LOUDOUN AMATEUR RADIO GROUP

HIGH ALTITUDE BALLOON PROJECT

MASTER FLIGHT PROCEDURES MANUAL

FLIGHT 2003A

HIGH ALTITUDE BALLOON CARRYING AMATEUR TELEVISION

FLIGHT 01

(HABCAT-1)

Prepared by

Tom Dawson

WB3AKD

FLIGHT DESCRIPTION

HABCAT-1 is LARG's first flight of 2003. The flight train will consist of a new Amateur TV (ATV) payload with a 70 cm. downlink, an instrumentation payload with a 2 meter downlink, a 4 foot parachute and a 1000 gram latex balloon.

The launch site will be selected so as to produce a predicted touchdown point near Berryville, VA.

Based on sea level launch conditions and 2.5 kg total payload weight, the estimated ascent rate is 1500 ft/min and the estimated burst altitude is 84000 ft. for a total flight time of approximately 80 minutes.

PAYLOAD DESCRIPTIONS

ATV Payload

John Rehwinkel KG4L constructed the ATV payload video and signal-processing module. It consists of a Color Video camera, a Garmin Tripmate GPS receiver (Rockwell Zodiac Engine), and a video titling card that adds GPS and callsign information to the video Downlink.

The ATV transmitter is a 2 Watt PEP, 439.25 MHz ATV transmitter kit from North Country Radio.

Batteries for the two ATV payload modules are separate to allow independent development and testing efforts.

Total battery life of the ATV transmitter module determined by testing is about 6 hours, and total battery life of the Video module is in excess of 6 hours.

Instrumentation Payload

The instrumentation payload is the veteran "Hot Chips" payload (so called because of the high internal temperatures caused by the use of linear voltage regulators). This payload measures air pressure, battery voltage, and internal and external temperatures and downlinks via the data via 2 meters FM MCW at about 20 WPM. The payload transmits on 145.65 MHz and emits about 1 frame per minute. This is the primary tracking beacon for recovery.

The TLM Frame structure is "DE K4LRG/B <Frame Number> / <Baro Counts> / <Battery millivolts> / <internal temp (K)> / <external temp (K)> / <reference count> / AR"

Total battery life exceeds 10 hours.

OPERATIONAL PROCEDURES

General

Flight operations are conducted by three teams: Launch, Mission Control, and Tracking/Recovery.

The Launch team carries all equipment to the launch site, assembles the flight train, activates the payloads and releases the flight train in coordination with Mission Control.

Mission control is a fixed station in a favorable communications location that is responsible for coordinating communications and activities between the widely dispersed Launch and Tracking/Recovery stations. During the Flight, Mission Control collects VHF bearings from the tracking stations and plots them on a map, and attempts to fix the location of the balloon. Mission control may also collect telemetry and video data.

The Tracking and Recovery team establishes mobile tracking stations, usually on high ground, and measures the bearings to the balloon and relays this information to Mission Control for plotting. When the flight is terminated, they travel to the last known location of the balloon and DF to the touch down site via the VHF beacon signal.

FLIGHT OPERATIONS PROCEDURES

Step 1:
TIME 05:00
Launch Team:
Depart for Launch Site.

Step 2:
TIME 08:00

Mission Control:
Setup and verify equipment. Establish contact and determine status of other teams.

Launch Team:
Arrive at Launch Site-begin equipment preparation.
Prepare to fill balloon and notify Mission Control
Stand By for Clearance to fill the balloon.

Tracking/Recovery Teams:
Arrive on sites
Notify Mission Control
Prepare and verify equipment

Step 3:
TIME 08:30

Mission Control:
Roll Call Tracking/Recovery Stations for status:
If Tracking stations are within 30 minutes of operational status, clear the Launch Team to fill the balloon.

Tracking/Recovery Teams:
Finish Preparations and relay GPS coordinates to Mission Control.
Use Degrees/Minutes/Seconds format

Launch Team:
When cleared, fill balloon and attach to flight train

Step 4:

Time 08:55

Mission Control:
Poll racking recovery teams for readiness
If 2 of three stations are ready, notify Launch Team Clear for Launch
Hold Frequency Clear Launch Announcement
Notify Tracking Recovery of Launch

Launch Team:
Verify Safe conditions and release the flight train.

Tracking/Recovery:
Stand by for Launch announcement
Stand by for Acquisition of Signal (AOS)

Step 4:

Time : Various

Mission Control:
At 10-minute intervals, poll the tracking stations for bearings.
Plot Bearings and relay estimated fix/altitude to all stations.
Keep all outstations apprised of the flight status.

