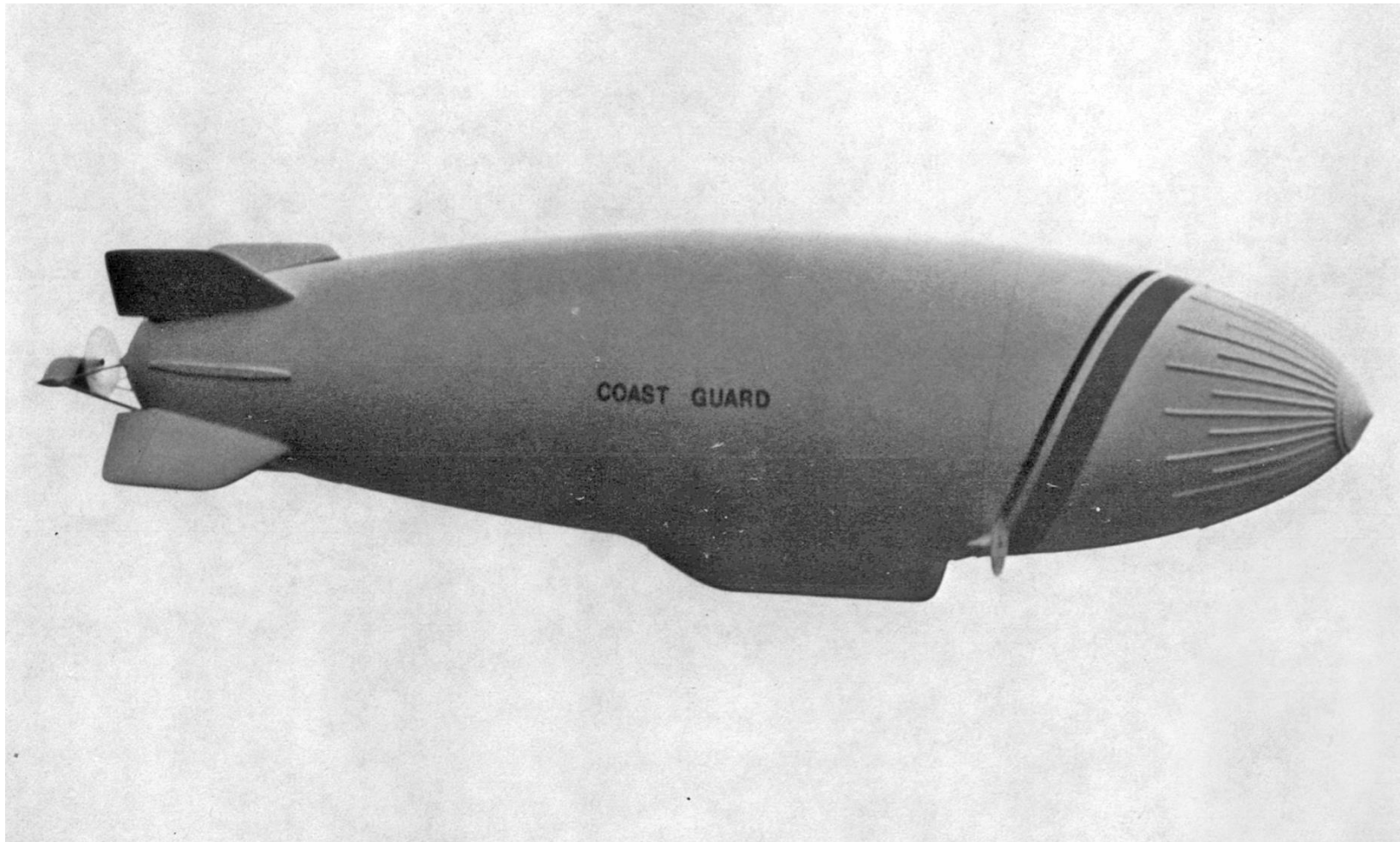
A conventional “heavy” STOL takeoff with vectored thrust required a takeoff run of just over 1,000 ft (305 m) with liftoff at 50 knots.

