National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: August 30, 1994

In reply refer to: A-94-157 through -160

Honorable David R. Hinson
Administrator
Federal Aviation Administration
Washington, D.C. 20591

On July 4, 1993, at 1510 eastern daylight time, a US/LTA Model 138S airship, N832US, came to rest on top and draped over a seven-story building in New York, New York, after the airship deflated in flight and became uncontrollable. The airship had been on an advertising flight 800 feet above the ground with commercial banners attached to both sides of the envelope when the envelope began to deflate. The pilot stated that he felt severe buffeting and subsequently lost flight control response. He believed that he had experienced a flight control malfunction. The pilot asked his airship-rated pilot/passenger to look at the rear of the airship to check the flight controls, and the passenger reported that one of the night signs (banners) from the right side of the airship was coming loose. The pilot increased engine power to stop the altitude loss but was unable to control the airship or to prevent its descent. The airship was destroyed. The pilot received serious injuries, and the passenger reported minor injuries.[1]

Video evidence filmed by witnesses showed that the forward right advertising banner came loose and tore its associated light projector off the envelope of the airship. The banner had been attached with velcro strips around the airship's perimeter with multiple fiber optic strands running to a light source. The projector was attached via cords and was laced to the side of the airship. There were six banner/projectors attached to the envelope. The videos showed the loose banner flapping, and later showed the banner and attached projector falling from the airship into a river.

A permanently attached patch used as a portion of the projector mount was ripped from the envelope but was found attached to the projector attachment cords. Analysis of video documentation and further examination of the envelope showed that a rip in the envelope fabric was initiated near the projector attachment patch. The loose banner, hanging from the airship by the projector, would have forced the triangular metal projector mount into the envelope fabric

---

[1]For more detailed information, read Brief of Accident, File #1036, New York, New York, July 4, 1993 (attached).

thereby ripping it. The rip continued for 38 feet along multiple panels and several gores in both horizontal and vertical directions. The Safety Board determined that as the airship began to deflate, the airship envelope lost its rigidity and the internal flight control cables became slack and ineffective. Additionally, as rigidity and helium were lost, the airship lost lift statically and aerodynamically.

Postaccident testing of the envelope fabric indicated that the fabric met or exceeded design and regulatory strength limits. However, there were no seams to prevent tears from travelling through gore sections nor was the fabric tear-resistant. Since envelope integrity is crucial to the safe operation of an airship, the Safety Board believes that, like the fabric in hot air balloons, airship envelope fabric should be tear-resistant or have a rip-stopping design to limit tears to small areas.

The pilot and passenger both stated that they were not aware of the loss of envelope pressure until the airship began to collapse, even though there was a pressure gauge (airship envelope pressure is measured in inches of water) and a low pressure indicator light to alert them of envelope damage. Although crew procedures for both major and minor envelope rips had been established, those actions were not accomplished because the crew did not initially recognize that the envelope was damaged. The applicable procedures state that the pressure within the airship envelope is required to be between 1.1 and 2.8 inches of water (pressure) for normal operations. The airship flight manual states that when the envelope pressure falls below 1.1 inches of water, the airship will begin to lose rigidity. However, the airship can operate with control retained at pressures as low as 0.5 inches of water. In fact, the recommended crew emergency procedure in the event of a tear in the envelope is to operate the airship with 0.5 inches of water even though some rigidity will be lost. If the emergency procedure is not followed, the ballonets[2] will attempt to keep the envelope pressure constant at the normal envelope pressure, which could drive helium through the tear. A warning light and alarm will activate when the envelope pressure drops below 0.9 inches of water. However, if the envelope has been breached, the ballonets will continue to inflate and the airship's automatic pressurization system will keep the pressure at a level that will not activate the alarm until substantial helium is lost. The Safety Board notes that the airship was not equipped nor required to be equipped with a ballonet inflation rate transducer or other device, which might have been more useful to the crew for indications of loss of significant quantities of helium. The Safety Board believes that had the airship been equipped with a better warning system, the pilot would have been alerted to the loss of pressure earlier and could have taken more prudent emergency actions to improve the possibilities of a controlled emergency landing.

---

[2] Ballonets are airbags contained within the envelope that are inflated with air to control the center-of-gravity (trim) through the movement of helium within the envelope. The airship has two ballonets-fore and aft. The envelope pressure and trim in the airship are controlled by varying the pressure and volume of the air in the ballonets by the control of outflow valves, either automatically or manually.