Tracking/Recovery:
Monitor bearings to the VHF Beacon.
Monitor Video if so equipped.

Launch Team:
Recover Launch equipment
Travel toward expected touchdown vicinity
Monitor/Record flight telemetry
Monitor/Record flight video

Step 5:

Time: Flight Termination/LOS

Mission Control:
Poll Tracking Stations for final bearings.
Determine if any stations still have the signal.
Poll Video Ground Stations for Final GPS LAT/LONG
Plot final fix
Relay all final data to outstations.

Tracking/Recovery:
Station with LOS breakdown and travel to vicinity of last known fix.
Station (if any) with strongest signal remains on station until signal is acquired by other T/R stations.

Launch Team:
Travels to T/D vicinity
Participate in T/R operations

Step 6:
Time: Payload(s) Found/Recovered
Mission Control:
Announce find/recovery to all stations
Terminate operations

Tracking/recovery:
Launch Team:

Recover payload(s)

Step 7:
Time: Operations Terminated

All Teams RTB

Balloon Flight Mission Control Procedures
Flight 2003A – HABCAT-1 24 MAY 2003
W4AU - John Unger
(Updated By Tom Dawson WB3AKD)

1. Establish comms with Launch, Tracking and Recovery Teams, synchronize watches, and request time to ops ready status for each Team
    - 1.1. Communications frequencies:
        - 1.1.1. 147.480 simplex
        - 1.1.2. 7.010 CW
        - 1.1.3. 7.280, and below LSB
    - 1.2. Other options:
        - 1.2.1. 147.060 (Frederick repeater),
        - 1.2.2. 147.255 (Martinsburg repeater)
2. Schedule launch time (approx. 0900 EDST) and relay to all Teams and synchronize watches.
3. Launch Team is ready to fill the balloon
    - 3.1. Verify that Tracking and Recovery Teams are ready for launch
4. When all teams are ready, clear the Launch Team to fill the balloon.
5. Launch Team is ready to release the balloon
    - 5.1. Verify all teams ready to copy balloon signal
6. Give permission for Launch Team release the balloon; record launch time.
7. Stand by for Acquisition of Signal (AOS)
8. Record AOS time and relay to all tracking teams.
9. Schedule tracking observations at 10-minute intervals from AOS.
    - 9.1. Plot initial tracking observation as soon as all tracking stations have AOS.
    - 9.2. Take bearings from Tracking Teams (repeat reports for others to copy) and plot fixes.
10. Monitor flight telemetry on downlink (145.650 MHz).
    - 10.1. Plot pressure (altitude) every transmission if possible and outside temperature.
11. Periodically report flight status to all teams.
12. Report max altitude (burst height) and descent phase to all teams.
13. Estimate descent time and calculate estimated touch down time.
14. Estimate landing area and relay to all teams.
15. Continue to plot fixes.
16. When downlink indicates touchdown:
    - 16.1. Call for final bearings
    - 16.2. Plot final fix
    - 16.3. Relay final fix to all trackers
    - 16.4. Assign one tracking station (or mission control) to monitor balloon package signal
    - 16.5. Terminate tracking ops and stand by until Tracking Teams are packed and ready to travel.

17. When tracking Teams are ready to travel terminate mission control ops and clear all teams to head for landing area.

MISSION CONTROL - EQUIPMENT LIST

1. Medium scale (~1:250,000) map(s) of region mounted on rigid board with compass rose at Mission Control location - W4AU
2. Protractor (large, circular; 0-360 degrees) -- W4AU
3. Large triangle or Straightedge (for drawing N - S lines through Tracking Team locations
4. Table of pressure vs. altitude -- WB3AKD
5. Notebook computer – N4OHE
6. DF gear – n4OHE
7. Compass – N40HE
8. 2-meter rig - Comms – N4OHE
9. 2-meter rig - tracking – N4OHE
10. HF rig - Comms – N4OHE

MISSION CONTROL - PERSONNEL DUTIES

1. Track balloon as part of Tracking Team
2. Record and plot data from Tracking Teams
3. Communicate with Launch, Tracking, and Recovery Teams
4. Record and plot data from balloon telemetry

Personnel:

Craig, N4OHE - record and plot tracking data
Tom KF4TNX, -communicate with other teams
K4LJH (at Home QTH)- record and plot balloon telemetry data - track balloon signal

