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In-Depth Review of the 1979 AIAA Lighter-Than-Air Systems Technology Conference

Mark D. Ardema

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National Aeronautics and
Space Administration



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Mark D. Ardema, Ames Research Center, Moffett Field, California



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Ames Research Center
Moffett Field, California 94035

In-Depth Review of the 1979 AIAA Lighter-Than-Air Systems Technology Conference

By MARK D. ARDEMA
Ames Research Center

The AIAA 1979 Lighter-Than-Air (LTA) Systems Technology Conference was held July 11-13 in Palo Alto, California. One hundred thirty-two (132) registered conferees heard 40 technical papers organized into seven sessions over the three-day period (see Appendix). Highlights of the Conference were: (1) the strong interest shown in patrol and surveillance airships, particularly for coastal patrol missions; (2) the session devoted to overviews of foreign activity; (3) the conference luncheon which featured an address by Morris B. Jobe, President of Goodyear Aerospace and included addresses by highranking Coast Guard and Navy officers; and (4) the presence of the Goodyear advertising airship Columbia, in which many of the conference attendees went for rides.

The 1979 meeting was the third in a series of AIAA LTA conferences. The first was held in 1975 in Snowmass, Colorado, and the second in 1977 in Melbourne, Florida. Continuing the tradition of biannual meetings, the next LTA conference has been tentatively scheduled for the summer of 1981 in Annapolis, Maryland.

Comparing the 1979 conference with the two previous ones shows that significant progress has been made in the LTA field in the last four years. Quantitatively, there were more papers presented than ever before. The larger number of papers submitted allowed the program committee to be more selective than in previous years and the result was a noticeable improvement in the technical content of the papers presented. Another significant change over the two previous conferences was the large number of papers concerned with specific applications. In spite of attempts to solicit papers on LTA applications from potential users, past meetings have been dominated by papers on vehicle concepts and parametric studies. At the 1979 meeting, however, four of the seven sessions focused on specific application areas.

The following is a chronological review of the seven sessions and the luncheon.

Patrol and Surveillance

The first three papers in this session were devoted to potential U.S. Coast Guard applications for LTA vehicles. In the first of these, Milton described Coast Guard responsibilities and missions. The key issues for LTA vehicles performing these missions are cost effectiveness and weather limitations on operations. Milton pointed out that adverse weather degrades the performance of all existing surface vessels and air vehicles and an

airship may be no worse in this regard. However, a research vehicle is needed to answer this and other operational questions.

In the next paper, Rappoport described selected Coast Guard missions in more detail. Many of these missions seem to offer good potential for LTA application. The most promising seems to be the Coastal Surveillance mission which is primarily concerned with illegal drug traffic and unlawful fishing activity within the 200-mile limit. For this mission, the airship offers an attractive compromise between the attributes of heavier-than-air craft (high speed but low payload and endurance) and surface ships (high payload and endurance but low speed). A hover-capable airship would be needed. Rappoport estimated the potential U.S. Coast Guard market for an airship of a 800,000 ft³ size to be about 45 vehicles.

Brown discussed an airship design to meet the Coast Guard mission requirements (Figure 1). The envelope size would be 875,000 ft³ giving a static gross lift of about 55,000 lb at sea level. A propulsion system of three turboshaft engines and propellers, offers the best compromise between low and high speed performance and weight. The stern propulsor would be vectorable to provide low speed control. This vehicle is projected to have impressive performance for many Coast Guard missions.

The potential role of airships for oceanography was assessed by Stevenson. Although surface vessels will continue to be indispensable for work in oceanography, there are tasks which they cannot do because of their limited field of view. For example, a high-endurance air vehicle such as an airship would be ideal for large-scale mapping of ocean turbulence, temperatures, and currents. This information is of interest to fisheries, surface vessel operators, the U.S. Navy, and others. An airship which would satisfy this application would be similar in size to the Coast Guard airship design discussed in Brown's paper.

The last two papers in the session were concerned with LTA vehicle application to ASW (antisubmarine warfare), AAW (antiair warfare), and AEW (airborne early warning). Kinny and Handler, in two separate but related papers, indicated that airships could be much more effective than existing vehicles for many of these applications. In particular, an airship would be an ideal platform for large phased-array radar. The vulnerability of the airship performing these missions may not be significantly worse than for existing vehicles. Kinny felt that a prototype vehicle is necessary to prove the LTA operational concepts.

Heavy Lift

The first three papers of this session dealt with heavy-lift applications exclusively while the last two had more general applicability. Gray's paper described a computer program which has been developed to do sizing, weight, and cost estimating for the buoyant quad-rotor (or Heli-stat) heavy-lift airship (HLA) concept. Figure 2 shows an example of this concept. The program has 58 inputs and breaks down the vehicle into 38 elements for weight and cost estimating.

As an example, the program predicts that for a moderate size production run, an 80-knot, 75-ton payload vehicle would cost \$25 million to buy and have a direct operating cost of \$2,900/hour.

Mettam gave a summary of the NASA-sponsored study of civil markets for heavy-lift airships. The primary goal of this study was to estimate the potential maximum number of HLA vehicles required to competitively satisfy worldwide markets for heavy lift in various payload sizes. Significant markets were identified in the 25-75 ton payload range (principally logging and ship off-loading) and in the 100-400 ton payload range (principally in heavy construction such as powerplants). The greatest potential market in terms of number of vehicles appears to be logging, and Mettam discussed the analysis of the logging market in some detail.