During the investigation of this accident, the certification process of airships was reviewed. The Safety Board found that airships are type-certificated according to various requirements of Title 14 Code of Federal Regulations (CFR) but are not assigned a specific part outlining the applicable requirements. Manufacturers use Advisory Circular (AC) 21.17-1A as a guide and satisfy selected regulations[3] through demonstration of flight. AC 21.17-1A is not regulatory, but provides a means, but not the only means, of compliance with the applicable CFRs before an airworthiness certificate is issued. The AC does not specify the strength requirement of airship envelope fabric and does not require the use of rip-stop envelope materials. AC 21.17-1A does not provide guidance regarding the protection of the airship envelope when a rip does occur.

The Safety Board is aware that changes in the design of hot air balloons have been introduced to reduce the potential for rips that might disable the envelope and is concerned that the regulations pertinent to airship envelopes do not address the same safety considerations. The Safety Board believes that airship manufacturing and certification requirements should include safeguards to substantially reduce the potential for gore-to-gore rips in airship envelopes, to prevent large rips that jeopardize the safety of the airship and its occupants. Such guidance is provided regarding manned free balloons in 14 CFR 31.25, "Factor of Safety." The Safety Board believes that AC 21.17-1A should similarly address airship envelope design criteria to include factors of safety that would reduce the potential for serious rips in envelope fabric.

The Safety Board is aware of new methods of binding materials into composite fabrics (weaving high-strength polymers into the envelope fabric) that increase strength and tear-resistance while decreasing envelope weight. The Safety Board believes that the FAA should research the feasibility of using such new materials in airship envelopes and, if the materials demonstrate success, encourage their use in airships and amend AC 21.17-1A and regulatory standards accordingly.

Therefore, the National Transportation Safety Board recommends that the Federal Aviation Administration:

> Encourage the US/LTA Company to redesign their existing airship envelopes and modify their existing airships when practicable to prevent gore-to-gore or panel-to-panel tear propagation. (Class II, Priority Action)(A-94-157)
>
> Require that rip-stop seams be designed, tested, and used in lighter-than-air airship envelopes, and incorporate into Advisory Circular 21.17-1A specifications on rip and tear propagation limitations. (Class II, Priority Action) (A-94-158)

---

[3] 14 CFR Parts 21, 23, 33, 35, 45, 91, and FAA Airship Design Criteria (ADC) P-8110-2.

Research the use of new high-strength polymers that may be incorporated into the fabric design of lighter-than-air aircraft envelopes, then disseminate the information to all manufacturers of lighter-than-air aircraft. If testing demonstrates that airship envelopes manufactured with high-strength polymers are substantially safer than current fabric designs, revise the associated regulatory standards accordingly. (Class II, Priority Action)(A-94-159)

Require that airships with fabric envelopes be equipped with envelope warning systems, such as ballonet airflow rate change sensors, that will promptly alert the pilot both aurally and visually of envelope rips. (Class II, Priority Action) (A-94-160)

Also as a result of its investigation, the Safety Board issued Safety Recommendations A-94-161 and -162 to the US/LTA Company.

Acting Chairman HALL, and Members LAUBER, HAMMERSCHMIDT, and VOGT concurred in these recommendations.

By: Jim Hall
Acting Chairman

National Transportation Safety Board
Washington, D.C. 20594 •

Brief of Accident

File No. - 1036 7/04/93 NEW YORK,NY A/C Reg. No. N832US Time (Lcl) - 1510 EDT

----Basic Information----

Type Operating Certificate-NONE (GENERAL AVIATION)

Type of Operation -BUSINESS
Flight Conducted Under -14 CFR 91
Accident Occurred During -CRUISE

Aircraft Damage
DESTROYED
Fire
NONE

	Injuries			
	Fatal	Serious	Minor	None
Crew	0	1	0	0
Pass	0	0	1	0

----Aircraft Information----

Make/Model - US LTA 138S AIRSHIP
Landing Gear - UNK/NR
Max Gross Wt - 8500
No. of Seats - 6

Eng Make/Model - LYCOMING IO-540-K2A5
Number Engines - 1
Engine Type - RECIP-FUEL INJECTED
Rated Power - 300 HP

ELT Installed/Activated - NO -N/A
Stall Warning System - NO

----Environment/Operations Information----

Weather Data
Wx Briefing - UNK/NR
Method - UNK/NR
Completeness - WEATHER NOT PERTINENT
Basic Weather - VMC
Wind Dir/Speed- 330/009 KTS
Visibility - 13.0 SM
Lowest Sky/Clouds - CLEAR
Lowest Ceiling - NONE
Obstructions to Vision- NONE
Precipitation - NONE
Condition of Light - DAYLIGHT

