Requirements, Specifications, Procedures and Certifications

David Snyder
NASA Glenn Research Center
for Explorer Post 632: BalloonSat
15 November 2006

Definitions

- **Requirements**
  - Descriptions of what is needed.
- **Procedures**
  - Documentation of how to accomplish things to ensure requirements are satisfied. Checklist is a kind of procedure.
- **Specifications**
  - Quantify requirements and operating conditions, or
  - Descriptions of equipment including operating conditions and measurement capability
- **Test/Analysis**
  - Confirm Requirements and specifications are met.
- **Certification**
  - Take responsibility that tests and analysis are met.

Priorities

How would you rank these? Why?

- **Safety**
- **Recovery**
- **Successful Measurements**

Why Requirements and Specifications?

- **Safety**
  - Air Space – FAA Regulations
  - Selves and Colleagues
    - High Pressure Gas
    - Equipment Handling
    - Travel
  - By-Standers
    - Parachute
    - Warnings

Why Requirements and Specifications?

- **Recovery**
  - Prediction
    - analysis
  - Launch Conditions and Criteria
    - Procedures and checklists
  - Tracking
    - procedures
  - Transportation
    - Procedures and checklists

Why Requirements and Specifications?

- **Successful Measurements**
  - Reliability
    - testing
  - Environmental Conditions
    - analysis
  - Testing/Analysis
  - Certification
    - responsibility

Safety
Safe Operation in Air Space

CFR 14 part 101

Moored Balloons, Kites, Unmanned Rockets and *Unmanned Free Balloons*

- **No Hazardous Operation (§101.7)**
- **Don't damage Aircraft**
- **Exempt Conditions: §101.1 par. (a) 4**
  - Payload Under 4 lb.
  - Payload Under 6 lb *And* density under 3 oz/in^2.
  - Total Payloads under 12 lb.
  - Rope requires impact force of less than 50 lb to break.
- **If exempt don't need: (§101.35)**
  - Two independent cut down systems
    - We use balloon burst as one method
  - Two independent flight termination methods
  - Radar reflector.

Safety
Safe Operation in Air Space

Notify FAA

- **Cleveland ARTCC - Oberlin**
  - Determine what Wavers are needed
  - how to get them. (Exempt)
  - For Cleveland Area: Mark.Agustanelli@faa.gov
- **File a NOTAM (Notice to Airmen)**
  - Cleveland Flight Service ((800 WX-BRIEF)
    - NOTAM fro HiBal (High Altitude Balloon)
    - Launch Site
      - *Airport*
      - *VOR (position relative to air navigation sites)*
    - Launch Time
    - Predicted Path
    - Duration (100m up + 45m down +35m uncertianty)
      - *Interested in time below 60kft*
      - *But we go up and down so it is useful to have the NOTAM expire at total end of flight*

Safety

High Pressure Gas Tanks

- If valve shears off, we will have a hundred pound missile.
- Requirement: High Pressure Tanks must be handled safely.
- Procedure: store gas tanks securely. Do not drop tank.
- Others?

Road Safety

- Requirement: Driver must pay attention to the road.
- Procedure: Each vehicle in "Chase" must have a navigator, *and* radio operator in addition to a driver.
- Procedure: Vehicle must be stopped during planning involving the driver.

Others?

Recovery

Train survival

- String - testing
- Knots - testing
- Boxes -testing
- Parachutes

Radio Tracking

- Test to temperature and pressure, EMI?
- Redundant and independent
- Independent radio bands, 2m (145mHz), 70 cm
- Beeper for ground location

Labels

- Return address, contact information,
- Laminated

Measurements

Test equipment

- **individually**
- **Under environmental conditions**
  - Cold temperatures / low pressure
    - Internal: -15 C (need to verify this temperature?)
      - *Potential Solution : Heater (more weight)?*
    - External: -60 C
- **Verify Operation**

Interoperability

- **Test together**
- **Unobstructed access**
- **Electromagnetic interference, EMI.**
  - Principally from radios.
  - Data may be noisier than w/radios off
  - Solution is more shielding

If it doesn't work,
is there any good reason to fly it?

Simulations

Purpose: Determine behavior

- Analytical (often computer models)
- Physical Testing
  - Reproduce important conditions.

NASA Testing

- Vacuum Testing
  - Tank 5, Tank 6 in B301
    - designed for electric propulsion testing
- Solar Simulator
  - 3 kW Xenon arc lamp
  - Reproduce 1 sun at 1 au over 12” diameter
    - Document solar cell performance
    - Can measure Temperature dependence.
- Extended temperature Chamber (ETC) (8”)
  - Low pressure
  - With Cold Plate (to -200C)
  - For solar simulator, but useful for our cold testing

String Strength Test

Purpose

- **Need balloon train to be reliable**
- **Want to satisfy FAR 101 requirement**
- **Measure strength of String and Knots.**

- Work in Pairs

- String has two relevant properties
  - Breaking strength
  - Elasticity – stretches with increasing force like a spring.

String Strength Test

Procedure

- **For both 50lb and 100lb string**
  - Cut 36” length
  - Tie ~24” length between Spring clamps
  - Calibrate Force sensor with Weights
  - Break String record smallest resistance
  - Where (Physically) did string break?
- **Repeat with a knot in middle.**