2017 Scientific Ballooning Technologies Workshop

NASA Super Pressure Balloon

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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

Days at Float

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

GPS Altitude Variation From Average Float Altitude (m)
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>18.8 MCF</td>
<td>5,000 Lbs</td>
<td>~110 KFT</td>
<td>631 NT, 659 NT</td>
<td>6.5 hours</td>
<td>Aug 14, 2012, Dec 28, 2014, Mar 26, 2015, May 16, 2016, April 24, 2017</td>
</tr>
<tr>
<td></td>
<td>5,000 Lbs</td>
<td></td>
<td>662 NT, 669 NT</td>
<td>43 hours</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5,000 Lbs</td>
<td></td>
<td>679 NT</td>
<td>46 days</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5,500 Lbs</td>
<td></td>
<td></td>
<td>12 days</td>
<td></td>
</tr>
<tr>
<td>26 MCF</td>
<td>4,000 Lbs</td>
<td>~117 KFT</td>
<td></td>
<td></td>
<td></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.
Wanaka, New Zealand

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

• WFF Completed a Biological Evaluation and Environmental Assessment for SPB (ULDB) Program Southern Hemisphere Flight Operations covering Antarctica and New Zealand-launched SPBs.

• The Program received a Finding Of No Significant Impact and has received approval from NASA and concurrence from NOAA and NSF to proceed with Operations.

• The stratospheric anticyclone over Antarctica provides a stable balloon trajectory, once the anticyclone breaks down trajectories are highly variable.

• Increased operational area (more northern latitudes) for 2017 mission.

• In the event of ocean termination, the entire balloon system will be valve downed to the water surface and submerged.
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
2016 - 18.8 MCF SPB

- Launch Site: Wanaka, New Zealand
- Volume: ~532,152 m$^3$ (~18,793,000 ft$^3$)
- Launch Date: May 16, 2016 @ 23:35 Z
- Suspended Load: 2,268 kg (5,000 lbs.)
- Flight Time – 46 Days, 20 hours, 19 minutes
669 NT SPB-COSI
Launched: 16 May 2016 / 23:35:00 Z
Impact: 2 July 2016 / 19:54:00 Z
Total Flight Time: 46 days, 20 hours, 19 minutes

Lowest Altitude During Flight ~ 22 km Due to Loss of Gas During Flight.
669 NT SPB-COSI
Launched: 16 May 2016 / 23:35:00 Z
Impact: 2 July 2016 / 19:54:00 Z
Total Flight Time: 46 days, 20 hours, 19 minutes
The Balloon Performed as a Hybrid – SPB During Day – ZP at Night Later in the Mission.
• Launch Site: Wanaka, New Zealand
• Volume: ~532,152 m³ (~18,793,000 ft³)
• Launch Date: April 24, 2017 @ 22:50 Z
• Suspended Load: 2,495 kg (5,500 lbs.)
• Flight Time – 12 days, 4 hours, 34 mins
• Flying the Extreme Universe Space Observatory (EUSO) as a Mission of Opportunity
Note: Initially, 1200 pounds of ballast – dropped over 1100 pounds of it in drops on 4/29, 4/30, 5/1, 5/3, and 5/6
• 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