Meeting Minutes – Sunday, September 25, 2011

Tripoli Indiana – TRA Prefecture #132
Indiana Rocketry Society – NAR Section #711

1) President Doug Jackson called the meeting to order at 7:07 PM at the Purdue Extension Office.
2) Roll call was taken – All officers were present. 12 members total.
3) Previous Meeting Minutes approved as read.
4) **Officer's Reports**
   a) **President**
      i) Need to make decision whether or not to proceed with County Line Challenge event for T/S by next meeting
      ii) Motion to cancel Saturday, Oct. 10 Launch day, and change Sunday, Oct. 11th Launch designation from EX to Commercial if Ash Grove site is not available. Passed
   b) **VP**
      i) Need to request Ash Grove site be plowed before launch season begins.
   c) **Treasurer** – Report approved as presented
   d) **Web Master**
      i) Plans to post launch reports on website as time permits
   e) **Prefect**
      i) Reported on TRA Safety Vest program. Has requested vests for TI
   f) **Member @ Large** – No Report
   g) **Equipment Manager –**
      i) Has purchased and parts for new leads
      ii) New blast deflectors need to be welded to launch tower
5) **Old Business**
   a) **County Line Challenge –** Richard Cash presented his proposal for the County Line Challenge event. (presentation attached) Highlights were...
      i) Vehicle: AeroTech Aerospike bulk pack. Includes 2 motors per kit.
      ii) Participant age: Grades 9-12
      iii) Team size = 6 max.
      iv) # of teams/school – 1st 6 teams from each county
      v) Should we hold a supervised build day to provide team support?
      vi) Awards: Trophy for winning team (stays with school permanently). Possibly medals for others.
      vii) Sponsorship: No sponsorship, No media coverage prior to the event.
      viii) Vote on whether or not to proceed at next meeting.
   b) Launch Pad Requirements
      i) Need one more HP pad
      ii) David has design drawings
      iii) Gus volunteered to weld
   c) **Club Incorporation –** Vic reported
      i) Club incorporation would allow TI to self insure launches
      ii) Self Insurance would allow comingling of EX and Commercial Launches
      iii) Incorporation with an already incorporated club would put TI under the other club's BOD – Loss of local control would be undesirable
      iv) Stand-alone incorporation would require 501c3 designation – Undesirable due to bookkeeping requirements.
6) **New Business**
   a) **Launch System**
      i) Doug expressed the need for a launch control system with ease of set-up and operation as well as safety as primary design criteria. Announced that David Reese will lead this project.
      ii) David presented his initial design considerations. (presentation attached)
   b) **Equipment Maintenance**

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i) Scheduled an equipment maintenance day for Sunday Nov. 6th @ 2PM at Doug's place.

c) **2012 BOD Elections**
   i) Doug called for nominations to begin. Requested volunteers for 2012 officers. Several nominations were offered.
   ii) Set meeting date of October 16th @ 7PM for the purpose of Election

7) **Announcements** –
8) **Meeting adjourned @** 8:54 PM

Attachments:

County Line Challenge Presentation
Launch System Presentation

County Line Challenge

Who to invite:

North White	Harrison
Twin Lakes	West Lafayette
Frontier	Lafayette Jefferson

The teams need to calculate the Center of Pressure using the Barrowman Equations.

The winner will be the team with the lowest number calculated by:

Distance from pad + |calculated altitude – observed altitude|

Tripoli Indiana will provide the rocket kits and the launch day motor.

Where does the money come from?

Tripoli Indiana and insurance fee or try to find a sponsor. Do we invite local press (newspaper and/or TV)?

Each team will pay an "Insurance" fee of $30.00

Built Day:

A single centrally located point or an individual built with each team?

