

Piasecki Aircraft Corporation (PiAC) Helistats

Peter Lobner, Updated 24 August 2021

1. Introduction:

There have been many different designs of airship / helicopter hybrid aircraft (a helistat) in which the airship part of the hybrid aircraft carries the empty weight of the aircraft itself and helicopter rotors deployed in some fashion around the airship work in concert to lift and propel the fully loaded aircraft without the need for an exchange of ballast.



Frank Piasecki founded the Piasecki Aircraft Corporation (PiAC) in 1955 in Essington, PA. From the mid-1950s through the mid-1980s, Piasecki was a major force in the development of helistat technology and flight testing in the US. The company's website is here:

<https://www.piasecki.com>

In this article, we'll take a look at PiAC helistats patents, designs and one heavy-lift helistat that actually flew, the Piasecki PA-97-34J.

2. Piasecki helistat patents

Piasecki Patent US 3,008,655, "Helicopter and Balloon Aircraft Unit" (1958)

Frank Piasecki filed a patent application for a "Helicopter and Balloon Aircraft Unit" on 17 March 1958 and received Patent US 3,008,655 on 14 November 1961. This patent described an early concept for a helistat with a large, spherical helium balloon coupled to a central load beam that was connected to two tandem-rotor helicopters by a rigid cross beam. The helicopters have an integrated control system that enables a single pilot to fly the helistat. This general configuration is shown in the following figure.

