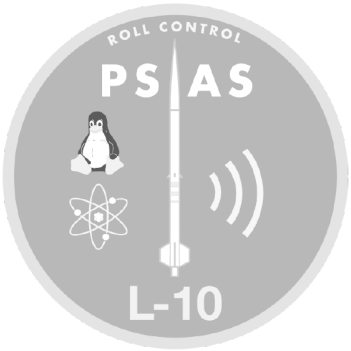
L-10



LAUNCH OPERATIONS HANDBOOK

LAUNCH SITE SETUP, ROCKET BUTTONUP, COUNTDOWN, LAUNCH,
AND RECOVERY PROCEDURES

DATE: _____ No: _____

Published under authority of

PORTLAND STATE AEROSPACE SOCIETY

PSAS

Contents

- 9v Batteries

11.7 Cables

- Roll Control launch detect shorting tether.
- Opal docking station and FTDI cable.
- TeleMetrum receive cable and antenna (multiple okay)
- ARTS data cable (LEDs, USB Serial Adaptor)

11.8 General Stuff

- screw/nut/bolt assortments
- Binoculars
- 1200fps camera

- Launch rail teather to rocket
- Umbilical Bar
- high-visibility coverings for guy-wires

11.5 Motor

- Motor Casing
- Forward and Aft Closures
- Main fuel grains
- Smoke Grain
- O-rings
- Special motor tools, if necessary
- Igniters
- 1/8 inch dowels
- Grain removial 2x4
- Plastic trash bag for burned liner (it smells really bad)

11.6 Electrical Tools and Supplies

- Dell LCD Monitor w/ S-Video and composite input (with external power supply)
- JTAG adaptor
- USB Cables
- USB hub w/ power supply and mini-usb cable
- Multi Meter
- Soldering Iron
- Resistor assortment
- 12volt to 120VAC inverter w/ 12v battery clamps
- 120vac to multi-voltage output AC wall wart adapters (2)
- car usb charger
- 12v car battery, if available
- 4 channel Agelent Oscilloscope
- AA batteries
- AAA batteries
- D batteries

- 4 inch angle grinder
- sawzall
- sand paper
- hand sanding block
- super glue
- 5 min epoxy
- 30 minute epoxy (may be needed for epoxying aerotech motor grains)
- jb-weld
- full drill bit set
- 1/2 inch corded drill
- hack saw
- metal files
- counter sinks
- deburing tool
- lighter

11.4 Launch Tower Parts

- blast shield
- launch tower tub, which should include at least the following:
  - -(3) sets of guy wires
  - -(4) sand screws
- launch tower electrical tub
  - -With long orange wires for igniter and safety boxes
  - -RF feed-line for tower computer to antenna
- tower computer
- 12v batteries for tower computer
- solar panel for tower computer
- antenna bar for tower
- launch rail
- tower top section
- tower bottom section
- tower base
- Ropes and pulleys and such to raise and lower the rail

Chapter 1

Launch Tower

Overview:

