Tripoli Level 3 Certification Report

Project: SA Great

14/01/2026

Author: Lachlan Miegel

TRA Number: 32226

TAP Reviewer 1: David Boyd

TAP Reviewer 2: Pete Lam

1. Project Overview

The purpose of this document is to provide the Tripoli Technical Advisory Panel (TAP) members with the required information pertaining to the design, manufacturing, and preparation of Tripoli Rocketry Association (TRA) Member 32226 Level 3 Certification rocket, hereafter referred to as SA Great.

SA Great is being prepared and constructed by Lachlan Miegel for the purpose of achieving a TRA Level 3 HPR Certification. This rocket will be entirely designed, manufactured, and prepared independently using minimal commercial off-the-shelf (COTS) components where possible.

1.1. Proposed Rocket

The proposed rocket has been initially developed using OpenRocket (OR), used for conceptualisation and simulations, with OnShape being used for development for the physical model.

SA Great is designed to have a continuous 114mm (4.5") ID airframe, from COTS carbon tubes, standing at 2550 mm tall with a 98 mm motor mount and four-fin design. The proposed rocket is intended to reach 25 000ft at Mach 2.0, implementing a dual separation dual deploy recovery mechanism. The airframe, bar body tubes, is intended to be scratch built, with COTS avionics systems being used as the primary and secondary flight computers, with COTS GPS.

1.2. Proposed Motor

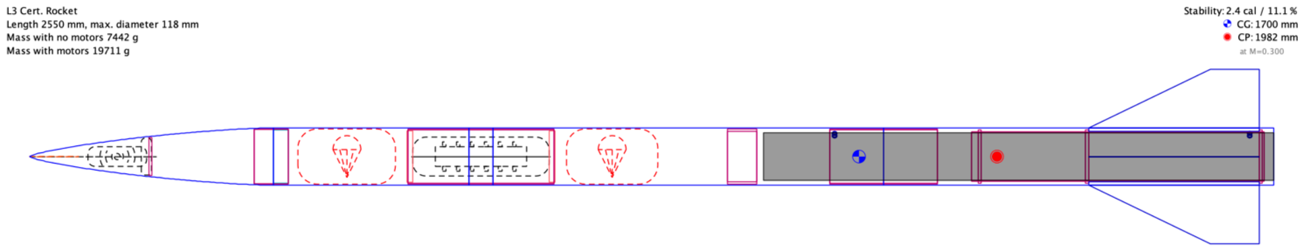
The motor proposed is an AeroTech N3300R, using the RMS-98/15360 casing borrowed from ARES Rocketry. This motor will propel the rocket to Mach 2, with the airframe undergoing an estimated 28 G-forces during motor burn. The motor specifications are seen below.

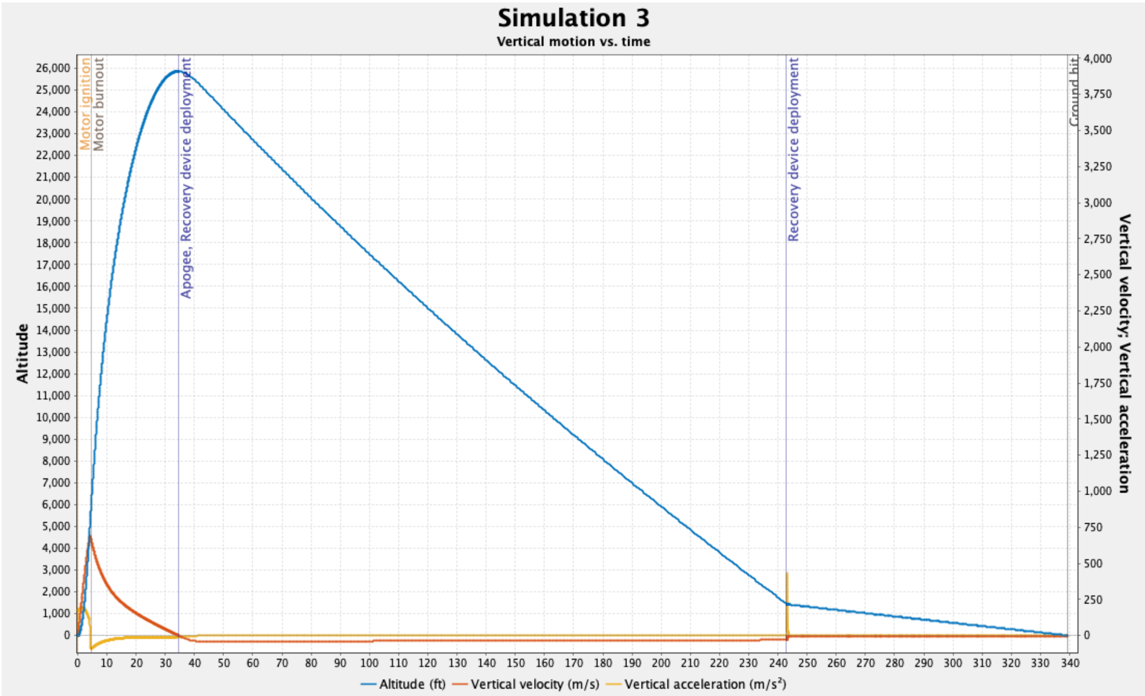
Descriptor	Specification
Total Impulse	13410 N·s
Burn Time	4.1 s
Peak Thrust	4226 N
Propellant Weight	7338 g
Total Weight	12054 g