Equation to calculate altitude:

Definition of Terms

- m = rocket mass in kg
- g = acceleration of gravity = 9.81 m/s^2
- A = rocket cross-sectional area in m^2
- C_d = drag coefficient = 0.75 for average rocket
- ρ (rho) = air density = 1.22 kg/m^3
- t = motor burn time in seconds (NOTE: little t)
- T = motor thrust in Newtons (NOTE: big T)
- I = motor impulse in Newton-seconds
- v = burnout velocity in m/s
- y_1 = altitude at burnout
- y_c = coasting distance
- Note that the peak altitude is $y_1 + y_c$
- t_a = coasting time => delay time for motor

Note on the rocket mass: you usually know the empty (no motor) mass of your rocket m_r. You can usually find the loaded mass of your motor, m_e, and the mass of the propellant, m_p. Aerotech provides these numbers in their spec sheets and with the motors

- average mass during boost is $m_r + m_e - m_p/2$
  use this value for all but the y_c, q_a, and q_b calculations.

- mass during coast is $m_r + m_e - m_p$
  use this value for the y_c, q_a, and q_b calculations.

Note that the peak altitude is $y_1 + y_c$

$$k = \frac{1}{2}\rho C_d A$$

$$q = \sqrt{\frac{T - mg}{k}}$$

$$x = \frac{2kq}{m} = 2\frac{\sqrt{(T - mg)\cdot k}}{m}$$

$$t = \frac{I}{T}$$

$$v = q\frac{1 - e^{-xt}}{1 + e^{-xt}}$$

$$y_1 = \frac{-m}{2k}\ln\left(\frac{T - mg - kv^2}{T - mg}\right)$$

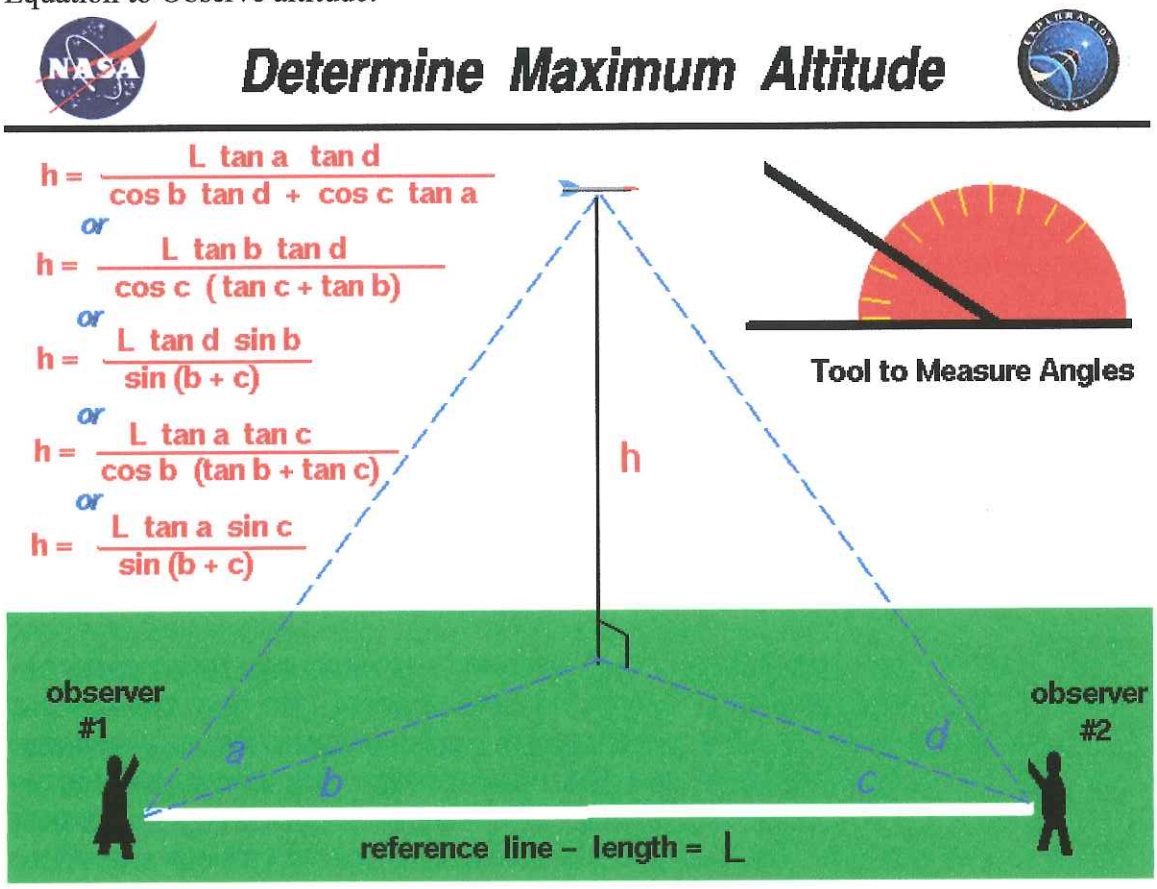
$$y_c = \frac{m}{2k}\ln\left(\frac{mg + kv^2}{mg}\right)$$