Use of airships in logging was further examined by Erickson. Current typical logging costs are: ground (cable) -- \$14/1,000 board feet; balloon -- \$23; and helicopter -- \$42. Use of the helicopter is limited by its high operating cost and low range. An HLA could extend the use of aerial logging and lead to better forest management by enabling the harvesting of timber that would otherwise be lost. Use of HLA's will be highly dependent on vehicle operating cost. The question of whether or not to use the HLA must be determined by a detailed analysis for each tract of timber.

Topping discussed the structural loads due to gusts on airships, particularly of the HLA type. He indicated that the loads could be much higher for "heavy" airships than for neutrally buoyant or "light" ones. This provides an incentive for minimizing "heaviness" in LTA vehicles.

Development of a computerized finite element program for three-dimensional membrane structures was described by Sampath. Two membrane elements are available and the program uses Rayleigh's method to solve for natural frequencies and modes. Application to an HLA configuration has shown that the added mass of the adjacent outside air and the inside lifting gas is very important in vibration analyses of airship envelopes.

Overviews of Foreign Activity

This session began with a review of British activity by Nayler. LTA activity in the United Kingdom has consisted largely of part-time efforts by individuals and development work by small companies. There has been no LTA funding by the British Government. Companies engaged in LTA development and promotion include Aerospace Developments, Airfloat Transport, Cameron Balloon, Skyships, Solar Airship, Thermo-Skyships, and Thunder Balloons. Perhaps the most significant recent development has been the construction and first flight of the AD-500 airship by Aerospace Developments (Figure 3).

Laurie-Lean covered recent Canadian activity, including a market study of LTA application in the province of Alberta by Goodyear, a study of natural gas transportation by LTA vehicle, and an ongoing study of LTA vehicle concepts and related markets by CANADAIR. A recent productivity analysis showed that LTA vehicles are not competitive with fixed-wing transport airplanes for productivity missions, a finding in agreement with many past studies. Current Canadian needs for which LTA vehicles seem to offer good promise are short-haul/heavy-lift and coastal patrol. Laurie-Lean stated that there is a need for proof-of-concept vehicles for these applications.

Japanese LTA activity was reviewed by Iinuma. The two earliest applications for LTA vehicles in Japan are likely to be for short-haul/heavy-lift and for intercity passenger transportation. The electric power industry is investing \$6.5 billion in new plant construction per year in Japan, and an HLA seems to have great potential for reducing the costs of moving heavy plant components. Twenty-five million dollars is being sought from the Japanese Government for development of an HLA. Short-haul passenger transportation is a continuing problem in Japan due to mountainous regions and open water separating many of the principal population centers. An airship may be a competitive form of passenger transportation system in this special geographical situation.

Muller began by reviewing the LTA symposium held by AERALL earlier this year in Paris. He then described the Helicostat and Dynasoar Projects in France. The Helicostat is a HLA concept employing two helicopter propulsion systems. With a payload of 2-4 tons, it would be used principally in logging. Development of the Helicostat is currently inactive. A movie shown by Muller of a flight of a radio-controlled subscale model of the Dynasoar concept demonstrated that the model has good performance and controllability.

An exposition by deHeer on transportation problems in Hawaii was included in the session on foreign activity. Distribution of people and goods among seven islands and high-prevailing winds and seas make intrastate transportation difficult in Hawaii. Current service is provided by barge and aircraft but is somewhat inadequate from cost and dependability standpoints. LTA vehicles are seen as a potential solution and the Hawaii State Government is considering doing preliminary studies of an LTA inter-island transportation system.

Luncheon

Prior to Jobe's luncheon speech, brief addresses were given by Rear Admiral Alfred P. Manning (Chief of the Office of Research and Development of the U.S. Coast Guard) and Rear Admiral Carl J. Seiberlich (currently Commander of Naval Military Personnel, U.S. Navy). Manning discussed current Coast Guard needs for improved patrol and surveillance capability.

Recent legislation by the Congress (extension of territorial waters to 200 miles offshore, requirement to keep track of all oil tankers in U.S. waters, etc.) has greatly increased the Coast Guard's responsibility. Since available resources have not kept pace with these increased responsibilities, new, more efficient patrol and surveillance systems are needed and LTA vehicles are seen as a possibility. In addition to their good performance in endurance missions, airships would provide other benefits such as increased "presence" and improved environment for flight crews.

Seiberlich, the 1979 Chairman of the AIAA's LTA Technical Committee, reviewed recent progress in LTA starting with the Interagency Monterey Workshop in 1974. He stated that the field has now reached the point where serious development effort should be considered. What is needed, he feels, are proof-of-concept vehicles for the heavy-lift and coastal patrol applications. Seiberlich, who has over 4,000 hours of LTA flight time, also made favorable comparisons of LTA crew environment qualities with those of other types of aircraft.