2. Design & Manufacturing Details

2.1. Airframe & Simulation

Pictured below is the Open Rocket of SA Great, showing all key features of the airframe including approximate CG and CP markers.



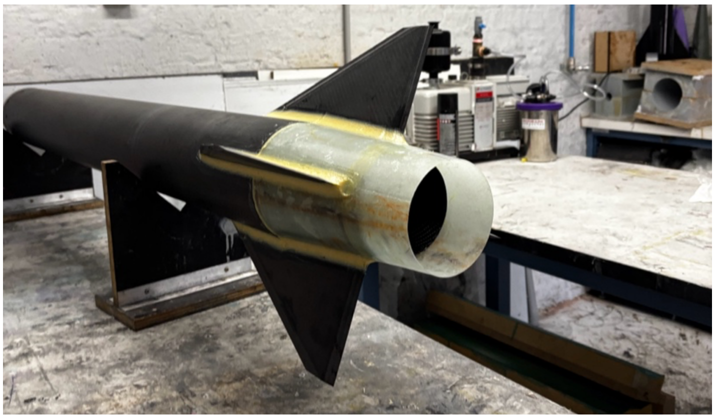


2.1.1. Booster Tube

The airframe is of composite construction, featuring roll-wrapped carbon tubes, carbon plate fins and centering rings, carbon motor tube, fibreglass coupler and nosecone, and 6061-T6 aluminium bulkheads.

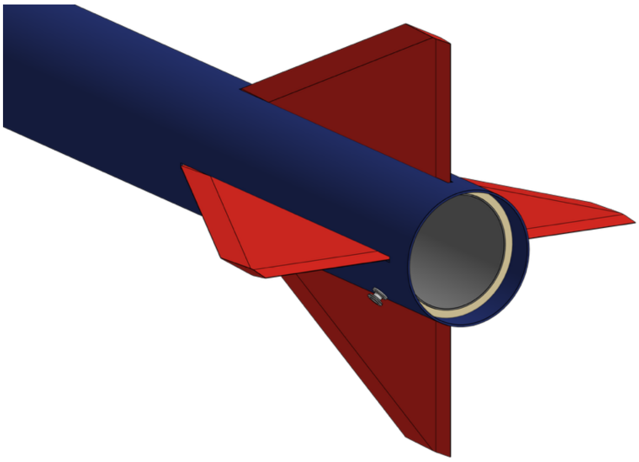
The booster tube will be comprised of two 800mm long segments of tube that will be bonded together. Purchasing a body tube at the desired 1600mm long segment would require high shipping costs, so two 800mm long segments is more cost effective. The fins will be waterjet cut from 5mm thick carbon plate, then chamfered into a double-diamond profile. The fins will be bonded onto the motor tube, made in-house, using Epikote MGS BPR 135 bonding paste, using an MDF jig for alignment. Waterjet cut centering rings will be made from the same 5mm carbon plate and bonded at equidistant spacing on the motor tube using the same paste.