Nov. 14, 1961

F. N. PIASECKI

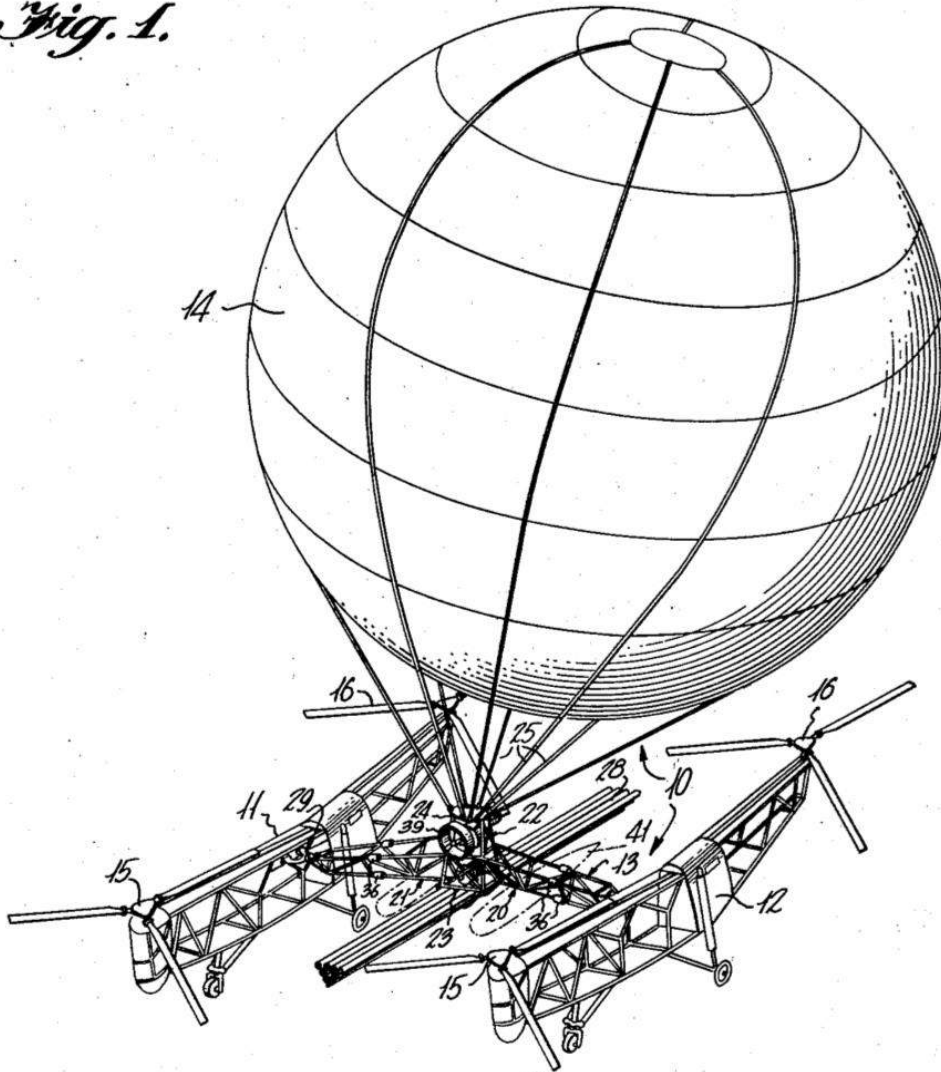
3,008,665

HELICOPTER AND BALLOON AIRCRAFT UNIT

Filed March 17, 1958

3 Sheets-Sheet 1

Fig. 1.



As described in the patent,

“The present invention relates in general to helicopters, and more particularly to an assembly of a plurality of interconnected helicopters and a balloon forming an aircraft unit particularly suitable for transporting heavy loads..... beyond the normal capability of helicopters.”

You can read Patent US 3,008,655 here:

<https://patents.google.com/patent/US3008665>

Piasecki Patent US 4,591,112A, “Vectored thrust airship” (1979)

On 12 October 1979 Frank Piasecki and Donald Meyers filed a patent application for a “Vectored thrust airship,” which was a more advanced design for a helistat, with a large blimp-shaped aerostat connected to four individual helicopters with an integrated control system flown by a single pilot. They received Patent US 4,591,112 A on 27 May 1986. The patent describes the basic design and operation of this helistat as follows:

“An airship with provisions for vectored thrust provided by a plurality of controllable pitch rotor thrust producing units attached to the elongated aerostat hull spaced from and on opposite sides of the center of overall mass of the airship. The pitch control systems for the rotors of all thrust units include collective and cyclic pitch controls of the main, horizontally rotating lifting rotors and the control systems are interconnected to be operable by a master control which establishes both similar and differential pitch settings of the rotors of selected thrust units in a manner to establish vectored thrust in directions which establish the required amounts of vertical lift, propulsion thrust, trim and control forces to control all flight aspects of the airship.”

You can read Patent US 4,591,112A here:

<https://patents.google.com/patent/US4591112A/en>

Frank Piasecki notes, “Semi-rigid pressure envelopes or rigid envelopes can be adapted to the Hell-Stat concept. The longitudinal and lateral support beam structure, which serves to attach the helicopters and support the payload, can be tied structurally to the structural frames of the rigid envelope. In the case of the semi-rigid (envelope), the helicopter attachment and load-support beams can be made integral with the fore-and-aft keel structure.”

The patent includes several helistat design concepts, including the following:

