Preliminary Design Review

November 18, 2008

University of Idaho
NASA Ames Research Center
SOAREX VII Mission

Design, construct, test, and fly an ultralight (<1kg) atmospheric entry and descent microprobe carrying instrumentation to measure acceleration and atmospheric structure from 100 km to the surface.
Flight Sequence

- **Launch:**
  - Deliver intact to 200 km
- **Activation:**
  - Power up after deployment
- **Data Collection:**
  - Acquire pressure, temperature, and acceleration data
- **Data Storage:**
  - Record data in recoverable format
- **Landing:**
  - Survive ocean impact
- **Recovery:**
  - Retrieve from ocean
## Design Specifications

<table>
<thead>
<tr>
<th>GENERAL</th>
<th>SPECIFIC</th>
<th>ACCEPTABLE</th>
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<tbody>
<tr>
<td>Survivability</td>
<td>Must withstand impact</td>
<td>Withstand 25 Gs</td>
</tr>
<tr>
<td></td>
<td>Must survive in ocean</td>
<td>Pass a dunk test with no leaks</td>
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<tr>
<td></td>
<td>Must survive heating</td>
<td>Internal temperature must stay below 85°C in a math model</td>
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<tr>
<td></td>
<td>Parachute must stay securely fastened</td>
<td>Connections can withstand 50-lbf in tension</td>
</tr>
<tr>
<td>Recovery</td>
<td>Contain radio transmitter</td>
<td>Must transmit at least 10 miles</td>
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<tr>
<td></td>
<td>Easy to visually locate</td>
<td>Can be seen from 100m away without aid</td>
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<td></td>
<td>Strobe lights facing up in water</td>
<td>Must be above the water line</td>
</tr>
<tr>
<td>Measurements</td>
<td>Pressure</td>
<td>Measure .00001atm - .01atm with &lt; ±2% of full range</td>
</tr>
<tr>
<td></td>
<td>Accelerometer</td>
<td>Three axis system; ± 25 Gs</td>
</tr>
<tr>
<td></td>
<td>Temperature</td>
<td>-100°C to 1500°C ±0.5°C</td>
</tr>
<tr>
<td></td>
<td>Sample rate</td>
<td>&gt; 10Hz</td>
</tr>
<tr>
<td>Physical Properties</td>
<td>Weight</td>
<td>1 kg</td>
</tr>
<tr>
<td></td>
<td>Size</td>
<td>6 inch sphere</td>
</tr>
<tr>
<td></td>
<td>Internal shape</td>
<td>Must not deform more than 2% of diameter during mission</td>
</tr>
<tr>
<td></td>
<td>Buoyant</td>
<td>Must float indefinitely</td>
</tr>
<tr>
<td></td>
<td>Center of mass (C.O.M.)</td>
<td>Centered along flight axis</td>
</tr>
<tr>
<td></td>
<td>C.O.P. at least 1 inch above C.O.M. to keep probe oriented</td>
<td></td>
</tr>
<tr>
<td>Deployment</td>
<td>Turn on once released</td>
<td>Reed Switch</td>
</tr>
<tr>
<td></td>
<td>Must turn on</td>
<td>Redundant system using multiple types of switches</td>
</tr>
<tr>
<td>Data Storage</td>
<td>Must hold all data collected</td>
<td>1 GB of storage</td>
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</table>
# Design Overview

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<th>ELECTRICAL SYSTEMS</th>
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<td>2. Internal Layout</td>
<td>2. Battery</td>
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<td>3. 3-Axis Accelerometer</td>
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<td>4. Parachute Hooks</td>
<td>4. Thermocouple</td>
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<td>5. Thermistor</td>
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<td>6. Pressure Transducer</td>
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<td>7. Locating Devices</td>
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Outer Assembly

- Rods exposed for fasteners
- Vented to equalize pressure with Gore-Tex between SIRCA and metal to keep water out
Parachute Hook Force Analysis

~ 2-lbf maximum at each weld
Internal Layout

- Mounting surface
  - Steel, Titanium, or Aluminum
- Mounting Rods
  - $\frac{1}{4}''$ diameter
- Electronic components suspended from rods and fastened to the mounting surface
Deployment Switch

- Reed Switch
- Inexpensive (< $1 each)
- Two will be installed in case one fails

Information Sheet:
Electrical Collaboration Diagram

- Battery Power
- Microprocessor
- Memory
- Pressure
- Temperature
- Accelerometer
Microcontroller

- Rabbit RCM4300
- 8-bit Microprocessor
- Power Requirement
  - 350mA @ 3.3V
- Operating Temp:
  - -20°C to +85°C
- 1 GB NAND Flash
- Price:
  - $299

Information Sheet: http://www.rabbit.com/products/RCM4300/index.shtml#kit
Battery

- Li-ion
- Voltage supplied
  - 3.3V
- Core cell weight
  - 39 grams
- Quantity:
  - 2 batteries

Information Sheet:
http://www.a123systems.com/products

Cells: 18650
3-Axis Accelerometer

- Open Frame Design
  - Light-weight: 46 grams
- Measures up to ± 25 g
- Power Requirement:
  - 9mA at +5VDC
- Operating Temperature:
  - -40°C to +85°C
- Part Number:
  - CXL25GP3
- Price:
  - $345

Information Sheet: http://www.xbow.com/Products/Product_pdf_files/Accel_pdf/GP_Series_Datasheet.pdf
Thermocouple

- Maximum Operating Temperature:
  - 2300°C
- Sheath Diameter:
  - 0.125”
- Bare wire leads
  - Less expensive
  - Sauder directly to Rabbit board
- C-type calibration
- Part Number:
  - XTA-W5R26-U-125-30-H-RP-6
- Price:
  - $225

Information Sheet:
Thermistor

- Measure Internal Temp.
- Accurate to ±0.2°C
- Requires 10-15μA
- Operating Temperature:
  - -80°C to 120°C
- Small size: Fast response to temperature change
- Base Resistance:
  - 5 kΩ at 25°C

Information Sheet:
http://www.omega.com/Temperature/pdf/44000_THERMIS_ELEMENTS.pdf
Pressure Transducer

- Flexible connectors
- Sub-miniature size
- Board mountable
- Low Cost: ~$40

Information Sheet:

Information Sheet:
Recovery

Transmitter

- $650 - $1900
- Telonics can track it for an additional charge

Information Sheet:
http://telonics.com/products/argosMarine/

LED

- 900 lumens
- 3.6 V @ 2800 mA

Information Sheet:
Budget

- **Mechanical Components**
  - Weight Range:
    - 500 – 1000 grams
  - Price Range:
    - $80 - $250

- **Electrical Components**
  - Weight Range:
    - 377 - 658 grams
  - Price Range:
    - $1609 - $3619

Total Price Range
$1689 - $3869