The body tube will have fin slots cut into the tube and then the fin-can slid and bonded to the body tube with large structural epoxy fillets of approximately 10mm radius, using the same Epikote epoxy. Finally, a tip-to-tip over the fins will complete the booster tube, adding approximately 0.8mm of thickness at the fin top chords, and 1.2-1.6mm of thickness at the root chord. Fin flutter calculations demonstrated the flutter velocity to be about Mach 2.6.

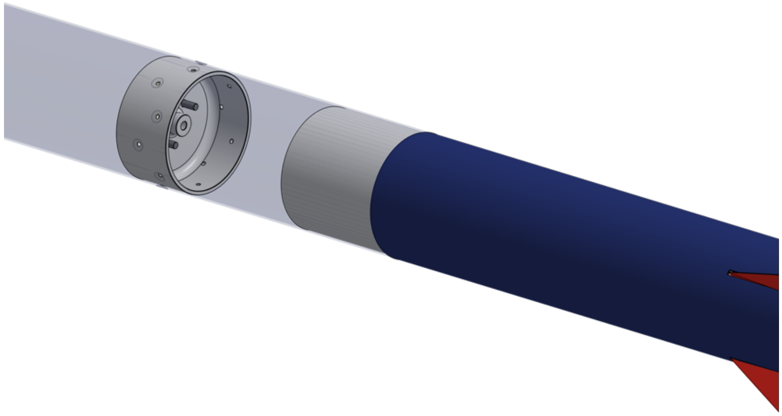


Pictured above is how the fins will appear after the structural fillets are applied. This picture is indicative only of the filleting style and epoxy used.

The booster tube will also house the motor retainer, using a 3/8” threaded hole to fasten the top enclosure, with the motor retainer being radially attached. This part will be machined out of 6061-T6 aluminium and also include a mounting point for a U-bolt. Thrust will go through the airframe via the aft enclosure interfacing with the motor tube, rather than through the motor retainer.



Pictured above is the aft section of the airframe, whilst the motor is not pictured, the thrust will be transferred through the airframe via the beige ring through the lip on the motor casing. The beige ring represents the aft centering ring made from carbon fibre, which is bonded to the motor tube, trailing fin edge, and booster body tube using Epikote. This will deliver a maximum force of approximately 4300N. The motor is then held into the airframe by a retainer that uses the 3/8” threaded hole at the top enclosure.



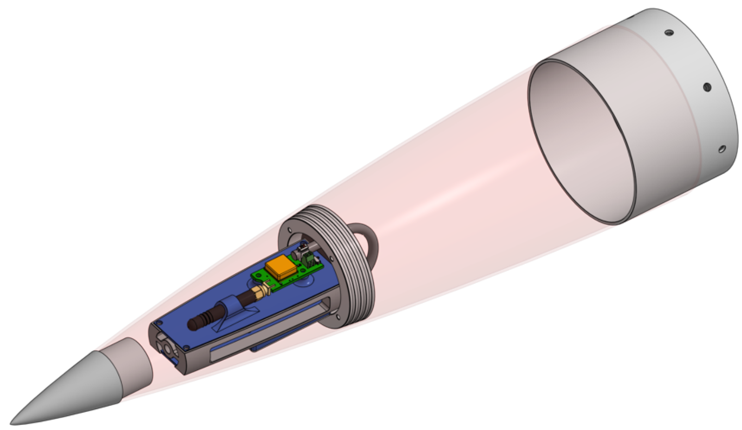
Pictured above is the motor retainer with the body tube made transparent for visualisation. 12 M5 countersunk screws will secure the motor retainer into the body tube, preventing the motor from sliding free from the airframe after motor burnout. The retainer will need to support the mass of the motor whilst on the pad, and with the 12 bolt design, will be able to hold approximately 80kg, using the known shear strength of the bolt and estimates on what the composite tubes can support.