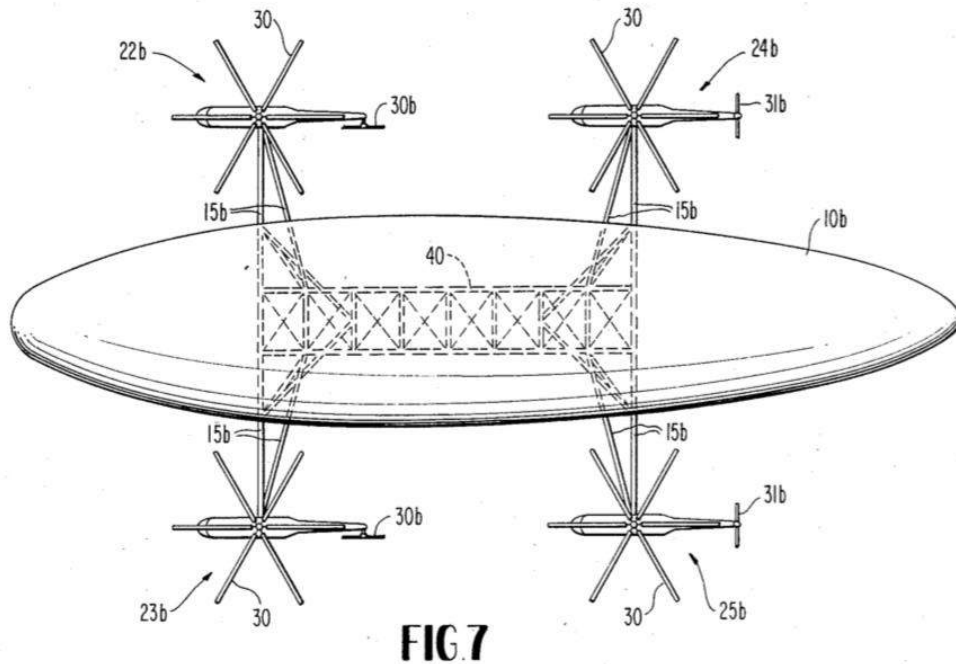


FIG. 7

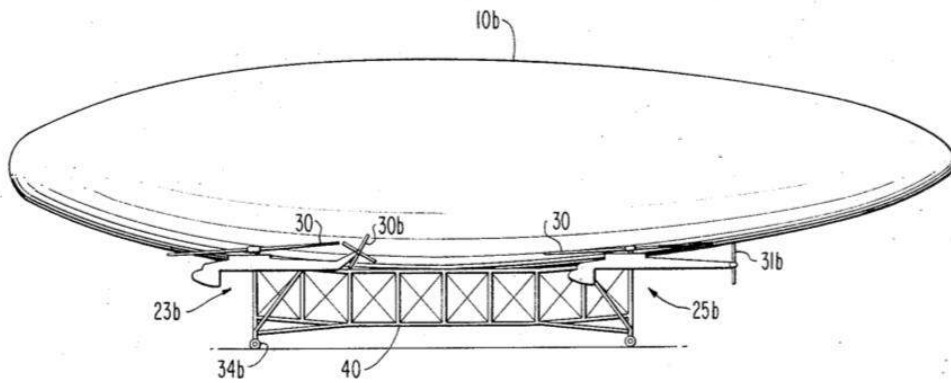


FIG. 8

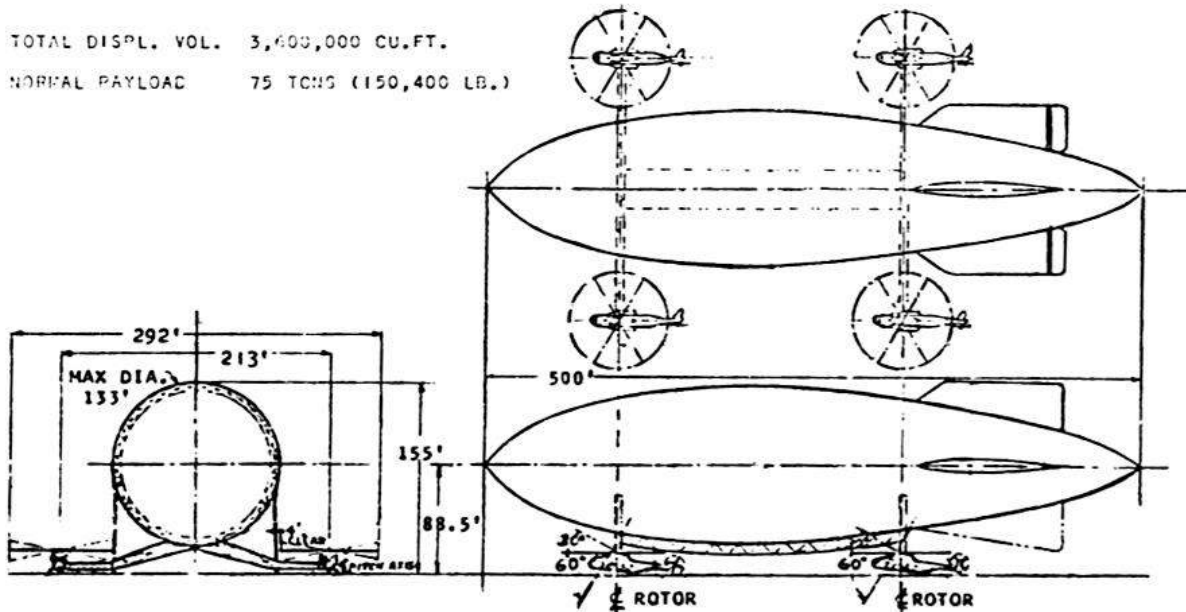
The above helistat is comprised of a non-rigid lift gas envelope (10b) and four helicopters (22b, 23b, 24b & 25b) that are connected via cantilever arms (15b) to the rigid keel structure (40).