LAUNCH OPERATIONS PROCEDURE
LOUDOUN AMATEUR RADIO GROUP

FLIGHT 2003A (HABCAT-1)

LAUNCH OPERATIONS PROCEDURE

20 MAY 2003

Tom Dawson, Chairman, LARG Balloon Committee

1. Launch Schedule:

    1.1. Arrive Launch site at or about 08:00 EDT
    1.2. Schedule Balloon Release about 09:00 EDT

2. Personnel:

Tom Dawson WB3AKD
Pam Bozzi N4OPN

3. Equipment:

    3.1. Ground Support Equipment (GSE):
    3.1.1. Launch Team Procedure data 20 MAY 2003
    3.1.2. 2 Tanks Helium
    3.1.3. Helium Regulator
    3.1.4. Fill Tube with ball valve
    3.1.5. Paper strip 2” wide 7 “ long
    3.1.6. 2” screw type hose clamp
    3.1.7. Tarp and Pad
    3.1.8. Scale
    3.1.9. Sand for free-lift weight
    3.1.10. 1-gallon paint can for holding sand
    3.1.11. Cotton Gloves
    3.1.12. Snap clips

    3.2. Flight Equipment:
    3.2.1. 1000g Balloon
    3.2.2. Instrumentation payload
    3.2.3. Photo Payload
    3.2.4. 3 lengths of cotton string pre-cut and wrapped on separate marked cardboard
    3.2.5. tubes, 15, 30 and 55 feet.
    3.2.6. 2 6-foot lengths of cotton string for tying the neck of the balloon.
    3.2.7. 4-foot Parachute.

3.3. Communications Equipment:

3.3.1. HF Transceiver
3.3.2. VHF Transceiver programmed for communication frequencies
3.3.3. VHF Receiver for 145.65 D/L
3.3.4. Tape recorder or computer for D/L recording

1. Procedures:

1.1. Arrive on Site and establish Communications with Mission Control.

1.2. Prepare Filling Apparatus: Attach Regulator to tank, close fill valve.

2. Prepare Flight Train:

2.1. Verify Instrumentation P/L operational by plugging in umbilical connector and verifying TLM transmission. Remove Umbilical Plug.

2.2. Verify Video P/L operational by plugging in umbilical connectors and verifying ATV signal on TV monitor.
2.3. Weigh both payloads and record:
2.4. Instrumentation P/L ______lbs.
Camera P/L ______ lbs.

2.5. Attach 30 ft. of cotton string to suspension loop on Instrumentation payload and attach free end to bottom of camera payload.

2.6. Attach 55 ft of cotton string to top of camera P/L and attach free end to bottom of parachute shroud lines.

2.7. Attach 15-foot length of cotton string to top loop of parachute. Place free end in a convenient location for attaching to the inflated balloon.

3. Prepare To Fill Balloon:

3.1. Calculate weight test weight as follows: Measure the total Flight Train Weight
3.1.1. Train Weight (kg)=__________________

3.1.2. Multiply by 2 for Total Lift (assuming for 100% free lift)
3.1.3. Total Lift = ___________________________

3.1.4. Subtract Balloon and filler tube weight (Balloon Weight + 500g filler tube) to get the test weight.
3.1.5. Test weight (kg) = ___________________________

3.2. Add Sand to can until the required weight is attained. Attach sand can to filler tube

3.3. Lay out tarp and pad for filling.

3.4. Unroll Balloon on pad

3.5. Put neck of balloon over filler tube, wrap protective paper strip around neck and clamp with hose clamp.

3.6.
Verify Fill Valve Closed: Open He Tank valve. Set Regulator to 8-9 PSI.

3.7. Advise Mission Control that the balloon is ready to fill and wait for clearance to fill.

4. **BALLOON INFLATION**
4.1. When cleared to fill the balloon, open Fill Valve. Stabilize balloon as it fills. Insure no twisting or bulging of neck.
4.2. Fill until test weight just lifts off of the ground. Close Fill Valve.

5. **SECURE BALLOON AND ATTACH FLIGHT TRAIN**
5.1. Turn on Video camera/GPS module.
5.1.1. This Allows the GPS receiver to acquire satellites

5.2. Tie off neck of balloon just above the fill tube, wrap twice and tie twice.

5.3. Tie additional safety line around neck of balloon; wrap and tie twice then tie free end to a firm anchor.

5.4. Close all tank valves.

5.5. Remove hose clamp and protective paper from neck of balloon and remove filler tube.

5.6. Fold neck back once or twice and wrap twice and tie three times.

5.7. Attach free end of string from the flight train.

6. ACTIVATE PAYLOADS/FINAL LAUNCH PREPARATIONS

6.1. On the minute, activate Instrumentation Payload, and then the video transmitter P/L's by plugging in umbilical connectors and tightening the tie-wraps.