The gondola was 70 ft (21.3 m) long and 7.5 ft (2.3 m) wide. It is supported at the floor level by an internal and external catenary system. An inflatable rubber raft with outboard motor was stored in a compartment at the aft end of the gondola and could be deployed through a trap door by hydraulic winches.

With good low-speed control, the ZP3G could tow a passive anti-submarine sonar array or a small disabled ship (up to 400 tons).



Goodyear Aerospace Corporation ZP3G internal arrangement. Source: NADC-80149-60 (1980)



*Rendering of a Goodyear Aerospace Corporation ZP3G design in Coast Guard colors.
Source: NASA Tech Memo 81158 (1979)*

3. Bell Aerospace Textron MPA

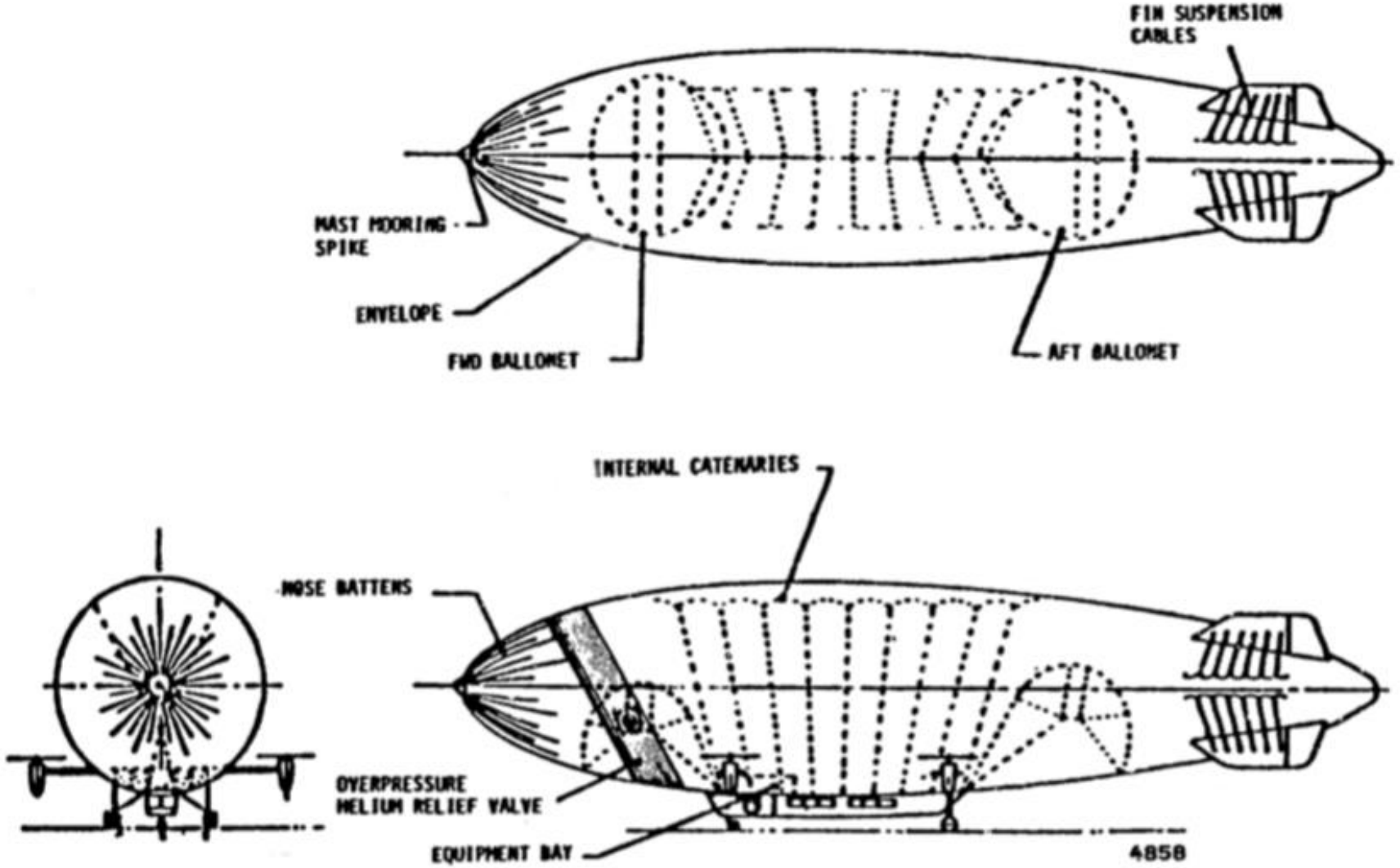
The Bell MPA design had a non-rigid, pressurized envelope with a single lift gas volume and two ballonets: forward, aft.