2.1.2. Nosecone & Extension Tube

The nosecone construction will use a method that involves a singular female mould that is exactly one half of a nosecone. This mould will be 3D printed and then prepared to create one half of the nosecone shell. Two halves of the shell will be produced and then bonded internally with fibreglass strips. The fibreglass construction is chosen over carbon fibre due to the GPS being located in the nosecone, allowing for RF transparency. The nose tip will be turned out of brass, acting as ballast, and providing an aerodynamic point to withstand the intense speeds.

The nosecone will house a bulkhead for the GPS to sit, and an attachment point for a shock cord, in a similar way to previous ARES rockets. This bulkhead will have a ring that epoxies into the nosecone shell, with the bulkhead fixturing the GPS and U-bolt. The epoxy used to bond the ring to the inside of the nosecone is Epikote MGS-BPR 135 bonding paste, with a shear strength of 20,000,000 N/m^2 on a $1mm^2$ sample, as such should withstand the shock load from a parachute release. To further hold the GPS bulkhead in place, the nosetip will sit on the shoulder of the nosecone shell and tension the bulkhead via an M6 threaded rod, adding a secondary fixturing method of the parachute attachment point. This threaded rod will screw into the nosetip and bolt onto the bulkhead, using Loctite.

The nosecone will have a short fibreglass coupler that has an aluminium ring that allows the nosecone to be affixed to the extension tube using radial bolts, with the separating point located at the avionics bay coupler. The overall expected mass of the nosecone and internal components is approximately 900 grams. This sub-assembly is seen below.



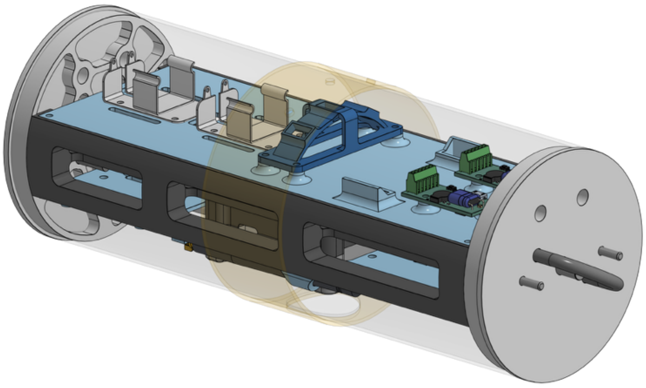
2.1.3. Coupler & Switchband

The coupler will be a 300mm long fibreglass construction, manufactured by laying fibreglass internally to a prepared body tube for a precision fit. Two bulkheads will enclose the avionics bay with the fibreglass tube protecting the avionics, machined out of 6061-T6 aluminium. The avionics bay will be 3D printed out of ABS-GF, a proprietary ABS blend that has incorporated glass fibres for added structural and thermal properties. The avionics bulkheads will have a mounting space for a U-bolt and the threaded rods securing the two bulkheads and providing tension.

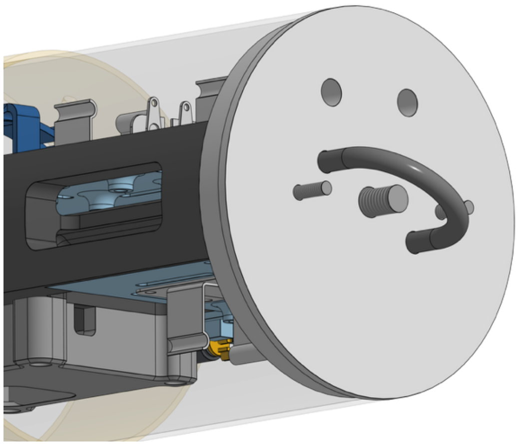
The avionics bay is secured to the bulkheads with three threaded rods that run through the sled and bolt to either bulkhead. There is a large central M8 threaded rod that will resist the tension placed by the two parachute fixtures, and two M4 threaded rods that resist the sled from spinning between the bulkheads and providing auxiliary tension strength. This design ensures the avionics bay cannot spin between the bulkheads and has ample strength to resist the shock force during separation and recovery events.