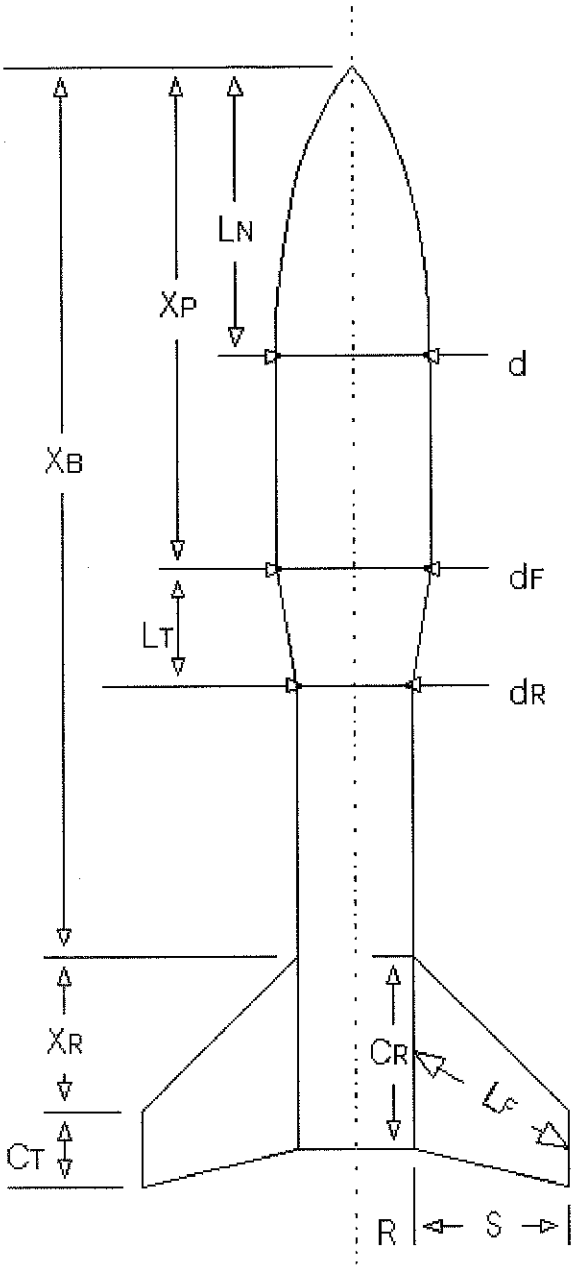
$$q_a = \sqrt{\frac{mg}{k}}$$

$$q_b = \sqrt{\frac{gk}{m}}$$

$$t_a = \frac{\tan^{-1}\left(v/q_a\right)}{q_b}$$

Equation to Observe altitude:





Barrowman I

Computing Center of Pressure

The Barrowman equations permit you to determine the stability of your rocket by finding the location of the center of pressure (CP). The value computed is the distance from the tip of the rocket's nose to the CP. In order for your rocket to be stable, you would like the CP to be aft of the center of gravity (CG).

The computation of CP isn't as hard as it looks at first. Check out the spreadsheet example at the bottom of this page.

You can find the CG of your rocket by simply finding the balance point after loading recovery system and motor. (Literally - balance the rocket on your hand - or finger - and that's the CG). You can then measure from the tip of the rocket's nose to the CG. The calculated CP distance should be greater than the measured CG distance by one rocket diameter. This is called "one caliber stability".