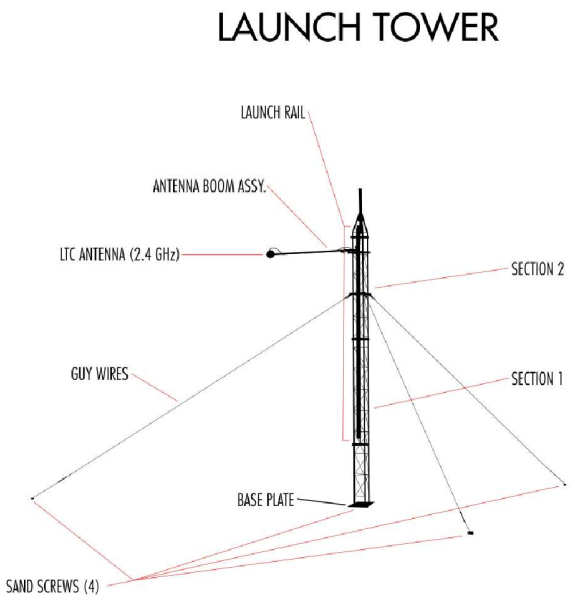


Figure 1.1: Launch tower overview

1.1 Setup

1. Lay top tower and bottom tower end-to-end on ground, at 120 degrees off center such that antenna boom will point down during lifting
2. Put top and bottom tower pieces together, aligning the A, B, C indicators, with 1/4-20 hex bolts/nuts
3. Put base of tower on
4. Mount rail alignment brackets
    i. Loose fit launch rail alignment brackets, look for markings on the brackets and on the tower
    ii. Lay mount launch rail to pivot point, and lay down to align brackets, then tighten brackets in place
    iii. Remove launch rail.
5. Pre-string ropes from the top tower piece toward the bottom, including quick-links that will be used to tie to rail. Be sure the put the rope through the middle of the tower
6. Set end of tower on ladder to raise top from ground
7. Mount the antenna and antenna bar
8. Attach and run the RF feedline to the antenna
9. Screw sand screw into ground near base of tower and affix rope/chain to base of tower and sand screw such that when the tower is put up it won't slip out from underneath the lifters
10. Pre-place sand screws at 120 degree intervals around tower, pre-attach guy wires to the tower and lay out on ground in approximate final locations
11. Place 3 people on the guy wire ends to assist in stabilization of tower during lifting
12. 3 strong people at tower base to push up tower
13. Push up tower, rotating tower 120 degrees such that antenna bar is pointing downward. When the tower goes up, rotate until it's in desired alignment.

- 100ft Extension cord
- paint pole (for GoPro camera at tower)

11.2.4 Support Supplies

- cardboard PSAS sign to post by road
- super-lube, for motor assembly
- fire extinguisher
- first aid kit
- 1/8 inch dia dowels, 3-4 ft long, for holding igniters in place in pyros (or small square balsa wood lengths)
- E-matches
- 3-in-1 oil
- WD-40
- electrical tape
- duct tape
- safety glasses
- zip ties
- blue masking tape
- Motor removal 2x4 kit (should be in one of the plastic tubs)
- latex gloves, used during motor assembly/gluing/greesing
- gasoline (if bringing dirt bikes), 5 gallons
- 1/4in or 5/16in dowels, handy for a variety of things...
- big trash bags
- a tarp
- A few Misc 2x4s and 4x4s (just in case)
- card tables and chairs
- narrow string/rope
- ear plugs
- rubber bands

11.3 Emergency Tools & Supplies

- orbital sander
- dremmel tool
- sae tap/die set

- mini-sledge hammer
- screw drivers
- security screw driver bit set
- pliers
- snap ring pliers (for motor retainment rings if necessary)
- allen wrench sets
- box cutter

- Level (should be perminently in tower box)
- measuring tape
- strap wrenches for motor assembly
- scissors
- sheet metal shears
- small hand-mirror on wand (for viewing LED colors on rail-side of rocket)
- tool belt
- philips quick-insert hex bits
- hex bit extensions
- hex bit to socket adaptors (1/4, 3/8, 1/2)
- calipers
- leather work-gloves

11.2.2 Power Tools

- DeWalt Right Angle Drill for driving in sand screws
- 120VAC generator (for generator->tools, needed during tower setup)
- cordless drill (with extra battery and charger)

11.2.3 Support Tools

- saw horses (4)
- Little Giant Ladder
- 75lb digital postal scale (final weight of rocket necessary)
- digital hanging fish scale (final weight of rocket necessary)
- digital jewelers scale
- (3) orange safety cones for top of sand screws

14. Use high-torque to screw in sand screws in approximate locations, snug, but do not tighten
15. Install launch rail with pulleys
16. Draw up pulleys till rail is vertical
17. Get Level, and tighten and level the launch rail with guy-wire turnbuckles and chain links as necessary
18. Hang blast shield on tower behind where motor will start its burn
19. Mount tower computer to back of launch tower, sitting on top of metal step affixed with 2 u-bolts.
20. Proceed to Launch Tower Computer Setup.