Itinerary
Last Departure Point
BEDFORD,MA
Destination
LINDEN,NJ

ATC/Airspace
Type of Flight Plan - NONE
Type of Clearance - NONE
Type Apch/Lndg - FORCED LANDING

Airport Proximity
OFF AIRPORT/STRIP

Airport Data
Runway Ident - N/A
Runway Lth/Wid - N/A
Runway Surface - N/A
Runway Status - N/A

----Personnel Information----

Pilot-In-Command
Certificate(s)/Rating(s)
COMMERCIAL
SE LAND
AIRSHIP

Instrument Rating(s) - AIRPLANE

Age - 63
Biennial Flight Review
Current - YES
Months Since - 13
Aircraft Type - 138S

Medical Certificate - VALID MEDICAL-WAIVERS/LIMIT

Flight Time (Hours)

Total	- 5100	Last 24 Hrs	- UNK/NR
Make/Model	- 250	Last 30 Days	- UNK/NR
Instrument	- UNK/NR	Last 90 Days	- UNK/NR
Multi-Eng	- UNK/NR	Rotorcraft	- UNK/NR

----Narrative----

THE PILOT REPORTED THAT WHILE CRUISING AT 800 FT HE EXPERIENCED SEVERE BUFFETING WITH A SUBSEQUENT LOSS OF DIRECTIONAL CONTROL. HE WAS LOSING ALTITUDE SO HE INCREASED ENGINE POWER TO REDUCE HIS SINK RATE. THE PASSENGER REPORTED TO THE PILOT THAT THE NIGHT SIGN SEEMED TO BE COMING LOOSE. THE AIRSHIP CAME TO REST DRAPED OVER A SEVEN STORY BUILDING. A WITNESS REPORTED SEEING THE AIRSHIP HEADING SOUTH. HE REPORTED THAT IT SEEMED NORMAL; HOWEVER. SHORTLY THEREAFTER HE NOTICED A HOLE ON THE UNDERSIDE WHICH KEPT GETTING LARGER. PRIOR TO THE TEAR THE WITNESS REPORTED SEEING A SMALL DARK MASS WITH A WHITE FLEXIBLE MATERIAL FALL FROM THE AIRSHIP. EXAMINATION OF THE AIRSHIP REVEALED THAT A SECTION OF THE RIGHT BANNER, WHICH WAS SECURED TO THE ENVELOPE BY VELCRO TAPE, AND A PROJECTOR. WHICH WAS LACED TO A LACING STRIP GLUED TO THE ENVELOPE, HAD SEPARATED TEARING THE ENVELOPE. THE ENVELOPE DID NOT CONTAIN SEAMS TO PREVENT TEARS NOR WAS THE FABRIC TEAR RESISTANT. HOWEVER THE FABRIC MET OR EXCEEDED DESIGN AND FAA REGULATORY STRENGTH LIMITS.

File No. - 1036 7/04/93 NEW YORK, NY A/C Reg. No. N832US Time (Lcl) - 1510 EDT

Occurrence #1 AIRFRAME/COMPONENT/SYSTEM FAILURE/MALFUNCTION
Phase of Operation CRUISE

Finding(s)
1. ELECTRIC SIGN ON AIRCRAFT - SEPARATION
2. BALLOON EQUIPMENT, ENVELOPE - INADEQUATE
3. AIRCRAFT/EQUIPMENT, INADEQUATE DESIGN - MANUFACTURER
4. INSUFFICIENT STANDARDS/REQUIREMENTS, AIRCRAFT - FAA(ORGANIZATION)
5. BALLOON EQUIPMENT, ENVELOPE - FAILURE, TOTAL

Occurrence #2 IN FLIGHT COLLISION WITH OBJECT
Phase of Operation DESCENT - UNCONTROLLED

Finding(s)
6. OBJECT - RESIDENCE

----Probable Cause----

The National Transportation Safety Board determines that the Probable Cause(s) of this accident was: INADEQUATE DESIGN OF, AND DESIGN STANDARDS FOR, THE AIRSHIP WHICH RESULTED IN AN ENVELOPE FAILURE FOLLOWING SEPARATION OF A PORTION OF THE NIGHT SIGN EQUIPMENT.