2016 Scientific Ballooning Technologies Workshop

NASA Super Pressure Balloon

Debbie Fairbrother
NASA Balloon Program Office
Suborbital and Special Orbital Projects Directorate
Wallop’s Flight Facility

May 9, 2016
Two Types of Balloons

Super Pressure Balloon maintains nearly constant volume – under development

- Allows Ultra Long Duration Balloon (ULDB) Flights
- Provides stable altitude Long Duration Balloon (LDB) flights at mid-latitudes

Zero-Pressure (ZP) Balloon changes volume due to radiative input

- Used for Conventional Flights and Polar LDB Flights
Altitude Stability Comparison

Flights from Antarctica

- Super Pressure
- Zero Pressure

GPS Altitude Variation From Average Float Altitude (m)

Days at Float

- 615N BLAST, +1,429 m -1,910 m
- 616NT Super Pressure Balloon, +212 m -182 m
Super Pressure Development

- The NASA SPB is being developed to provide a stable platform at constant density altitude for extended duration science investigations at polar and mid-latitudes

- An incremental approach has been applied to the development.

<table>
<thead>
<tr>
<th>Volume</th>
<th>Suspended Weight</th>
<th>Altitude</th>
<th>Flight Number</th>
<th>Duration</th>
<th>Launch Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>7 MCF</td>
<td>1,500 Lbs</td>
<td>~110 KFT</td>
<td>591 NT</td>
<td>54 days</td>
<td>Dec 28, 2008</td>
</tr>
<tr>
<td>14.9 MCF</td>
<td>4,000 Lbs</td>
<td>~110 KFT</td>
<td>616 NT</td>
<td>22 days</td>
<td>Jan 9, 2011</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>659 NT</td>
<td>43 hours</td>
<td>TBD</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>662 NT</td>
<td>32 days</td>
<td>TBD</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>669 NT</td>
<td>TBD</td>
<td>TBD</td>
</tr>
<tr>
<td>26 MCF</td>
<td>4,000 Lbs</td>
<td>~117 KFT</td>
<td></td>
<td></td>
<td>TBD</td>
</tr>
</tbody>
</table>

Several science groups are requesting a suspended weight of 5,500 pounds on the 18.8 MCF; therefore, some future test flights will have higher suspended weights when appropriate.
• Launch Site: McMurdo Station, Antarctica
• Volume: 200,684 m$^3$ (7,089,000 ft$^3$)
• Launch Date: December 28, 2008
• Suspended Load: 682 kg (1,500 lbs)
• Flight Time: 54 Days, 1 hour, 29 minutes
• Near constant altitude for the flight duration
• Launch Site: McMurdo Station, Antarctica
• Volume: 422,352 m$^3$ (14,915,000 ft$^3$)
• Launch Date: January 9, 2011
• Suspended Load: 1,818 kg (4,000 lbs)
• Flight Time: 22 Days, 2 hours
• Near constant altitude for the flight duration
Mid-Latitude Location for SPB
Wanaka, New Zealand

- Far Enough North
- Far Enough South
- Airport Location
- Geography
- Low Populations
- Stratospheric Trajectories
- Infrastructure
- Accommodations
Environmental Considerations

Legend
- Latitude/Longitude
- Updated marine sensitive areas (Jan. 2016)
- FY2015 marine sensitive areas
- Land areas 90 to 29 degrees South
- Ice shelves
- Marine area 90 to 29 degrees South
- Action Area (90 to 29 degrees South)

Safety Considerations

- Trajectory Analysis Pre-Launch
- Airport Closed During Launch Operations
- Roadblocks
- Go-No Go prior to Land Mass
- Go-No Go ~ every 24 hour when over land
Flight Monitoring

- Wanaka team will monitor and support flight from launch pre-ops to end of LOS
- Palestine Operations Control Center will be online at launch and take over after leaving LOS capabilities in Wanaka
- SPB team will monitor the entire flight remotely
- Palestine Operations Control Center will be manned 24 hours from launch until termination
- Science typically monitors from home institution
2015 - 18.8 MCF SPB

- Launch Site: Wanaka, New Zealand
- Volume: ~532,152 m$^3$ (~18,793,000 ft$^3$)
- Launch Date: March 26, 2015
- Suspended Load: 2,268 kg (5,000 lbs.)
- Flight Time – 32 Days, 5 hours, 51 minutes
- First multi-day diurnal flight!
Flight performance of this balloon was exceptional. Total flight time was 32 days 5 hours 51 minutes, a record for this size balloon at these altitudes at these latitudes for this duration.
Minimal altitude drops occur while crossing over extremely cold storms.
No ballast was dropped during the flight until the very end!

Flight performance of this balloon was exceptional.
Total flight time was 32 days 5 hours 51 minutes, a record for this size balloon at these altitudes at these latitudes for this duration.
Flight 662 NT – Last 8 days

Altitude (Feet)

Differential Pressure (Pa)

Date/Time

2015 - 18.8 MCF SPB
Waiting on weather!!!!

- Launch Site: Wanaka, New Zealand
- Volume: \( \sim 532,152 \text{ m}^3 \) (\( \sim 18,793,000 \text{ ft}^3 \))
- Launch Date: Flight Ready
- Suspended Load: 2,268 kg (5,000 lbs.)
- Flight Time – TBD
- Flying the Compton Spectrometer and Imager (COSI) as a Mission of Opportunity
• Inflated volume = 18.8 million cubic feet
• Number of Gores = 280
• Number of Gore Width Measurements = 6,440 (23 per gore)
• Amount of Load Tape Tendon in Balloon = 137,760 feet (26 miles)
• Amount of film visually inspected, re-rolled and dispensed for this balloon > 1.3 million square feet - over 30 acres of film
• Minimum amount of walking just to seal balloon = 55 miles
• Balloon shipping box 16 ft. x 6 ft. x 5.3 ft.
• Gross Weight of Balloon in Box = 8,832 pounds