Jobe began his address by briefly reviewing the past history of LTA development and accomplishments. He then summarized recent work in LTA R & D and market assessment. The results of this work provide convincing evidence that there are viable roles for modern LTA vehicles. Jobe stated that development programs for operational vehicles are now warranted for both the heavy-lift/short-haul and coastal patrol and surveillance applications. The major obstacle to beginning these development programs is the difficulty of obtaining the initial investment capital. In Jobe's view, the development cost of the patrol airship should be born by the U.S. Government since it would be the principal user, whereas most of the development cost of an HLA concept could (and should) be borne by private industry. However, the initial, relatively high risk portion of the HLA R & D cost should logically be funded by the Government as an inducement to industry to develop the operational vehicle.

Aerodynamics, Flight Mechanics and Control

In the paper by Dalton a rapid calculation method was described for computing the shapes of streamlined bodies in axially symmetric flow that have a prescribed velocity or pressure distribution. The method involves an iterative procedure using line sources and sinks on the axis and converges typically within several iterations to the desired pressure distribution. The boundary-layer method used can treat the thickened viscous flow on the boat-tail. Several examples were given for bodies for which data on pressure distributions are available.

A complete design concept and plan for obtaining static forces and moments on a small scale Heli-stat-type HLA model in a wind tunnel was described by Schwind. The work was sponsored by NASA as part of its technology development program for HLA vehicles. The data will be used in support of flight dynamics simulation. For reasons of simultaneous Reynolds

number and rotor downwash scaling, the NASA 12-Foot Pressure Wind Tunnel was identified as being the only small-scale tunnel in which the tests can be run. The model will have great flexibility in terms of hull shape, rotor placement, rotor tilt (to simulate cyclic pitch), and model attitude relative to the wind.

DeLaurier described the development of equations of motion in both the pitch and yaw planes (uncoupled) for conventional airships. The equations are linearized about a given trim point with simple control input and can account for heaviness of the airship. The theory was applied to two early rigid airships and a more recent inverted-Y-tail airship for which some data on stability derivatives are available. The resulting predicted motions are related to qualitative observations of the handling qualities of these airships. Interesting parallels were drawn between types of airship motions and classical stability behavior of aircraft.

Curtiss described results of a theoretical and experimental investigation of the Aerocrane HLA concept. A 10-m diameter radio-controlled flying model was tested in the airship dock at Lakehurst to determine its hovering and forward flight handling qualities. Results showed good agreement with a theoretical model of vehicle motion. The influence of end plate controls on the rotors in supplying direct side force was investigated theoretically and found to be an attractive means of propelling the vehicle without the necessity of tilting the hull and rotor plane.

Recent work on simulation of the pitch plane flight dynamics of an HLA configuration was described by Nagabhushan. With a single point suspension for payload, an instability was identified for longitudinal motion very similar to an instability found in the previous paper for the Aerocrane. Attention was drawn to the many ways in which control can be effected on this vehicle concept, which has tail controls, collective and cyclic main rotor pitch, and thrust control on vertical propellers for cruise thrust. Nagabhushan stated that there is a need for good simulation studies to determine optimum methods of control.

In continuation of the same subject, Meyers described some work concerned with methods of controlling the Heli-stat HLA. Use of rotor collective and cyclic pitch to provide trim under various conditions of wind, vehicle attitude, and load was described.

In his paper, Pavilecka described some recent studies on providing direct thrust at the bow and stern of a conventional airship hull to control its motion. The studies apply modern technology to a concept first demonstrated in the early 1930's in Italy and showed apparent savings in weight of the direct thrust approach over the use of conventional tail surfaces. A lively discussion following the presentation centered on the assumptions made with regard to energy consumption in thrust control of a statically unstable airship.

Long Range Transportation

Brewer presented the results of a study of the productivity of fully air-buoyant (FAB) and semi-air-buoyant (SAB) airships in long-range transportation missions. For FAB's, a closed-form solution was obtained for optimum values of cruise speed and productivity. It was found that for maximum productivity two-thirds of the useful load should be payload and one-third should be fuel. This results in an inverse relationship between range and optimum speed. The SAB's were analyzed for a variety of conditions and it was found that: (1) the best mode of operation (e.g., flight at maximum lift-to-drag ratio, flight at constant speed, ballast collection versus no ballast collection) depends on the range to be flown and (2) SAB's and FAB's have roughly equivalent productivity performance, with SAB's tending to be somewhat better at short range and FAB's somewhat better at long range.

The potential of airships for strategic airlift was discussed by Pasquet. Current airlift capability is only about one-third of that which would be needed for a major European contingency, leading to a search for new systems. Although an airship would have low productivity as compared with transport airplanes, an airship would have much lower fuel consumption per ton of payload delivered. This means that refueling in Europe would not be necessary, thereby not depleting fuel stocks. The U.S. Air Force has no current plans to increase their LTA activity past the preliminary study stage.

The subject of strategic airlift by LTA vehicles was continued by Glod. He stated that generally airships have been found to be competitive only in situations where airplanes are unable to do the job well or at all. Examples of such cases are transportation over very long ranges or to remote, unprepared sites. A study of strategic airlift from the United States to Europe showed that a low-aspect ratio SAB was the best LTA vehicle. Large numbers of airships would be required to satisfy this mission.

Mackrodt gave the results of further parametric study of a hybrid airship concept which consists of an axially symmetric lifting gas envelope and a slender delta wing (aspect ratio 1.5). The delta wing hybrid was found to be superior to other types of airships and also to transport airplanes in terms of payload/range capability and fuel efficiency.

