HALE Airship

Manufacture, Flight and Operation

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21 km

Source: nstar
**Design Objectives**

- Platform provision over a given point for a period of 3 to 5 years.

- After launch, the airship will function without further maintenance for its design life.
Manufacturing Considerations

• Airship Materials

• Manufacturing Techniques
  – Manufacturing unit
  – Location of unit
Flying Operations

- Launch and Transit
- Ground to Ship Communications
- Recovery
- Certification and Insurance
Airship Materials

- Airship skin non-rigid
  4 primary layers:
  - Environmental Shield
  - Helium Barrier
  - Primary Structure
  - Bonding Layer
Airship Materials

Fabric Data:
- Ultimate Tensile Strength: 730 Kg/5cm
- Fabric Weight: 295 g/m²
- Helium Loss at NPT: 0.003 L/m²/24hrs
- Helium Loss at 45 mbar, -45°C: INCONSEQUENTIAL
• **Environmental Shield**
  – protects from UV radiation
  – Tedlar construction

• **Helium Barrier**
  – PVDC film
  – Sarran most common, EVAL better performer
• **Primary Structure**
  – strength to weight ratio critical
  – preferred candidate materials: Vectran and PBO
  – Vectran commercially available
  – PBO offers significant weight saving

• **Bonding Layer**
  – layer welded
  – structural bond on inside of ship
  – thin weather tape on outside
  – polyurethane dominating compound
Layout Airship

- non-rigid envelope
- solar generator for day operation
- control surfaces
- inverted Y-tail
- Power Storage and Power Conditioning
- Tx/Rx
- Payload
- gimbaled stern propeller
**Technical Realisation**

- Envelope: LTL design, based on 20 years of experience
- Propeller: Efficiency-optimised design, two-bladed (Uni Delft)
- Motor: Efficiency and Reliability driven, direct drive for propeller
  - EC-motor with rare-earth magnets, external rotor (Swiss Design)
- Rigid fins with control surfaces
- Thin-film solar cells on polymer substrate
- COTS electrolyser, weight-reduced and adapted for operational conditions
- PEM fuel cell
Manufacturing Techniques

**Hot air welding**: a continuous jet of hot air is directed in between the tape and the two pieces of fabric. The melted surfaces are then bonded under the pressure of two rubber rollers. This is the main process of seam welding.

**Impulse welding**: this intermittent process uses electrical resistance to heat up a plate. These custom built units are used for final seams and assembly work.
**Welding**

*Wedge welding*: similar process to hot air but uses a hot wedge as the heat source. This is a portable unit, ideal for final seams.

*RF welding*: an intermittent process of two electrodes heated by an RF radiation clamping down on two pieces of fabric. Electrodes can be customised for specific shapes.
Manufacturing Unit

Move fabric during manufacture as little as possible to minimise risk of solar cell damage or penetration of skin.
Quality checks

Bay 1: Fabric inspection machine to check incoming material

Bay 3: Helium sniffer to survey entire hull for any leaks.
Quality checks

Bay 1: Load testing, fabric to sustain 730kg loading per 50mm

Bay 1: Q Panel, UV exposure testing
Flight

Transit to Altitude - airship fully inflated

30 degree nose up attitude

Mast attached to airship by nose coupling

Climb rate
600 feet/min.
(3 meters/sec.)

Climb power derived from excess helium venting until airship reaches cruising altitude
## Weight Status

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<th>Status:</th>
<th>size</th>
<th>specific weight</th>
<th>Mass</th>
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<tr>
<td>envelope</td>
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<td>diaphragm</td>
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<tr>
<td>payload</td>
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</table>
Drag Components

Total Drag Coefficient: 0.026
Power Demand

Motor Power [kW] vs Speed [m/s]

- Sprint Speed
- D-20 Design Point

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Regenerative Fuel System
Transit to Station

- Airship will reach cruise altitude 2 hours after launch;
- Uses propulsive power and wind for positioning;

- On station, the control system counteracts vertical and horizontal drift;
- Horizontal motion driven by wind speed and gust intensity;
- Vertical motion driven primarily by daytime heating causing helium expansion.
Communications

• **Launch and recovery**
  – encrypted UHF (line of sight only)

• **Transit to Station**
  – satellite control

• **On Station**
  – payload traffic channel piggybacked

• **Payload Communication**
  – independent
Recovery

• Once launched, the airship should operate without maintenance;
• For recovery the airship must be positioned to land at a fixed location;
• Limited propelling ability near surface;
• Rate of descent is less than ascent;
• Ballonet fans are required for descent.
Compliancy

Certification

– LBA/CAA currently applying existing certification requirements

– where this is not applicable the airship manufacturer must prove equivalent safety to another form of flight

Insurance

– $200,000 for $100,000,000 third party cover (0.2%)