The basic design of the later PA-97-34J helistat was very similar to the one shown in patent Figures 7 and 8.

3. Piasecki early helistat concept designs

The Piasecki 75 ton project X-97-0004 (1975)

This helistat design concept had a 75-ton (68 metric ton) payload capacity based on using four existing CH-53D heavy-lift helicopters and an aerostat with a gas envelope volume of 3,600,000 ft³ (102,000 m³). The gas envelope's overall length was 500 ft (152.4 m), with a diameter of 133 ft (40.5 m). The helistat had an overall height of 155 ft (47.2 m) and an overall width with rotors operating of 292 ft (89 m).



DWG. 97-X-0004. HELI-STAT WITH FOUR CH-53D'S
FIGURE 2

Project X-97-0004 . Source: Frank Piasecki (1975)

The 75 ton helistat had the following general characteristics:

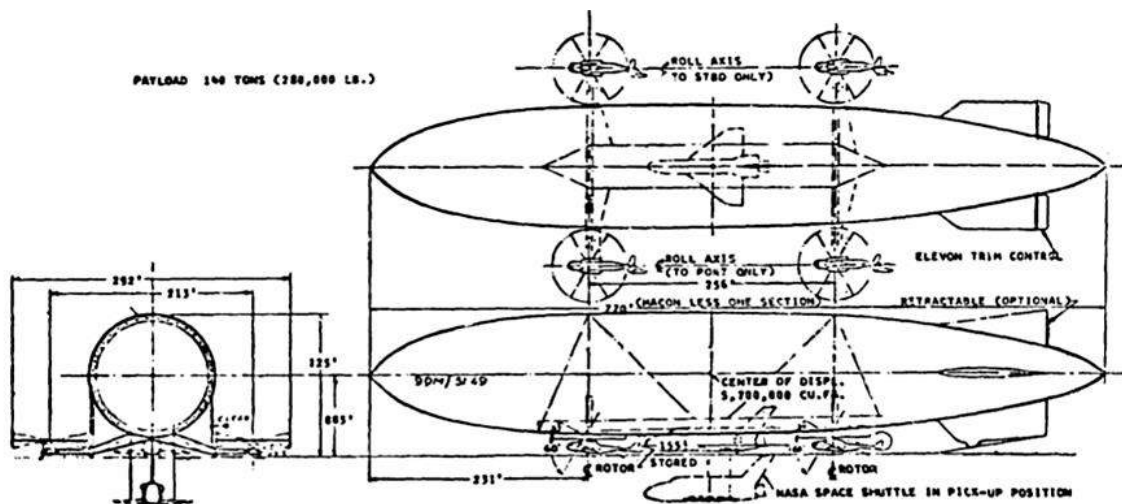
- Maximum gross weight: 345,940 lb (156,915 kg)
- Empty weight: 177,540 lb (80,531 kg)
- Useful load (payload, crew, fuel & oil): 168,400 lb (76,385kg)
- Payload: 150,400 lb (68,220 kg)
- Cruise speed: 100 mph (161 kph)
- Operating altitude (ferry): 10,000 ft (3,048 m)
- Hover ceiling: 6,000 ft (1,829 m)
- Rate of climb: 500 fpm (vertical), 2,000 fpm (forward flight)

- Range (full load): 160 miles (257 km)
- Range (ferry): 2,000 miles (3,219 km)

The Piasecki 140 ton project X-97-0011 "Gargantua" (1975)

Project X-97-0011 "Gargantua" was a design concept for a huge helistat with a 140 ton (127 metric ton) payload capacity. This helistat was created from four Sikorsky CH-53E heavy-lift helicopters connected to a rigid (dirigible) airship with a gas envelope volume of 5,700,000 ft³ (161,400 m³). The aerostat had the streamlined shape of the Navy's 1930-vintage dirigible *Macon*, but with one less middle section in the hull. Gargantua had an overall length of 770 ft (234.7 m), a hull diameter of 133 ft (40.5 m) and an overall height of 125 ft (38.1 m). Overall width with the rotors operating was 292 ft (89 m).

The Gargantua was designed for transporting the National Aeronautics and Space Administration (NASA) Space Shuttle and other very large cargo items. There was a longitudinal recessed cargo bay under the hull that would have enabled the Space Shuttle to have been hoisted up and carried as a semi-submerged load, with only the wings and lower fuselage outside of the cargo bay.