Airworthiness requirements for modern airships as they are evolving in the United Kingdom were discussed by Niedermayer. Formulation of these requirements began in 1976 when Aerospace Developments applied for a Certificate of Airworthiness for the AD 500 Airship. Items considered so far include flight requirements (both performance and handling qualities), structural requirements, design and construction requirements, and engine and other equipment installation. Niedermayer stressed that the work done up to now is just a beginning and that much more effort will be needed to develop suitable airworthiness requirements for the types of modern airships currently being proposed.

New high-strength fibers with possible application to LTA vehicles were described by Horn. Properties of many of these fibers were presented. It was concluded that Kevlar holds great promise as an airship structural material, especially in uniaxial loading members such as ropes and cables. Use of Kevlar in these and other applications will significantly improve the performance of LTA vehicles.

High Altitude Platforms

This session included reports of studies on the uses of remotely-piloted vehicles operating in the strato-null region of the atmosphere (approximately 50 mb pressure altitude). It encompassed two major areas of application: communications stations and sensor and surveillance platforms. Potential ocean and coastal zone remote sensing and associated communications requirements were covered in a paper by Escoe. Thirty-four possible sensing needs in environmental, weather, legal surveillance, ship safety, search and rescue, and fish and game areas were identified.

A more pragmatic analysis of sensing missions was reported in Kuhner's paper. This used data from a parallel study (reviewed in Sinko's paper) of vehicles suitable for high-altitude applications. Kuhner's paper concluded that many High Altitude Powered Platform (HAPP) missions involving sensing were best served by airplanes except in cases where continuous or long endurance observation was required. Civil communications for commercial or educational needs appeared to offer many advantages with enormous cost savings and many new services.

Various power options were discussed in a paper by Marcy. It was found that speeds up to 100 knots could be achieved by a variety of power sources including solar-rechargeable fuel cells and airbreathing engines. A promising combination involved solar heat and steam turbine systems. Low-drag hulls were also discussed as offering good potential for reduced power requirements.

One exception to the high altitude category was a survey of sensor applications at all altitudes reported by Needleman. These were selected from inquiries of government agencies and universities involved in such programs. Various types of aerostats were considered usable including tethered and free balloons and small and large airships.

Sinko identified two sizes of LTA aircraft as suitable for HAPP missions. Each was remotely piloted and powered by electric motors driving propellers. Microwave power would be beamed to the airships from ground stations and converted to dc electricity by rectifying antennas on the airships. It was assumed that once operating altitude was achieved, the airship would compensate for pressure and temperature changes by means of a balloonet air pressure system. Altitude would be maintained by flying dynamically heavy or light.

In the last paper of the session, wind velocities at 1000 to 10 mb pressure altitudes were discussed by Strganac. Twenty-five U.S. sites and 21 foreign sites were selected for analysis. The frequencies of occurrence for winds of various velocities were identified for the four seasons and compared with the feasibility of operating HAPP vehicles with selected maximum design speeds. A 66-knot vehicle would be required to provide a 95% capability for U.S. sites whereas a 94-knot vehicle would be needed for Pacific and European sites.

Overview of U.S. Research and Development Programs and Operational Systems

Heinsheimer began this session by reviewing the ATMOSAT Program. In this program, a 10-m diameter superpressure balloon has been designed, constructed, and flown successfully. The balloon envelope is made of an advanced Kevlar fabric. The principal use of the balloon has been in pollution-monitoring flights in Southern California.

In the next paper, Hirl began by reviewing communication needs and problems in developing countries. In many such areas tethered aerostats are a costeffective solution to these problems. A shaped balloon made of a Dacron/ Mylar/Tedlar laminate has been developed for this application. The largest balloon constructed to date has a volume of 365,000 ft³. Tethered balloon systems have been installed in Iran, Nigeria, and Korea, where uses have included broadcasting, radio relay, and telephone transmission.

Development of remotely-piloted miniblimps (RPMB's) was discussed by Seemann. RPMB's of up to 10,000 ft³ have been built and flown to demonstrate the concept. The first application is expected to be law enforcement where the RPMB concept is projected to have several economic and operational advantages over other patrol and surveillance systems. Introduction of an RPMB system for law enforcement in Southern California has been delayed by municipal budget cuts.

Kelley reviewed the corporate funded R & D Program at Goodyear Aerospace. The program is focused on the heavy-lift and maritime patrol applications and is designed to complement government-funded work. A broad spectrum of technology is being addressed, including structures, materials, propulsion, and flight dynamics. Kelley stated that the company is confident that the technology and the markets are ready for vehicle development.

Continuing the review of ongoing programs, Eney described efforts underway in the U.S. Navy. In the high-altitude platform program (called HI-SPOT), an RFP for design studies is about to be released. Two contractors are expected to be funded through early stages of the program. In the patrol and heavy-lift areas, there have been many small studies made and what is needed now, Eney feels, is demonstration hardware. The Navy has recently purchased the HX-1, a small radio-controlled airship made by the HOV-AIR-SHIP company. A film showed that the HX-1 has excellent controllability.

In the last paper of the meeting, Ardema and Mayer reviewed the NASA LTA Program. Ardema began by discussing the hybrid airship technology work at NASA-Ames. The current principal elements of this program are a flight dynamics analysis and simulation (contract to be awarded shortly) and a small-scale wind-tunnel test of the buoyant quad-rotor HLA concept. A research aircraft project is being formulated and will be proposed for future implementation. Mayer then reviewed NASA activity in LTA high altitude platforms (HAPP).