Chapter 11

Inventory

11.1 Things that the group should have at least one of

- First aid kit, trauma kit if possible
- Jumper Cables
- Extra water, Ice if possible for heat stroke

11.2 Primary Tools & Supplies

11.2.1 Hand Tools

- box-wrenches
- ignition wrenches
- socket set
- socket extensions
- Adapter to connect automotive socket to right angle drill
- automotive sockets (for sand-screws)
- breaker bar (1/2 automotive type)
- crescent wrenches (assorted sizes)
- normal hammer
- rubber mallet

Chapter 2

Overnight Checklist

- Charge DVR
- Charge Opal Data Logger
- Charge TeleMetrum
- Charge Roll Control

- USB to Serial adapter
- Serial to TTL or USB to TTL
- Video camera
- Binoculars
- Sun shade / open walled tent / canopy
- Clock or watch for ground station

10.4 Tools

General list, name by what you are bringing if you would like to get a count.

- CA (Cyanoacrylate)
- Gorilla Tape
- Butane soldering iron

- Way to cook your food
- Sleeping bag
- Toothbrush
- Deodorant
- Pillow
- Teddy Bear :)
- Tent or cover
- Change of clothes: Cold at night, usually hot during the day
- Sun Glasses
- Sandals
- Shoes
- PSAS shirt
- Chair
- Towel
- Toilet Paper (Just in case)
- Hat that covers the neck

10.3 Extras

This list will be more random, but worth listing as most pertain to more than one person.

- Tripoli card
- Ham radios
- Family band radios
- Radio antennas, hand mics, way to attach to body
- Extra batteries
- Laptop
- Tripod
- Camera and lenses
- Memory cards, usb sticks
- DC and AC chargers for various equip. (phone, radio, laptop, gps, flashlight)
- Music and headphones
- Note taking things: Paper portable, electronic
- GPS

Chapter 3

Recovery Checkout

3.1 ARTS-2

3.1.1 Program the ARTS-2

1. Connect 9v power, and RS-232 serial cable
2. Start up Data Analyzer application from Ozark Aerospace
3. Specify com port if necessary

3.1.2 Verify correct operation of ARTS-2

1. Goto altimeter -> diagnostics
2. Press chirp to test tone generation
3. With pyros disconnected, click boomer/sw, both pyros should show bad. Switch 2 should show 'off', and switch 1 show 'on'
4. Connect the resistor/led combo to each pyro channel, click boomer/sw to verify that the respective channel shows OK. Also test-fire each pyro with the respective LED to make sure it lights the LED.

3.1.3 Setup profiles

1. We will be using flight profile 1 (one). Make sure respective dip switch on (dip switch 1 should be 'On')
2. Goto the Altimeter -> Configuration
3. Verify Profile 1 is configured to deploy drogue at apogee, and main at 1000ft, with a 50hz sample rate. You can 'Load from Alt', and verify these numbers, and 'Save to Alt'. When saving to alt for profile 1, you'll hear 1 beep.
4. Verify Profile 2 is configured do deploy channel 1 at apogee, channel 2 at 1000ft, and a 50 hz rate... Just to be safe, save this to the altimeter. When saving to alt for profile 2, you'll hear 2 beeps.

Chapter 10

Personal Supplies

The purpose of this list is to give ideas to attendees as to what they should bring. It can freeze at night and can be over 100 deg. F during the day. This trip: should not freeze at night, expect 90s during the day Sunday.

10.1 Life Functions per person

These things should be on hand per person.