DWG. 97-X-0011. "GARGANTUA" HELI-STAT, MACON AND FOUR CH-53E'S
FIGURE 1

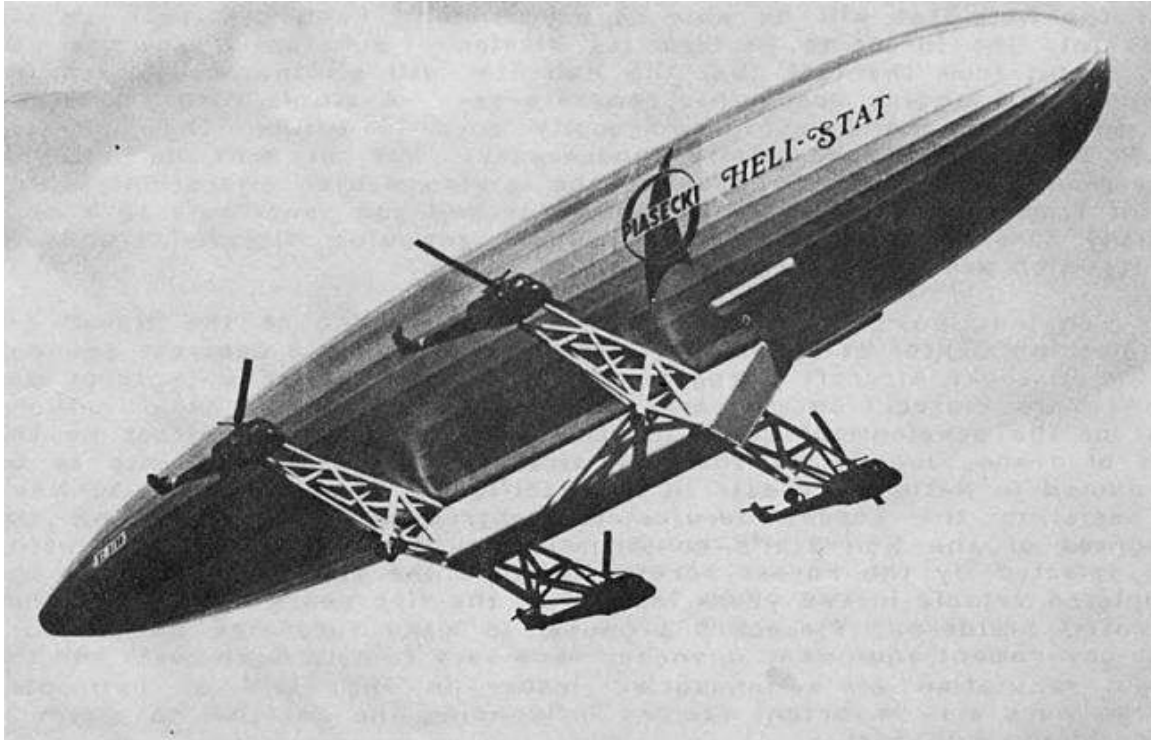
Project X-97-0011 "Gargantua" helistat. Note scale relative to the Space Shuttle. Source: Frank Piasecki (1975)

The Piasecki project PA-97-212B helistat (1977)

The 1977 project PA-97-212B helistat was designed to use four Bell 212B (UH-1N) "Twin Huey" utility helicopters.



*The Piasecki helistat concept for the Forest Service.
Source: Piasecki*



*The project PA-97-212B helistat with 4 x Huey helicopters.
Source: Piasecki Aircraft Corporation via US Forest Service*

4. The Piasecki PA-97-34J helistat (1979 – 1986)

In the early 1970s, the US Forest Service initiated Project Falcon, which was a research and development program for advanced logging systems to "...provide more wood products for a growing population and, at the same time, accommodate an increasing concern over the natural environment." In the late 1970s, Piasecki proposed a helistat to the Forest Service to demonstrate a heavy vertical airlifter for harvesting timber from inaccessible terrain. The Forest Service expected the helistat to carry 25 tons (one truckload, 22.7 metric tons) of timber for distances of up to 5 miles (8 km) over steep mountainous terrain.

