R.E.A.C.H. Mk0 Data Sheet

Key

1. **(?UL) - Indicates that value falls in the higher range of possible values**
2. **(?LL) - Indicates that value falls in the lower range of possible values**

Project Overview

Our aim is to achieve the following with R.E.A.C.H.:

1. Develop & test a cost-effective solution for experimental testing of new concepts;
2. Mk0 aims to test a novel recovery method;
3. Set Amateur Asian Record for Altitude (Apoapsis) and Eurasian Record for Range of an Amateur Rocket;
4. Ultimately breach the Karman Line.

TGT: Break Aerospace Limit

Total Budget: 50,000 INR

We expect some assistance from research organizations for infrastructural support.

Infrastructure Outsourcing List

Rocket Statistics

Attribute	Details	Numbers	Notes
Dimensions	2m Cylinder with 0.1 Nose Cone of 0.05m Radius	2.1 x 0.05	Aluminium 6061-T6
Mass (Wet)	-	4Kg	-
Range	100 Km (+ve Acceleration)	100Km/60Mi	Karman Line
Communications	Microwave/RF Transceiver	120Km Range	Undecided
Logging & Data	9 Degrees Sensor & 1080p Video & 3Hz Frame Capture	-	Refer to Electronics List
Power	Internal, Reinforced battery pack	-	-
Fuel (Solid)	Bipropellant: (Aluminium + HTPB) + Ammonium Perchlorate	9.92 MJ/Kg	Energy Capacity
Motor Dimensions	Aluminium Pipe 0.04m Radius with 5-star bore	-	Designed to be detachable with minimal Thrust variance
Recovery	Parachute-less Hybrid Recovery	Internal Sustained G_{max} = 45G	Insanity

Trajectory Overview

Launch is expected at first light. Launch will be into Wind. Secondary Fins will induce a stabilizing spin.

Communications will stream sensor data & 1080p Pictures (Colour) @ 3fps.

At the line, as acceleration is reported negative by sensors; the recovery fins, which have the radius of curvature of the rocket, will deploy & extend via compressed air.

The connection point of the 3 fins will be 5cm above the ejection mechanism for the motor, just below the battery pack & compressed air tank. After successful telescoping, fins will lock into position and rocket will get a negative velocity.

Due to Centre of Mass & the Gyroscopic Effect, The rocket will exhibit formidable resistance to deflection from its axis of spin which will only improve as the rocket gains spin. However, the rocket will be allowed to drift in the XZ-Plane laterally.

When the rocket has drifted down to acceptable height (50m - 100m), the motor casing will be ejected & the compressed air will be routed to nozzles on the recovery fins. This will turn the whole contraption into a powered helicopter, generating lift, which would bring velocity to zero.

The rocket is then allowed to 'gently crash' into the ground; destroying the part of the fuselage that housed the motor and the fins to slow the rotation. The part of the fuselage above the junction (1.75+ m) of the recovery fins will be recoverable.

Build Materials

1. Structural

S No	Part	Projected Cost	Quantity	Notes
1	Aluminium 6061-T6 10mm	INR 5000/m^2 (?UL)	1.5	Fuselage is 0.05 (Radius) x 2 (Height) + 0.1 (Nose Cone)
2	Stainless Steel Cylinder 0.06m x 0.1m	INR 2000	1	Tentative Aluminium 6061-T6
3	Welding Tools	INR 2000	DNM	-
4	Compressed Air Tank 15L @ 2 atm	INR 3400 (?UL)	1	Dimensions are Tentative
5	Lever/Latch Locks	INR 250	4	-
6	Aluminium/Copper/Plastic/Rubber Tubing 20mm	INR 500/m (?UL)	2	-
7	Gas Valves 20mm	INR 100	2	Rated for 4 Atm
8	Servos	INR 300 (?UL)	4	For Valve Operation
9	Shock Absorbent Foam	INR 400/m^2 (?UL)	1.5	Non-Flammable
10	Telescopic Recovery Fins	Custom	3	1.75 + 1.5 + 1.25
11	Gyroscopes	INR 400	2	-

Assorted Adhesives & Tools & Mounts Not Included

Total (?UL): 20,300 INR

2. Solid Rocket Motor

S No	Chemical	Projected Cost/KG	Projected Quantity (?UL)	Notes

1	Laboratory Grade Aluminium Powder	INR 300	1	Main Fuel
2	Polybutadiene Pellets	INR 200	1	Binding Agent
3	Ammonium Perchlorate	INR 200	3	OX

Material for Test Fires Not Included

Total (?UL): 3,000 INR

3. ### Electronics

See Full Part List

Total (?UL): INR 20,000

TOTAL COST (?UL): 45,300 INR

Fuel Mixes

Points to Consider:

1. Al oxidation to Al_2O_3 is highly exothermic with 62 KJ/g of Al.
2. OX decays only above 1000K.
3. Burn Temperature should not exceed Melting Point of casing.
4. Thermal Conductivity of the Mix should be infinitesimal. (BDR will help)
5. Chamber Pressure should be constantly high. (BDR will help)
6. Mixtures denoted in the following convention; Binder/OX/Fuel Mass %

	Stoichiometric	JAXA/ISRO	Wikipedic
Mass Composition	12/58/30	12/68/20	16/68/16
Quantized Fuel Unit	3.4g	5g	6.25g
Total Mass	2660g	2660g	2660g
Fuel Units	782	532	425
Range (1% EF)	12Km	8Km	6Km
Target System EF (100Km)	9%	13%	16%
Final Velocity	1477m/s	1464m/s	1451m/s
Target Burn Time	136s	137s	139s
Acceleration	10.9m/s^2	10.7m/s^2	10.5m/s^2
Mix Volume	1377cm^3	1426cm^3	1494cm^3
Tube Length @ 3cm Radius	49cm	51cm	53cm

Computational Framework

$$2NH_4ClO_4 \overset{1000+K}{\rightarrow} N_2 + 3H_2 + 2HCl + 4O_2$$

Stoichiometric Mixture Calculation

16 mol Al requires 6 mol OX

=> 432g Al requires 705g OX

=> 1g Al requires 1.7g OX

The Mass Percentage of Al is 37%

The Mass Percentage of OX is 63%

K.E. Was Calculated with: $\frac{1}{2}mv^2$

Height Was Calculated with: mgh