Terms in the equations are defined below (and in the diagram):

L_N = length of nose

d = diameter at base of nose

d_F = diameter at front of transition

d_R = diameter at rear of transition

L_T = length of transition

X_P = distance from tip of nose to front of transition

C_R = fin root chord

C_T = fin tip chord

S = fin semispan

L_F = length of fin mid-chord line

R = radius of body at aft end

X_R = distance between fin root leading edge and fin tip leading edge parallel to body

X_B = distance from nose tip to fin root chord leading edge

N = number of fins

Nose Cone Terms

$(C_N)_N = 2$

For Cone: $X_N = 0.666L_N$

For Ogive: $X_N = 0.466L_N$

Conical Transition Terms

$$(C_N)_T = 2\left[\left(\frac{d_R}{d}\right)^2 - \left(\frac{d_F}{d}\right)^2\right]$$

$$X_T = X_P + \frac{L_T}{3}\left[1 + \frac{1 - \frac{d_F}{d_R}}{1 - \left(\frac{d_F}{d_R}\right)^2}\right]$$

Fin Terms

$$(C_N)_F = \left[1 + \frac{R}{S+R}\right]\left[\frac{4N\left(\frac{S}{d}\right)^2}{1+\sqrt{1+\left(\frac{2L_F}{C_R+C_T}\right)^2}}\right]$$

$$X_F = X_B + \frac{X_R}{3}\frac{(C_R+2C_T)}{(C_R+C_T)} + \frac{1}{6}\left[(C_R+C_T) - \frac{(C_R C_T)}{(C_R+C_T)}\right]$$

Finding the Center of Pressure

Sum up coefficients: $(C_N)_R = (C_N)_N + (C_N)_T + (C_N)_F$

Find CP Distance from Nose Tip:

$$\bar{X} = \frac{(C_N)_N X_N + (C_N)_T X_T + (C_N)_F X_F}{(C_N)_R}$$

Invitation letter (Editing and suggestions gleefully accepted)

On April 2, 2012 Tripoli Indiana is having the "Thunderstruck County Line Challenge". This is a contest between local high schools where teams will build and fly model rockets. As part of the challenge the teams will have to calculate the Center of Pressure for their rocket, predict how high their rocket will fly and determine how to measure the height of a rocket in flight.

Tripoli Indiana would like to invite SCHOOL NAME HERE to represent COUNTY. There will need to be a $30.00 entrance fee to cover national insurance policies. SCHOOL NAME HERE will receive from Tripoli Indiana a KIT NAME HERE, a rocket motor, and guidance on building and flying your KIT NAME HERE.

If SCHOOL NAME HERE is interested in representing COUNTY HERE at the "Thunderstruck County Line Challenge" please respond to: CONTACT INFO

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Launch System Updates

Current System Issues

- Setup time
- Storability
- Reliability & Ruggedness
- Safety

Setup Time

- Difficult to identify system components necessary for day-to-day flying
  - Many disparate elements of system
- Range takes a long time to debug
  - Which pad with which leads?

Storability

- Difficult to store elements of system
  - Relay boxes not stackable
  - Fragility of components

Reliability & Ruggedness

- System can be unreliable
  - Failing relays, continuity check buttons, broken internal wiring
  - Long cable runs have high voltage drop and cannot pull in relays at away cell
- System is not rugged
  - Cannot be left out during inclement weather

Safety

- No indication of armed banks on the pad side
- Inability to isolate more than two halves of range
- Lack of reliability is a huge concern

Ideas for Fixes

Main Controller

- Add multiple separate ARM switches to more closely mimic pad setup
  - Typically banks of 6?
- Break it up into multiple controllers
  - 6-12 pads per controller would provide EXCELLENT isolation
  - Also fixes storage issue?