The Bell MPA propulsion system was comprised of four thrust vectoring turboprop engines rated at 1,077 shp (803 kW), each driving a large diameter prop / rotor. The engine and prop / rotor units were installed on transverse rigid outriggers that extend from the airship, above the front and back ends of the gondola. This placement provided clearance for the large diameter prop / rotors as they were vectored from horizontal (for cruise flight) to vertical (for vertical and hovering flight and for taxiing on the ground). In vertical flight, cyclic control of the prop / rotors provided lateral thrust and precise control of pitch and yaw. These propulsors would have been similar to the design developed by Bell and tested for NASA in 1980 – 1981 on the XV-15 (Bell Model 301) experimental VTOL aircraft.



Bell XV-15 with twin Lycoming T-53 turboshaft engines that are connected by a cross-shaft and drive three-bladed, 25 ft (7.6 m) diameter rotors. Source: NASA

The airship is initially “heavy” due to its large fuel load. Neutral buoyancy is reached when about 60% of the fuel has been consumed. When the airship returns to base, it is substantially “light.” In flight, this change in gross weight would be compensated for by the pitch angle of the hull, which adjusts the aerodynamic “up” or “down” force produced by the envelope. At the start of the flight, a heavy airship will fly with an “up” angle for added lift. Later in the flight the pitch angle will drop at zero at neutral buoyancy. By the end of the flight the airship will fly with a down angle to compensate for its increasing “lightness.” The thrust vectoring prop / rotors could be used as needed to compensate of any excess lightness or heaviness.

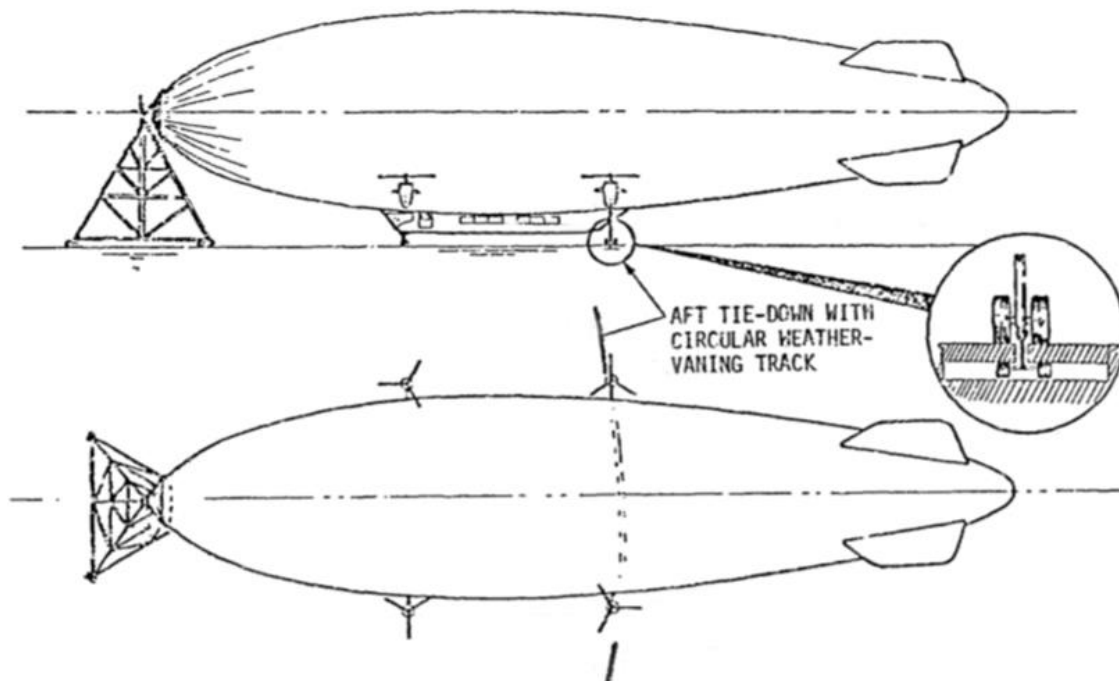


Bell Maritime Patrol Airship (MPA) internal arrangement. Source: NADC-80149-60 (1980)