The avionics sleds (light blue) are secured to the chassis using M3 screws into heat-insert nuts placed into the chassis (dark grey), with Loctite to ensure they do not come loose during flight. Each component is then secured to the sleds via more M3 screws into heat-insert nuts placed into the sleds, allowing for a modular design that is secure.

The switchband will be cut from a section of body tube, 50mm in length and epoxied centrally to the coupler. The coupler is designed to be of sliding nature and let the booster and extension tubes slide freely without incurring any bending moment. The coupler also contains a number of holes (3x 5mm and 1x 30mm) for switch functionality and GoPro vision, also acting as pressure equaliser holes such that the BR's take accurate measurements.



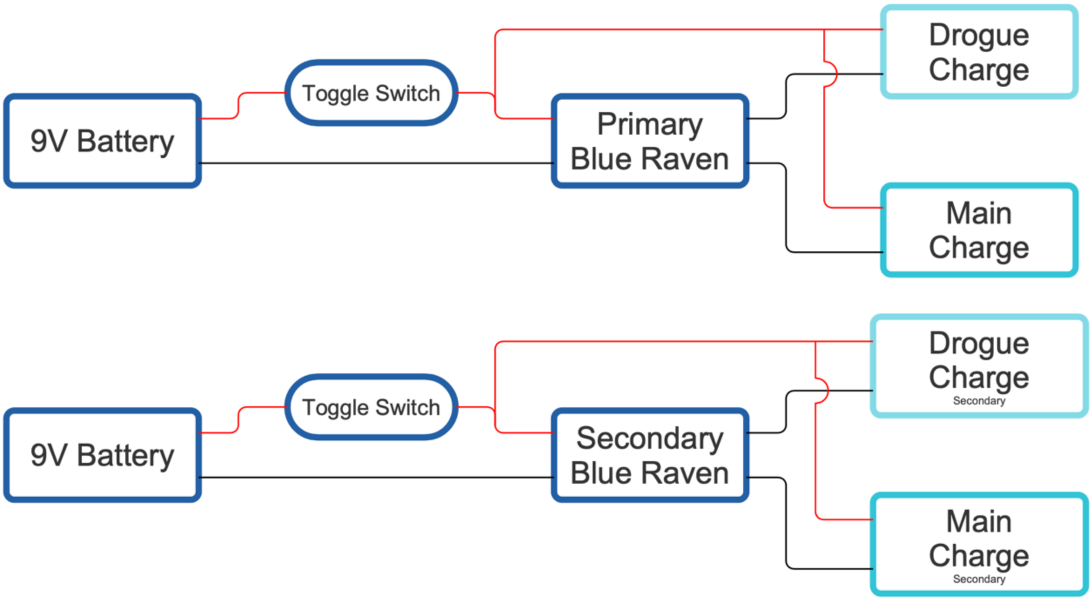
Pictured above is the coupler and avionics bay, with the two flight computers (righthand side), 9V battery mounts (lefthand side), and switch mount (dark blue) all visible.



Pictured above is a closeup of the bulkhead, the three threaded rods are seen on the end of the bulkhead, with the two vacant holes above there for wire passthrough for ejection charges. Nylock nuts with a washer and Loctite shall be used to secure all the threaded rods.

2.2. Avionics

The avionics system will feature two entirely independent Blue Raven systems, controlling the main and apogee separation events, and their respective redundant separation events. The GPS will use a Featherweight system, housed in the nosecone for RF transparency. The BR's will use 9v batteries and slide switches for arming, accessed through the switch band. The GPS will use a Li-Po cell, armed via a magnetic switch in the nosecone. The pyrotechnics will be pre-assembled and attached to the avionics bulkhead connectors using Wago snap connectors on launch-day, then armed via the switches accessed through the switchband.