- Water: lots of water, there is none on site
- Food: dinner, breakfast, lunch, dinner and snacks
- Coffee or tea or energy drinks
- Any pharmaceuticals or medial supplies you need to sustain life **and** methods for storing them in the desert heat/cold

10.2 Keep you cozy

- Flashlight
- Sunscreen
- Camelback or way to carry water without holding
- Canteen or water bottle
- Dishes to eat off of and with

Chapter 4

Payload Checkout

4.1 Camera Block

1. Apply 12 V to Payload
    - Red LED comes on ATV overlay board
    - ~190 mA
2. Power on DVR
    - DVR LEDs (top) Blue, pause Green, Red
    - ~190 mA
3. Power on GearCam
    - LEDs (top of camera block) Red, Blue slow blink
    - ~500 mA
4. Power down
5. Check files on SD cards

  - Wireless: essid=psas-ground wpa-psk=(consult label on AP)
  - Intranet: 5 wired ports offering DHCP leases, bridged with Wireless
  - Internet: 1 wired port attempts to get a DHCP lease
- LTC (root)
  - eth0: static=192.168.0.2 (not used, emergency hard-line)
  - wlan0: essid=psas static=192.168.128.2 (auto-connects to AP)
- TM3K Raspberry Pi - (pi)
  - eth0: static=192.168.128.10 (connect to AP Intranet port)
  - wlan0: essid=psas mode=ad-hoc channel=36(5.18GHz) static=172.17.0.2

9.2.2 Rocket

- rocket (root)
  - eth0: static=10.0.0.10
  - wlan0: essid=psas mode=ad-hoc channel=36(5.18GHz) static=172.17.0.1
- ADIS (10.0.0.20)
- Roll (10.0.0.30)
- debug ThinkPad (psas)
  - eth0: static=10.0.0.7 physically connect to rocket: `sudo ifconfig eth0 up 10.0.0.7; ping -n 10.0.0.10`
  - eth1: (wireless interface)

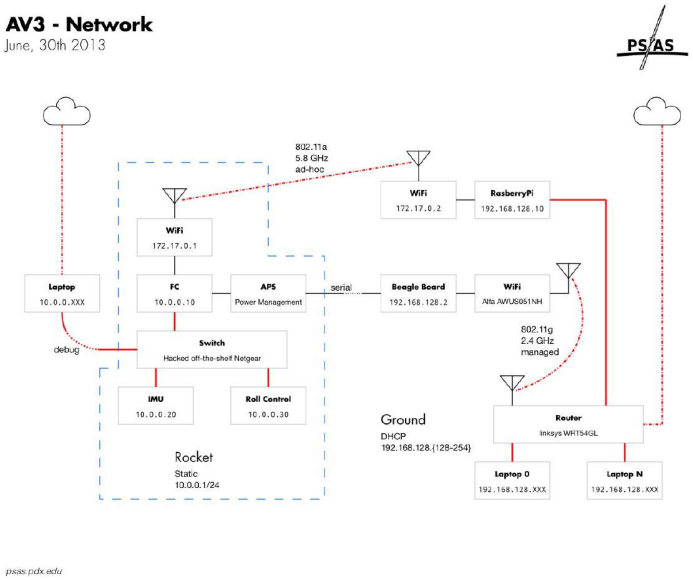


Figure 9.1: Network Diagram

Chapter 5

Buttonup

5.1 Payload Module

5.1.1 Pre-Assembly

1. Charge
   - TeleMetrum
   - DVR (has labeled charger)
2. Check Battery voltages
   - ARTS

5.1.2 Assembly

Note:

If the erector set has to be removed, the black ABS camera block has to be removed (4 8/32 bolts 3/32 hex heads).