The Bell MPA had twice the installed power of the Goodyear ZP3G. The Bell MPA's thrust vectoring engines gave it the ability to carry greater payload weight and operate aerostatically "light" or "heavy" over a much larger range than the NADC ZP-X and the Goodyear ZP3G. For example:

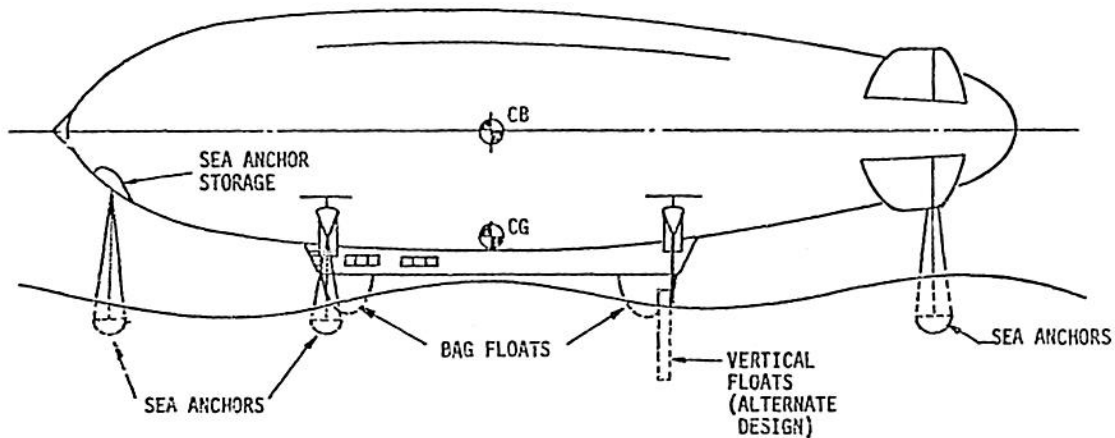
- The engines would be rotated fully up for a "heavy" vertical takeoff.
- Takeoff at an even heavier gross weight would be possible with the engines vectored less than full-up and a short takeoff run (hundreds of feet) to generate aerodynamic lift from the envelope.
- After landing "light" with the engines vectored vertically and generating a downward thrust, the Bell MPA was designed to taxi on its tricycle landing gear to a mooring mast or hangar.
- Ballast transfer would not be needed following a load exchange. The engine thrust vectors could be adjusted as needed to dynamically balance the airship.

An automated mooring system was proposed along with a tiedown on the rear landing gear that engaged a circular track and allowed the airship to weathercock, but not lift in strong winds.



Bell MPA mooring. Source: NADC-80149-60 (1980)

The Bell MPA included an inflatable flotation system to permit water landings at sea. Sea anchors extended from the nose and tail provided pitch stability in rough water.



Bell MPA floatation & sea anchor. Source: NADC-80149-60 (1980)

Acquisition cost was expected to be about \$5 million per airship based on a production run of 50 airships. The additional cost of ground facilities and training would bring the total acquisition cost to \$6.4 million per airship.

4. For additional information

- David Bailey and Harold Rappoport, "Maritime Patrol Airship Study (MPAS)," NADC-80149-60, Naval Air Development Center, 19 March 1980:
<https://apps.dtic.mil/sti/pdfs/ADA089483.pdf>
- Mark Ardema, "Missions and Vehicle Concepts for Modern, Propelled, Lighter-Than-Air Vehicles," NASA Technical Memorandum 86672, December 1984:
<https://ntrs.nasa.gov/api/citations/19850008448/downloads/19850008448.pdf>

Related Modern Airship articles

- Goodyear - N-Class blimps
- US Navy - ANVCE program airships (1976 – 1979)
- US Navy - YEZ-2A (Sentinel 1000 & 5000)