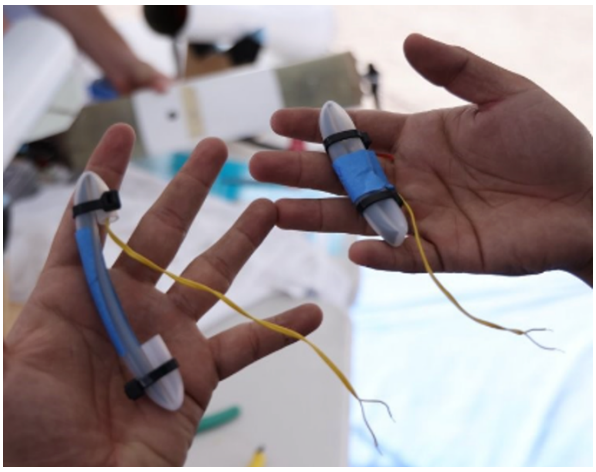
Each BR will use the Main and Apogee output, with the secondary BR programmed to trigger 1-2 seconds after the primary BR signals ejection. Each end of the avionics bulkhead contains 3 snap connectors that are epoxied on using Epikote MGS BPR 135, the negative (black) lead from each BR will go into its own connector, and the positive (red) lead will go to the third connector. Each charge has two wires, one wire will go into a connector with its required negative lead, and the other wire will share the common positive connector. This will be mirrored on both avionics bulkheads.

A separate system of ARES Rocketry avionics will also fly, housed on a separate side of the avionics sled, it will operate as a purely data-gathering system and have no effect on the flight-critical avionics, and hence is not depicted in the schematic.

Finally, a GoPro will also fly within the avionics bay, armed via turning the device on at the pad, it will record the duration of the flight and is not controlled by any additional hardware.

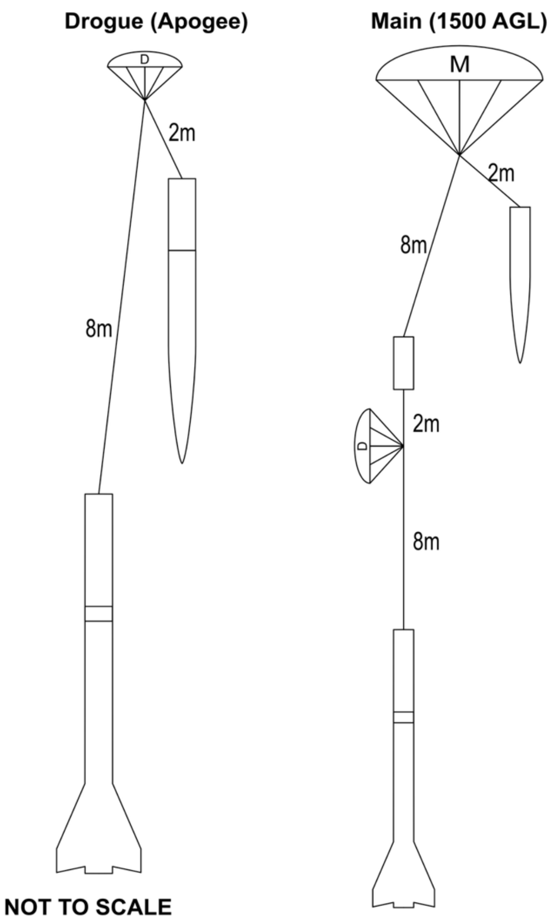
2.3. Recovery

The recovery employs a dual separation dual deploy mechanism, with the first event at apogee deploying a 24” pilot chute, and second event occurring at approximately 1500ft with a 96” Fruity Chutes Compact Iris. The separation will occur using 4F black powder (BP) packed into nylon burst tube, a proven method thanks to ARES that requires a few grams of BP to induce separation. A calculated 1.2 grams of BP is required as described in §3.1, although this will be increased by 0.5 grams and validated through ground-testing. The calculations for shear pins are seen in §3.2, requiring three shear pins per bay, although this number will be validated through ground separation testing. More pins may be required to secure the main parachute bay to ensure premature separation does not occur prior to main deployment during decent. There will be one vent hole in each parachute bay, 3mm in size and placed such that the recovery system will not obstruct air bleed to ensure pressure equalisation.



