GUIDELINES AND SUGGESTIONS FOR BALLOON GONDOLA DESIGN

MAY 9-11 2016
HUGO FRANCO
**Design Requirements**

- **Structural Integrity**
  - Primarily to survive termination event
    - Safety
    - Mission assurance
  - Has been sufficient for landing – Although not a CSBF requirement

- **Launchability**
  - Important to prevent damage
  - Allows for less than ideal launch conditions

- **Staging/Pickup**
  - Must be able to fit inside existing high bays
  - Allows for hoist pickup and roll out to launch vehicle

- **Recovery**
  - Some existing recovery limitations – particularly Antarctica
  - Crucial to stay within limitations for critical components
**Structural Requirements**

- **10G Vertical – 5G Side Load**
  - Based on ultimate load of the material (not yield)
  - Intended to prevent freefall of components

- **Rotator**
  - Critical Component
    - Single point failure
    - Watch for concentration factors

- **Suspension Lines (Where Applicable)**
  - Great historical data for steel cables
  - Have used synthetic systems before to save weight – Kevlar, Spectra
    - UV a concern, one time use perhaps

- **Structural Members**
  - Mostly made of Aluminum or other lite tough metals
  - Have flown Carbon Fiber/metal hybrids
    - Still learning to test and approve for certification
LAUNCHABILITY

- **PAYLOAD MUST BE ABLE TO SURVIVE LAUNCH**
  - These are dynamic launches
    - Damage to antennae, solar panels or other protruding objects
    - Sensitive equipment can be damaged
    - Latching mechanisms

- **MINIMUM DESIRED DISTANCES FROM LAUNCH VEHICLE**
  - “20 degree rule” – Assures minimum desired clearance Launch Vehicle
  - 6 ft. of ground clearance – Avoids contact with ground
  - 5 ft. of clearance from front end of vehicle – Avoids contact with front end of vehicle during launch

- **OTHER OBSERVATIONS**
  - Width/Length of payload – High MOI
  - Wide sections near the boom (higher)
    - Risk of contact with boom and damage
STAGING/GONDOLA PICKUP

● FACILITIES LIMITATIONS
  ➢ Height/Width of payload
    – Allow for weighing the payload inside the building (Antarctica)
    – Allow for ease of roll in/and out of building

● CART/WHEELS
  ➢ Allows people to work underneath
  ➢ Ideally allows for ballast hoppers and solar panels to stay attached for roll out.
    – Huge time saver
  ➢ Must be big enough for easy rollout
  ➢ Must allow rotation of payload for vehicle pickup
**RECOVERY**

- **GONDOLA DISASSEMBLY**
  - Critical components to stay within a certain allowable size and weight
    - Limited by recovery vehicle
      - Helo
      - Twin Otter and Bassler (Antarctica)
      - Land Vehicles
  - Easy/Quick Disassembly
    - Allows for quicker recovery - Antarctica
    - Data vaults and other critical components accessible
      - Trade off between access and protection
COMMON PITFALLS AND RECOMMENDATIONS

- **Wait too long to contact CSBF**
  - The sooner the better on gondola design
  - Pointing systems are critical and expensive components
    - The sooner we see the design the better
  - Placing CSBF equipment in appropriate location
    - Thermal considerations
    - Antenna placement

- **Providing analysis for maximum weight**
  - Final weights are usually higher than predicted
    - Avoids rerunning the analysis if overweight

- **Protective cage for SIP**

- **No appropriate casters/tyres**
  - Hard to maneuver