The Forestry Service funded development and testing of the PA-97-34J in 1980 via a \$10.7 million contract administered by the Naval Air Development Center. Total program cost was expected to be \$25 million, with \$11 million for helistat construction and flight testing and \$14 million for a planned three-year demonstration phase in the Gifford Pinchot National Forest in Washington State. The Forest

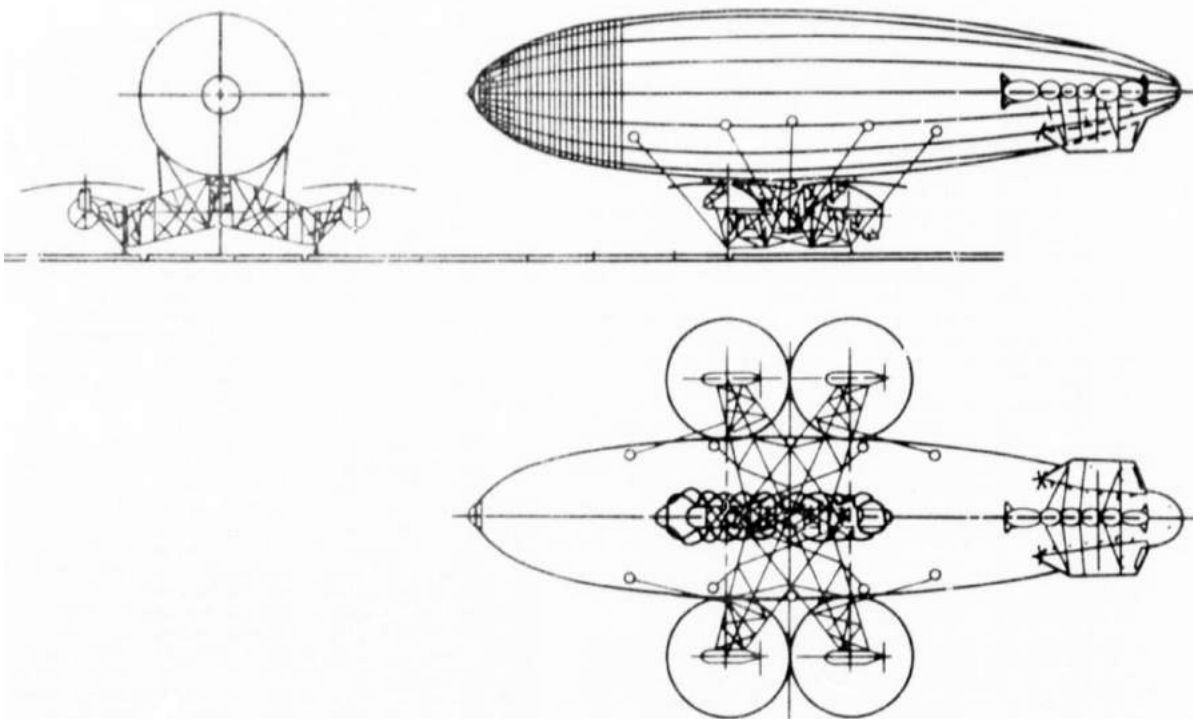
Service expected to recover most of the helistat project costs through timber sales during the demonstration phase, when the helistat was expected to harvest nearly \$19.6 million worth of timber.



Piasecki helistat concept for the Forest Service with 4 x Sikorsky H34J helicopters. Source: Piasecki

In addition to forest management, Piasecki saw applications for their helistat for patrolling sea areas, transporting military equipment, unloading cargo ships, building power lines, oil rigs, residential and office buildings.

Piasecki PA-97-34J was a very large semi-buoyant hybrid airship comprised of a retired Navy ZPG-2W blimp gas envelope, which formed the helium-filled aerostat, and four Sikorsky H-34J helicopters without their tail sections, connected beneath the blimp via a rigid framework.