Conclusions

A perceptive observer at the AIAA 1979 LTA Systems Technology Conference would have discerned the following points regarding the present state of LTA development:

1. Interest is now coalescing around a few applications for LTA vehicles. Missions for which there is general agreement that LTA vehicles can perform effectively and competitively are coastal patrol (see for example Figure 1) and heavy lift (see for example Figure 2). Other missions for which it appears that LTA vehicles may prove to be effective include deep ocean surveillance, interisland transportation, high altitude platforms, and law enforcement. The practice of defining LTA vehicle concepts and conducting parametric studies for applications for which LTA is fundamentally unsuited or uncompetitive, so prevalent in past years, has almost vanished.
2. Performance and economic estimates for proposed LTA vehicles and systems are also coalescing, thereby increasing confidence in the estimates of the capabilities of modern LTA vehicles. Absent from the 1979 LTA Conference were the excessively optimistic claims of airship performance and cost of past years.
3. Finally, several authors expressed the opinion that the most pressing need is for construction of LTA flight vehicles for research, proof-of-concept, and operational demonstration purposes. Most of the remaining uncertainties are connected with operational aspects such as ground handling, adverse weather effects, low-speed control, hover capability, and manpower requirements. Many of these aspects can be investigated only by flight test. Flight vehicles would also be necessary to validate the results of analytical and experimental research, particularly regarding development of suitable low-speed control systems.

Appendix

FINAL PROGRAM

AIAA LIGHTER-THAN-AIR SYSTEMS TECHNOLOGY CONFERENCE

PALO ALTO, CALIFORNIA

July 11-13, 1979

Session 1

Patrol & Surveillance

Chairman

K. Williams

U.S. Coast Guard

Washington, D.C

79-1570

Coast Guard Missions for Lighter-Than-Air-Vehicles

K. E. Williams and T. Milton, U.S.

Coast Guard, Washington, D.C

79-1571

Analysis of Coast Guard Missions for a Maritime Patrol Airship

H.K. Rappoport, Summit Research Corp., Gaithersburg, MD

79-1573

Tri-Rotor Coast Guard Airship

N. D. Brown, Goodyear Aerospace Corp., Akron, OH

79-1574

The potential Role of Airships for Oceanography

R. Stevenson, Scripps Institution of Oceanography, La Jolla, CA

79-1575

The Use of Airships for the Sea Control Mission

D. Kinney, Naval Weapons Center, China Lake, CA

79-1576

Lighter-Than-Air Vehicles for Open Ocean Patrol

G. S. Handler, Naval Weapons Center, China Lake, CA

Session 2

Heavy Lift

Chairman

D. Williams

Goodyear Aerospace Corp.

Akron, OH

79-1577

Weight and Cost Estimating Relationships for Heavy Lift Airships (HLA's)

D. W. Gray, Goodyear Aerospace Corp., Akron, OH

79-1579

A Study of Civil Markets for Heavy Lift Airships

P. J. Mettam, D. Hansen and R. W. Byrne, Booz-Allen Applied Research, Bethesda, MD, and M.D. Ardema, NASA Ames Research Center Moffett Field, CA

79-1580

Potential for Harvesting Timber with Lighter-Than-Air Vehicles

J. R. Erickson, U.S. Forest Service, WA, D.C.

79-1581

Structural Loads Due to Gusts on Semibuoyant Airships

A.D. Topping, Bell Aerospace Textron, New Orleans, LA

79-1582

Determination of the Natural Frequency of an Airship Model

S.G. Sampath, Battelle Columbus Labs, Columbus, OH; and W. Brewer, Goodyear Aerospace Corp., Akron, OH and G. H. Workman, Applied Mechanics, Inc., Columbus, OH

Session 3

Overviews of Foreign Activity

Chairman

N. Mayer

National Aeronautics & Space
Administration
Washington, D.C.

79-1583

British Lighter-Than-Air Activity:
A Review

A.W.I. Nayler, Royal Aeronautical
Society, London, UK

79-1585

Canadian Interest in LTA Technology
D.W. Laurie-Lean, National Research
Council, Ottawa, Canada

79-1587

Japanese LTA Mission Studies
K. Iinuma, Japan Buoyant Flight
Association, Tokyo, Japan

79-1588

French LTA Activity
C. Muller, A.E.R.A.L.L.,
Paris, France

Added Paper

Hawaiian LTA Activity
G.deHeer, State House
of Representatives,
Honolulu, Hawaii

Luncheon

Opening Remarks

RAdm A.P. Manning
U.S. Coast Guard
and RAdm C.J. Seiberlich
U.S. Navy

Guest Speaker

Morris B. Jobe
President
Goodyear Aerospace Corporation
"Rebirth of the Airship"

Session 4

Aerodynamics, Flight
Mechanics and Control

Chairman

S. B. Spangler

Nielsen Engineering & Research
Mt. View, CA

79-1589

Use of the Inverse Method to
Determine Low-Drag
Axisymmetric Shapes

C. Dalton & M. F. Zedan,
University of Houston, TX

79-1590

Small Scale Wind Tunnel Tests
on Heavy Lift Airship Configurations
R. G. Schwind and S. B. Spangler,
Nielsen Engineering & Research,
Mt. View, CA

79-1591

Airship Dynamic Stability
J. DeLaurier and D. Schenck,
University of Toronto,
Ontario, Canada

79-1592

A Study of the Precision Hover
Capabilities of the Aerocrane Hybrid
Heavy Lift Vehicle

H.C. Curtiss, Jr., W. F. Putnam
and R.M. McKillip, Princeton
University, Princeton, NJ

79-1593

Flight Dynamics Analyses and
Simulation of Heavy Lift Air-
ship, B. J. Nagabhushan,
Goodyear Aerospace Corp.