1. Cabling:
   - 12 V up (red/black) from ATV power breakout
   - A/V/GND down from camera (blue connector)

- Pyro (to recovery) must go up channels to not interfere with camera module.
- Large camera connector should be in the camera sled (so it can be attached later)

2. Check 9 V leads are terminated into ARTS and TeleMetrum
   - ARTS
   - TeleMetrum
3. Check switches on DVR
   - On the front: [Off/TV/LCD] should be **Off**
   - On the top: [Off/On/Rec] should **Off** (slid all the way away from you)
4. Aeroshell:
   i. Slide aeroshell down so the square hole lines up with the APS in the front of the camera sled
   ii. Slide until flush with top of module
5. Camera block
   i. Double check SD card is in place and tapped in.
   ii. Check USB in place
   iii. Turn camera block upside-down and attach keyed connector
   iv. Get cable into the grove and start to slide it in without pinching
   v. Slide camera block all the way in. There is a little spring in the last couple mm
   vi. Insert 4 8/32 buttonhead screws with washers.
   vii. Check HD cam is facing out the back ~ 1 mm

Chapter 9

Reference

9.1 Radios

Standard comm frequencies:

- 2-meter: **146.430 MHz**
- FRS/GMRS: **Channel 5**

9.1.1 Call Signs

- `KD7CJT` Andrew
- `KF7RAS` Nathan
- `KJ7SU` Glenn
- `KC7KWX` Casey
- `KF7VJX` Jenner
- `KF7NLF` Kenny
- `KG7DBF` Gavin

9.2 Network

9.2.1 Ground

- AP offers DHCP `192.168.128.{128-255}` (admin)

8.7 Drouge Doesn't Deploy

1. Heads up
2. Inform LCO of situation
3. Keep tracking
4. Get shovels
5. Copy off data to multiple disks

8.8 Main doesn deploy

1. Send recovery team
2. Get photos before touching

Chapter 6

On Tower Procedures

6.1 Tools for On Tower Procedures

- Small flashlight to view DVR inside aeroshell
- Spotting Tube, to block light while inspecting the DVR LEDs
- Medium flat-head screw driver, for main switches, make sure it will fit thru the aeroshell holes

6.2 Pre-Launch

1. Turn screw on camera module to extend camera outside the aeroshell. Go approximately until the black line is flush with the aeroshell. Do not over torque this.
2. Verify that LaunchControl can control LTC and LTC is working.
   i. Verify Igniters **NOT in**.
   ii. Attach 12v lightbulb to ignition leads.
   iii. Move shorting plug from LTC base to away box.
   iv. Turn red arming switch to on.
   v. Launch Control run through full sequence (light goes on for ignition).
   vi. Turn red arming switch to off.
   vii. Move shorting plug from away box to LTC base.

6.3 Switches

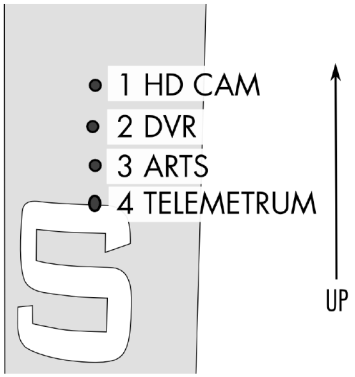


Figure 6.1: Payload module switch layout

1. Turn on HD camera (SW 1)
2. Turn on external camera (SW2)
3. Plug in monitor to the av-out pass-through and verify that the DVR is receiving video and recording.
4. Roll Control.
    i. Connect tether connector wire to roll control.
    ii. 10 second calibration to elapse, fins are twitching
    iii. Fins should go to neutral at completion of calibration sequence
    iv. Remove tether
        - Wait 4 seconds, fins should sling to one side, 4 seconds later, to the other side and so on
    v. Plug tether back in
        - Should run calibration sequence again
5. Turn on TeleMetrum (SW 4)
    i. Listen for beeps. 3 beeps good, low tone bad, 10 seconds Morse P (.–.)