Relay Boxes

- Relocate batteries from within relay boxes
  - Provide easier access to charging via external permanent connector (mains plug? Amphenol? Banana jacks?)
  - Reduce tendency to carry batteries *in* the box (⇒reduce tendency for boxes to fall apart while carrying ⇒reduce breakage of internal components)

Relay Boxes

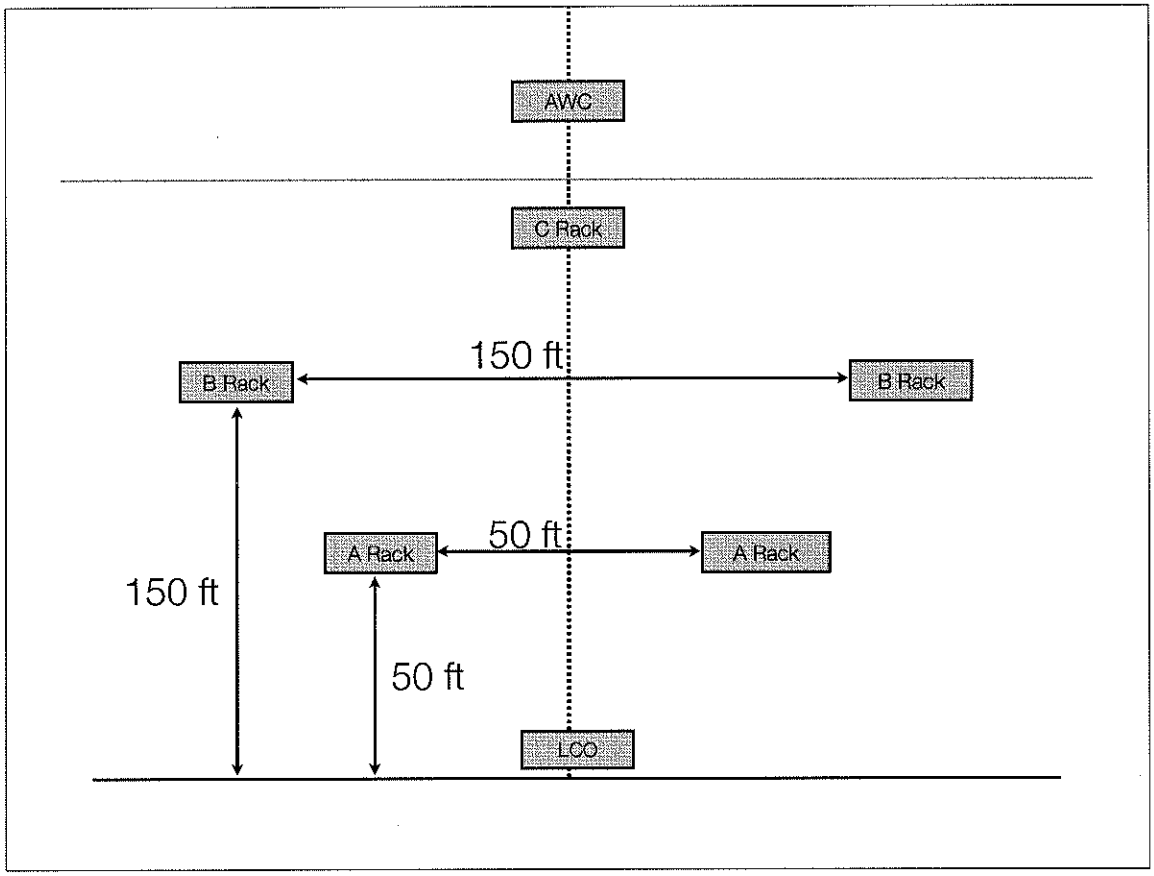
- Add safety strobe to relay banks
- Add "shorted relay" indicator on relay banks
- Check integrity of (existence of?) coil-collapse diodes on relays
  - Will improve reliability -- no more burned out relays