Akron, OH

79-1594

Controllability of Heavy Vertical
Air Lift Ships, the Piasecki
Heli-Stat, D.N. Meyers and
F.N. Piasecki. Piasecki Aircraft
Corp. Philadelphia, PA

79-1595

Thruster Control for Airships
V.H. Pavlecka, Airships
International, Inc. Tustin, CA

Session 5

Long Range Transportation

Chairman
B. H. Carson
U.S. Naval Academy
Annapolis, MD

79-1596

The Productivity of Airships in
Long Range Transportation
W. Brewer, Goodyear Aerospace
Corp., Akron, OH

79-1597

Lighter-Than-Air Craft for Strategic
Mobility
G.A. Pasquet, Dept. of the Air
Force, Hqs. Military Airlift
Command, Scott AFB, IL

79-1598

Airship Potential in Strategic Airlift
Operations

J.F. Glod, Goodyear Aerospace
Corp., Akron, OH

79-1599

Further Advancements in the Concept
of Delta-Winged Hybrid Airships
P.A. Mackrodt, DFVLR, Gottengen, IRG

79-1600

British Civil Airworthiness
Requirements for Airships
E.J. Niedermayer, Civil Aviation
Authority, Redhill, Surrey, UK

79-1601

High Strength Fibers for Lighter-
Than-Air Craft

M.H. Horn and J.J. Pigliacampi,
E.I. DuPont De Nemours & Co.,
Wilmington, DE

Session 6

High Altitude Platforms

Chairman
J. Eney
Naval Air Development Center
Warminster, PA

79-1602

Potential Applications of a High
Altitude Powered Platform in the
Ocean/Coastal Zone Community
D. Escoe, Mitre Corp., McLean, VA

79-1603

Applications of a High Altitude
Powered Platform
M.B. Kuhner, Battelle Columbus
Labs, Columbus, OH

79-1604

Propulsion Options for the HI SPOT
Long Endurance Drone Airship
W.L. Marcy, Martin Marietta
Aerospace, Denver, CO

79-1605

Scientific and Application User
Requirements for Unmanned
Airborne Platforms
H.C. Needleman, NASA Wallops
Flight Center, VA

79-1606

High Altitude Powered Platform: A
Microwave Powered Airship
J. W. Sinko, SRI International,
Menlo Park, CA

79-1607

High Altitude Platform Operating
Environment
T.W. Strganac, NASA Wallops
Flight Center, VA

Session 7

Overview of U.S. R&D
Programs and Operational
Systems

Chairman

A. Faye
NASA Ames Research Center
Moffett Field, CA79-1608ATMOSAT Balloon Flights
T. F. Heinsheimer, Aerospace Corp.,
Los Angeles, CA79-1609Tethered Telecommunications,
Broadcast and Monitoring Systems
J.P. Hirl, TCOM Corp. Columbia, MD79-1610Unmanned Mini-Blimp System
G.R. Seemann, Developmental
Sciences Inc., City of Industry, CA79-1611An Overview of Goodyear Heavy
Lift Development Activity
J.B. Kelley, Goodyear Aerospace
Corp., Akron, OH79-1612Overview of Navy Programs
J. Eney, Naval Air Development
Center, Warminster, PA79-1613Overview of NASA Programs
M.D. Ardema, NASA Ames
Research Center, Moffett Field, CA
and N. Mayer, NASA Headquarters,
WA., D.C.