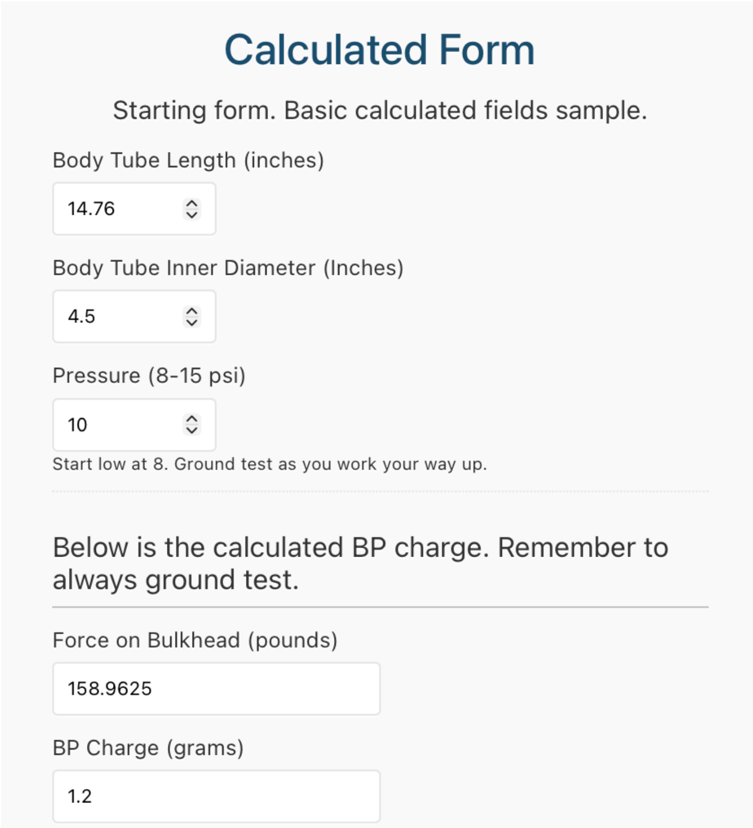
Pictured above is an example of the nylon burst tube containing BP, where these sealed vials contain an e-match and have their own atmosphere allowing for easier ignition at altitude. These tubes will be wrapped in a Nomex blanket and secured to the internal wall of the rocket using tape to reduce the risk of movement during fight. The e-match will be secured into the connectors as described above.

All lines are 5mm braided SK-75 Dyneema, an aramid fibre with approximately 3100kg of force before yielding. The lines shall be finger trapped and attached to each M6 316 stainless steel U-bolts using soft shackles at the nosecone, integrated avionics coupler, and motor retainer, with the line diagram pictured below.



3. Appendix

3.1. BP Calculation



Calculated Form

Starting form. Basic calculated fields sample.

Body Tube Length (inches)

14.76

Body Tube Inner Diameter (Inches)

4.5

Pressure (8-15 psi)

10

Start low at 8. Ground test as you work your way up.

Below is the calculated BP charge. Remember to always ground test.

Force on Bulkhead (pounds)

158.9625

BP Charge (grams)

1.2

3.2. Shear Pin Calculation

Pressure at apogee (25 000 ft) = 36600 Pa

Shear pins – M3 Nylon, ø2.4mm, Shear Strength = 298.126 N

$$\Delta P = P\text{internal} - P\text{external} = 101.325 - 36.600 = 64.725 \text{ kPa}$$

Force due to pressure differential

- Bulkhead diameter = 114mm, Area = 0.01021 m^2

$$Force\ on\ BH = P \times A = 64725 \times 0.01021$$
$$F = 660.7\ N$$

Number of shear pins

$$N = \frac{F}{Shear\ Pin\ Strength} = \frac{660.7}{298.126} = 2.22 \approx 3\ Pins$$

3.3. Epoxies within Airframe

Epikote MGS BPR 135 Bonding Paste is used to:

- Fin bonding onto motor tube
- Structural fin fillets
- Centering ring to motor tube and body tube
- GPS bulkhead onto nosecone internal
- Snap connector securing on avionics bulkheads

Westlake Systems L285 Laminating Resin is used to:

- Motor tube manufacturing
- Switchband onto coupler
- Tip to Tip
- Nosecone