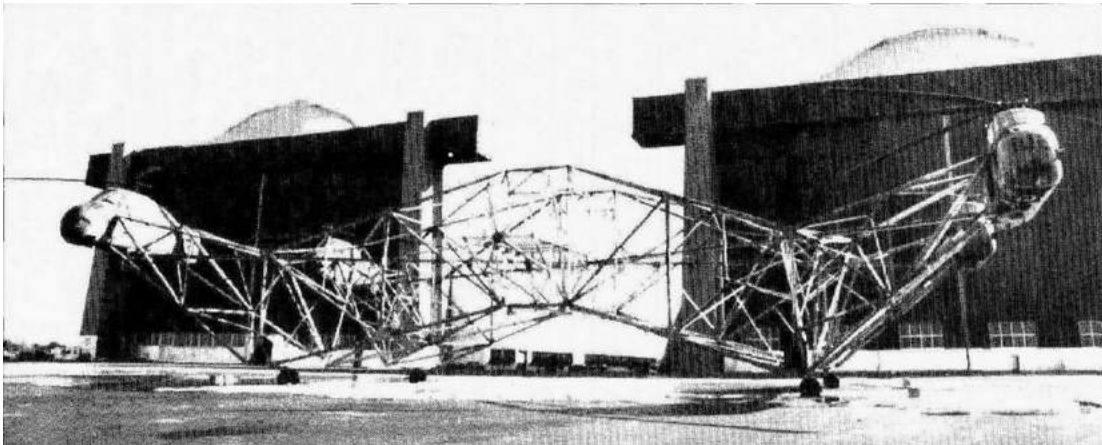


PA-97-34J three-view drawing. Source: UNIDO (1983)

The basic design parameters for this helistat were:

- Overall length: 343 ft (105 m)
- Overall height: 113 ft (34.4 m)
- Maximum width (rotors turning): 188 ft (60.6 m)
- Aerostat gas volume: 1,000,000 ft³ (28,317 m³)
- Gross weight: 107,051 lb (48,558 kg)
- Empty weight: 54,885 lb (24,895 kg)
- Aerostatic lift: 55,851 lb (25,334 kg)
- Dynamic lift: 51,200 lb (23,223 kg)
- Useful load (payload, crew, fuel & oil): 52,166 lb
- Cruise speed: 60 knots
- Working range (with reserves): 143 miles (230 km)
- Rate of climb: 100 fpm (vertical), 950 fpm (forward flight)
- Ceiling: 8,000 ft (2,438 m)
- Hover ceiling: 3,000 ft (914 m)

In June 1981, the General Accounting Office (GAO) reviewed the Forest Service's helistat demonstration program and recommended that program objectives and progress be reevaluated. At issue were the lack of end user input to the operational requirements for helistat logging and a concern that the PA-97-34J may not actually be suited for demonstrating the economics of aerial logging.



*Rigid framework for PA-97-34J.
Source: Flight Int'l 18 Feb 1984*



*Frank Piasecki & rigid helicopter framework for PA-97-34J.
Source: Flight Int'l 18 Feb 1984*

One pilot in the left rear helicopter cockpit flew the helistat. Flight engineers occupied the other three cockpits. The first static tests of the helistat's structure were carried out in 1983. The first tethered flights occurred in October 1985 at Lakehurst Naval Air Engineering Station. The PA-97-34J made its first free flight on 26 April 1986.



Piasecki PA-97-34J helistat. Source: US Navy via Wikipedia



Piasecki PA-97-34J helistat in flight. Source: US Navy



PA-97-34J in flight with US Forest Service markings.

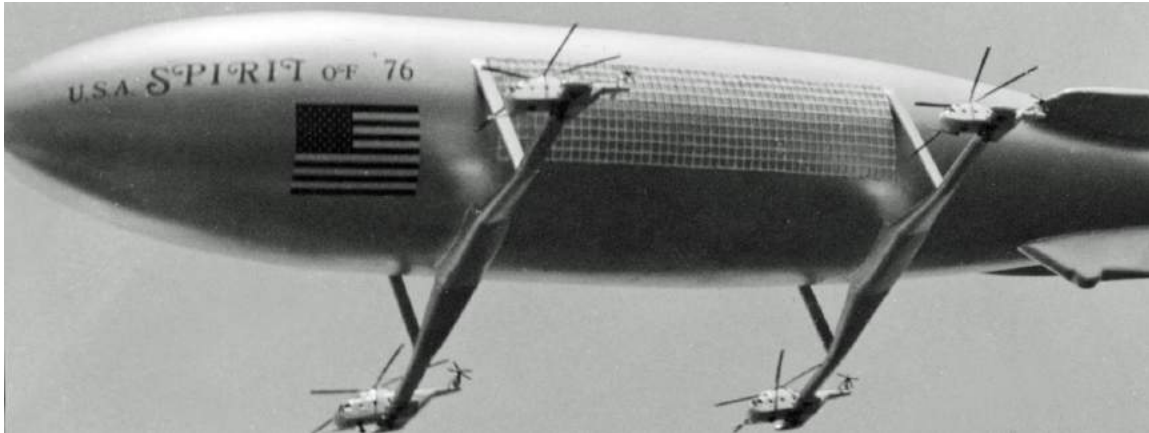
Source: Piasecki Aircraft Corporation via Planes in Polish Aviation