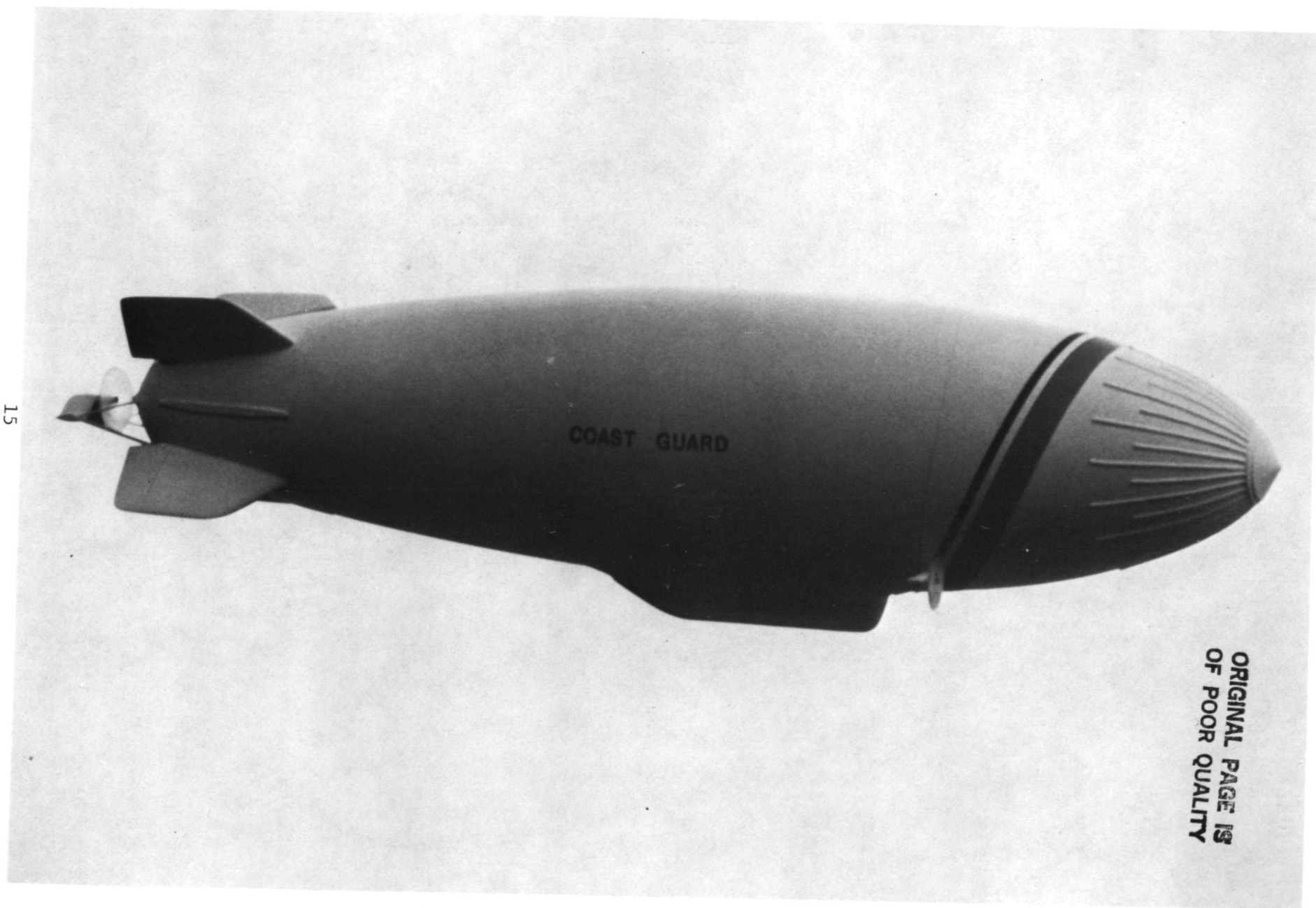


Figure 1.- Modern coastal patrol airship concept.