6.2. Advise Mission Control that the team is ready to launch.

6.3. With one launch team member holding each payload, move train out down wind of the balloon and await clearance to launch.

7. LAUNCH

7.1. When cleared to launch, verify visually that no aircraft are in the vicinity of the launch site.

7.2. When Airspace is clear, remove the safety weight, and holding the balloon by the neck walk toward the payload. Release the balloon prior to reaching the first payload.

7.3. The team members holding the payloads should hold them above their heads and let the balloon lift them out of their hands.

7.4. Record launch time and relay to Mission Control.

8. Post Launch Actions:

8.1. Monitor flight visually and confirm flight train is clear of all ground obstacles.

8.2. Verify Telemetry and Video are running normally and being recorded.

8.3. Disassemble and secure all fill gas apparatus.

8.4. When released by Mission control, Terminate Launch ops. Head for flight estimated destination.

8.5. Monitor and record telemetry and video continuously.

APPENDIX -I

Receiving and Decoding Telemetry

The instrumentation payload transmits a normal FM signal on 145.65 MHz and can be received by any 2 meter ham receiver or scanner. The tone is keyed by Morse Code at about 20 WPM. This greatly simplifies the ground station requirements for receiving the signal. The telemetry may be copied by hand, or a soundcard application called CWGET (available from http://ua9osv.da.ru/) may be employed for decoding and saving the Morse telemetry to a text file for later conversion and analysis.

The Instrumentation Payload Transmits the following information about once every minute.

- Identification text "DE K4LRG/B"
- Telemetry Frame Number- a sequential number starting at 00000 when the instrument is powered up.
- Pressure sensor Raw Counts (see below to interpret)
- Battery voltage directly in millivolts
- Interior temperature in Kelvin (subtract 273 for Celsius)
- Exterior temperature in Kelvin (subtract 273 for Celsius)
- Reference voltage counts. 10*counts/4095 should always be 6.24 Volts.

A complete frame looks like this:

DE K4LRG/B / 00012 / 02961 / 16660 / 00308 / 00281 / 02556 / AR

This Frame is the 12th frame received from the SKYEYE-2 payload on 21 July, 2002 and shows that the unit was powered up 12 minutes , the barometer count is 2961 (translates to 10770 feet using formulas below), battery voltage is 16.66 volts, the interior temperature is 35 C, the exterior temperature is 8 C and the reference voltage is 6.24 Volts.

Barometer counts may be converted to pressure in millibars as follows:

Pressure (mb) = ((Baro_Counts * 6/4095)-1)*(1013/5)

Pressure is converted to altitude in feet as follows (1976 standard atmosphere)

For P (mb) > 222.27

Alt = (1 – 10^(log10(P/1013)/ 5.2558797))/ 0.000006875586

And for P < 222.27

Alt = 36089.24+(ln(P/(1013*0.2233609))/-0.00004806346))

A spreadsheet is useful in converting the TLM to engineering units.

APPENDIX-II

RECEIVING THE TELEVISION SIGNAL

HABCAT-1 carries a 2 watt video transmitter that operates on 439.25 MHz.

An ATV down converter or a Cable ready TV may be used to receive the signal. The down converter translates the ATV signal to Channel 3 or 4 and it can then be recived by a normal TV set.

A cable ready TV or VCR can be used by connecting the RF input if the receiver to the antenna and programming the receiver to use the Cable Channel. Cable channel 60 picture carrier corresponds to 439.25 MHz.

Note that the receiver must be connected to an antenna. You will not receive ATV signals through your cable system.

Some portable TV receivers have a continuously variable tuner and you may be able to pick up the ATV signal by tuning the UHF tuner around channel 75 or so. This may be reception of an image frequency, however, so the sensitivity could be significantly degraded.

The transmitter emits an amplitude modulated TV signal. Peak Envelope Power occurs only on the Sync tips. The average power is about 0.4 watts. Thus you will almost certainly need a beam antenna to receive the signal. The antenna should be horizontally polarized.

A low noise preamp is almost essential, too, as the noise figure of typical TV/VCR receivers is about 7 dB.

The HABCAT-1 camera will be pointed downward at about a 45-degree angle. This will allow good ground image near the ground and good horizon image at altitude.