After 15 test flights, the PA-97 was destroyed during a flight test at Lakehurst on 1 July 1986, after a vibration-induced structural failure resulted in the starboard-aft helicopter breaking free from its mounting and its rotors cutting the aerostat's gas envelope. The other three helicopters also separated from their supporting framework during the crash, which killed one member of the flight crew. Development of the PA-97-34J was discontinued after the crash.

You can watch a short (4:58 minute) video, "Piasecki PA-97 Helistat - The craziest aircraft you have never heard of," at the following link: <https://www.youtube.com/watch?v=qaUhdDLv8Qk>

5. Piasecki advanced helistats

The Piasecki PA-97-34J was the first, and only, US helistat to fly. Piasecki had expected that this helistat would be the precursor to much larger helistats. The Vertical Flight Society reports that "Helistat payload capacities of up to 280 tons have been designed, but no upper limit has been set on the combined helicopter and airship lift capacity."



*Example of a Piasecki advanced helistat design, circa mid-1980s
Source: Piasecki via Vertical Lift Society*

12. For more information

- Frank Piasecki, “Ultra-heavy vertical lift system: The Heli-Stat,” Proceedings of the Interagency Workshop on Lighter than Air Vehicles, NASA-CR-137800, pp. 465 - 476, Doc ID 19760007967, 1 January 1975:
<https://ntrs.nasa.gov/citations/19760007967>
- Bernard Carson, “An Economic Comparison of Three Heavy Lift Airborne Systems, N76-12023, NASA Technical Report Server, circa 1975:
<https://ntrs.nasa.gov/api/citations/19760007935/downloads/19760007935.pdf>
- William J. White, “Airships for the Future,” pp. 142 - 143, “Heli-Stat,” Sterling Publishing Co., Inc., New York, ISBN 0-8069-0090-3, 1976
- “PA-97: Multiple helicopter Heavy-Lift System,” Piasecki Aircraft: <https://piasecki.com/wp-content/uploads/2018/12/PA-97.pdf>
- “Heli-Stat Fact Sheet,” Department of Agriculture, Forest Service, circa 1980: https://foresthistory.org/wp-content/uploads/2011/04/Heli-Stat_factsheet.pdf
- “Piasecki PA-97 ‘Heli-Stat’, 1975” (in Polish), Planes in Polish Aviation:
<http://www.samolotypolskie.pl/samoloty/14640/126/Piasecki-PA-97-Heli-Stat2>

- “Need to Reevaluate Helistat Program Objectives and Progress,” Report MASAD-81-31, General Accounting Office, 2 June 1981: <https://www.gao.gov/assets/140/133372.pdf>
- Anthony J. Dolman, “Current and Possible Future Developments in Lighter-Than-Air (LTA) System Technology,” Section 7.2, “The Piasecki Helistat,” United Nations Industrial Development Organization (UNIDO), 1983: <https://open.unido.org/api/documents/4793600/download/CURRENT%20AND%20POSSIBLE%20FUTURE%20DEVELOPMENTS%20IN%20LIGHTER-THAN-AIR%20>
- “ASN Wikibase Occurrence # 40405” (PA-97 crash 1 July 1986), Aviation Safety Network: <https://aviation-safety.net/wikibase/40405>
- Eben Lehman, “From Aerologger to ‘Balloondoggle’,” Forest History Society, 29 April 2011: <https://foresthistor.org/from-aerologger-to-balloondoggle/>

Related *Modern Airship* articles

- Helistats
- Goodyear Aerospace - Dynastat & airline feeder
- Goodyear Aerospace - Quad-rotor heavy-lift helistats
- SkyHook International & Boeing - JHL-40 HLV
- Hélicostats
- Obélix
- Bothe - Helitruck