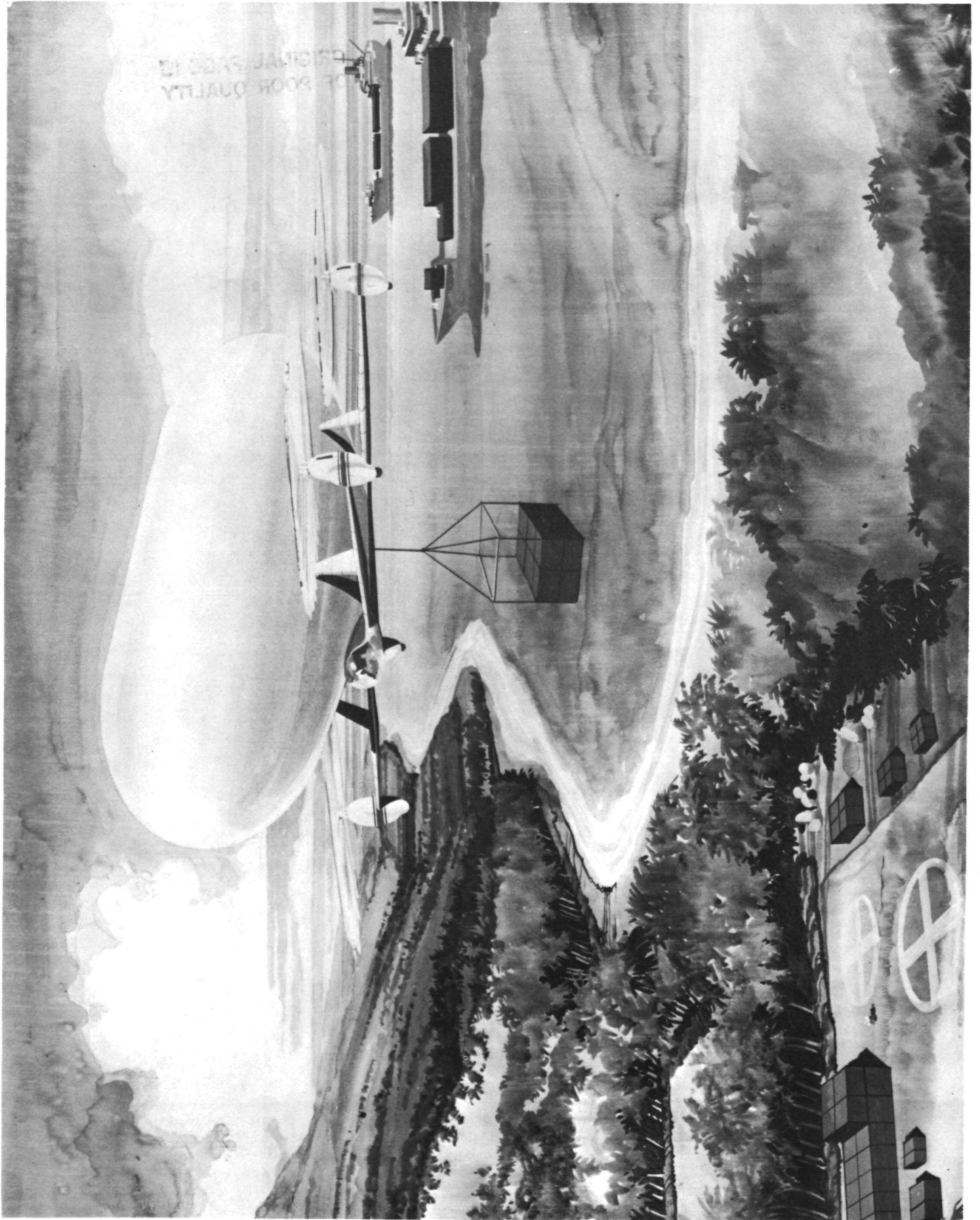


Figure 2.- Buoyant quad-rotor heavy-lift-airship concept.

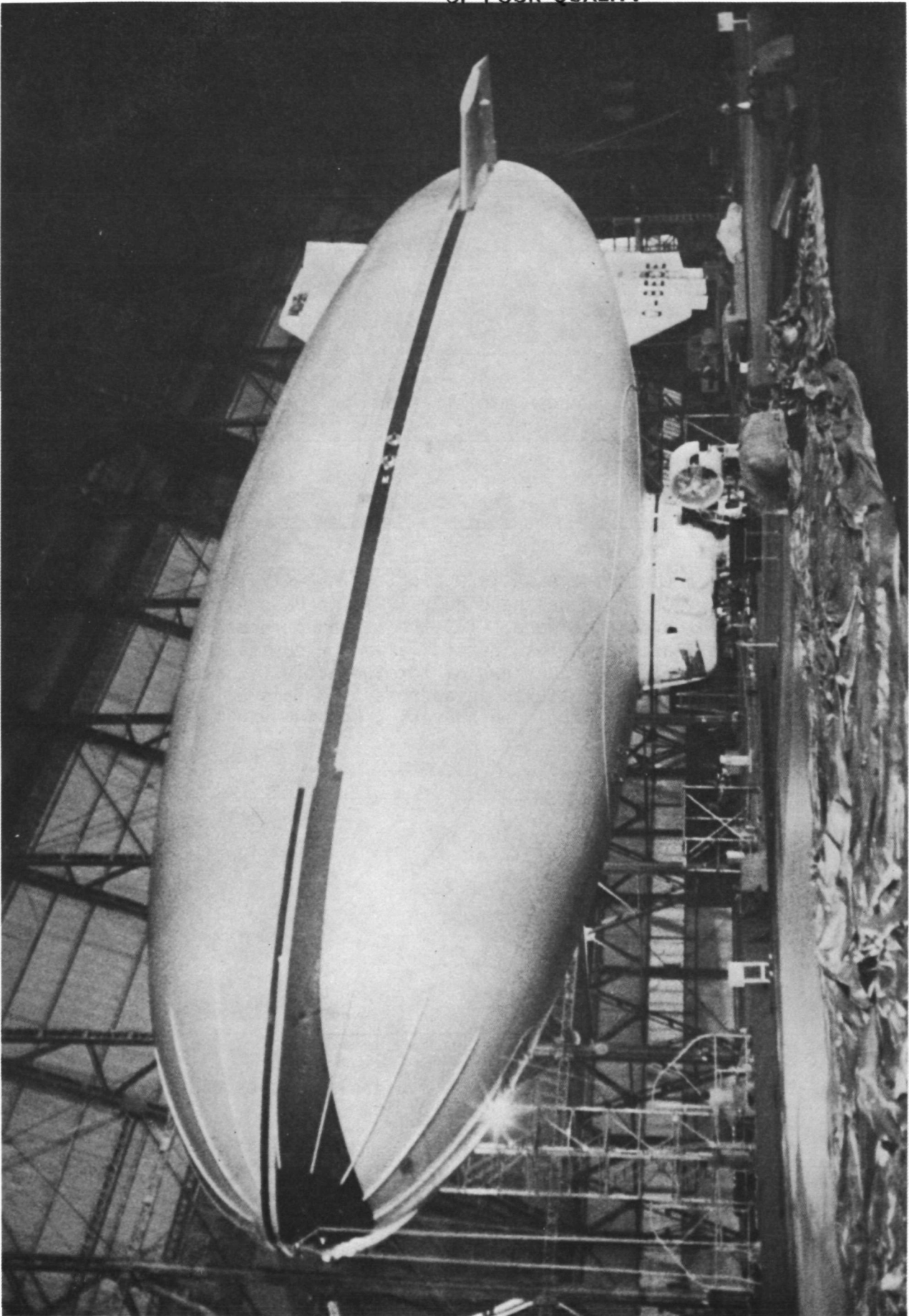


Figure 3.- AD-500 nonrigid airship of Aerospace Developments.

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