8.4 Fire After Launch

1. Inform LCO of situation
2. Keep core team focused on rocket
3. After parachute is seen send water and shovel people

8.5 CATO

1. Inform LCO of situation
2. Double check personel (nearest people OK)
3. Send fire and water people
4. Bring down loggers
5. Save logs to multiple disks
6. Turn of LTC
7. First people to site must take detailed photos of area before touching anyting

8.6 Shred

1. Inform LCO of situation
2. Double check personel (nearest people OK)
3. Bring down loggers
4. Save logs to multiple disks
5. Wait for other launches to clear
6. Start looking for parts
    - Take photos of each piece as it is before touching or moving

- FD

6. **ARM** rocket
7. Start countdown
8. Send ignite signal

8.2 Repeat Ignition Failure

1. **PSAFE** rocket
2. Inform LCO of situation
3. Turn on shore power
4. Turn off WiFi and ATV
5. Wait
6. Approach tower
7. Undo short bar an disarm LTC
8. Determin root cause
9. Restart from end of On Tower Procedures

8.3 Fire Near Rocket

1. **PSAFE** rocket
2. Inform LCO of situation
3. Turn on shore power
4. Turn off WiFi and ATV
5. Turn off FC
6. Send water and shovel people
7. Start over with On Tower Procedures

ii. Radio down to launch control to verify telemetry is streaming.

iii. Radio down to launch control to verify configuration coming from TeleMetrum is as expected.

6. Turn on ARTs (SW 3), verify good beep code (3 beeps).
7. Flight Director: Broadcast that Rocket is powered up and ready for flight.

6.4 Final Pre-Launch Procedures

1. Lay out Ignition Extension Cable with 3 boxes.

- Motor Box ~7ft away from nozzle.
- Away Box as far as possible, but try to keep orange cord from being run over.

1. Communicate with Launch Control for go-ahead to hook up igniter
2. Clear all personnel other than L3
3. Check Manual Arm switch on LTC is “off”
4. Verify Banana shorting Jumper is well placed in LTC shorting block
5. Verify Motor Box indicator is dark
6. Verify alligator clips are connected to the motor box
7. Insert motor igniter into motor
8. Communicate with Launch Control that igniter is in.
9. Connect the alligator clips to Igniter
10. Switch Manual Arm Switch to **ON**
11. Communicate with Launch Control that Arm Switch is on
12. Remove Banana shorting jumper
13. Move Away from the box

14. Final check that area is clear of other personnel
15. Verify that red LED in away box is OFF.
16. Insert shorting jumper into the Away box
17. Communicate with Launch Control that arming is complete
18. Leave the Launch area (run away).

Chapter 8

Contingency

8.1 Ignition Failure

Recycle the launch

1. **PSAFE** rocket
2. Inform LCO of situation and ask for recycle permision
3. Restart logging
4. Get in positions
    - Recovery eyes up
    - Cameras set
    - Trackmaster and spotter
5. Go/No-go poll
    - LTC
    - Recovery
    - TeleMetrium
    - Video
    - Trackmaster
    - Telemetry
    - FCF

Chapter 7

Launch Procedures

7.1 Basic Powerup

1. Get rocket on pad
2. Attach umbilical
3. Run LTC client
4. Turn on shore power
5. Turn on FC
6. Turn on WiFi
7. Turn on ATV

7.2 Systems Checkout

1. Trackmaster on
2. ssh into rocket over ATG link
3. Run FCF
4. Verify
    - data link

- logfiles
- video
- video recording

7.3 Terminal Count

1. Verify all power is on
2. Clear area for launch
3. Start RSO/LCO integration
4. Restart loggers
5. Turn off shore power
6. Check ground
    - Telemetry
    - Video
    - TeleMetrium
7. Check GPS lock
8. Get in positions
    - Recovery eyes up
    - Cameras set
    - Trackmaster and spotter
9. Go/No-go poll
    - LTC
    - Recovery
    - TeleMetrium
    - Video
    - Trackmaster
    - Telemetry
    - FCF
    - FD
10. **ARM** rocket

11. Start countdown
12. Send ignite signal