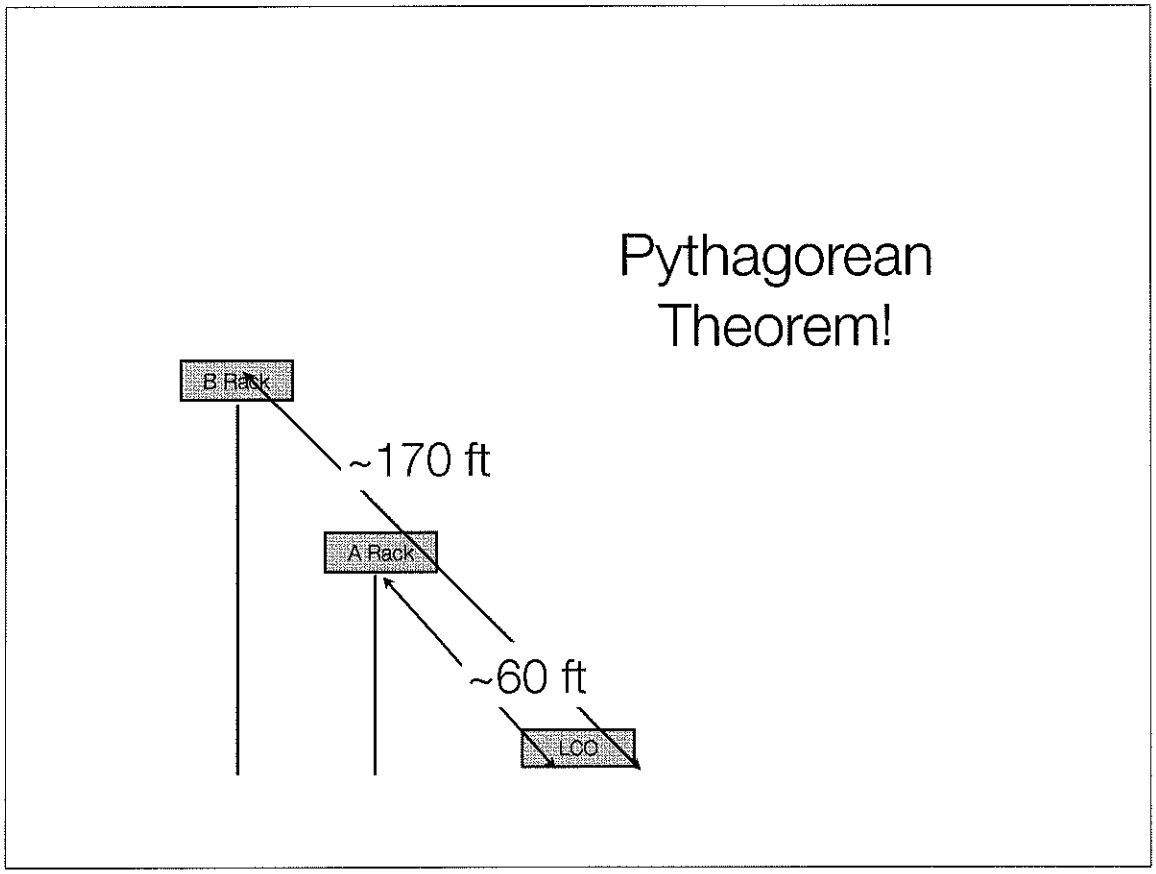
Relay Boxes

- Reduce size and improve case strength
    - Toolboxes are convenient, but they are falling apart

Reliability & Ruggedness

- All changes should be made with weathertight parts and/or covers that can be easily replaced
    - Trashbags don't count
- This should solve our reliability issues, too


AWC
C Rack
150 ft
B Rack
B Rack
50 ft
A Rack
A Rack
150 ft
50 ft
LCO


Pythagorean
Theorem!
B Rack
~170 ft
A Rack
~60 ft
LCO

Storage

- Get totes for pad equipment
- Dedicate a single tote to a single cable length/bank position (e.g., "B Rack Left" tote contains relay boxes for 6 pads and cables appropriate to stretch to that distance)

Cabling

- Neutrik connectors are nice, but we should bulk up cable gauge for wire runs (would fix AWC problem)
- Bundle cables together for various banks to decrease setup time/fix trip hazard/solve "which pad-which leads" problem
- Existing cables are too short
  - Daisy-chain would be nice, but could be inflexible based on equipment requirements of the day
  - Just make the damn wires long enough

Summary

- Separate main controller into multiple smaller ones for each bank/grouping
- Lengthen and thicken pad logic wires
- Improve relay boxes
- Add “armed” strobes
- Buy storage totes for each bank/grouping
- Make everything weatherproof