

Team 99 Project Technical Report to the 2026 IREC

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***Sabre III* is Team 99 University of Virginia's entry into the 10k Commercial-off-the-Shelf (COTS) category at the 2026 International Rocket Engineering Competition (IREC). The rocket is 10'4" long with a 6.17" maximum outer diameter and will be launched on an Aerotech M2500T motor to reach a projected apogee of 10,027' above ground level (AGL). *Sabre III* is made up of an external fiberglass nose cone, upper airframe, and booster tube with two internal coupler tubes connecting the airframe segments. The booster tube features a student-designed aluminum boat tail motor retainer and four carbon fiber fins that are strengthened with tip-to-tip reinforcement. *Sabre III* also features four main internal subsystems: recovery, airbrakes, payload, and live video systems. The recovery avionics and live video system are housed together in the central avionics bay in an improved configuration to maximize space efficiency. The airbrakes include a novel deployment method using a winder mechanism, and the apogee prediction software has been improved to an accuracy of within 10' of the target in simulation. A non-deploying rover payload will collect data on atmospheric conditions and validate the structural integrity and payload orientation system to prepare for a full deployment mission in the 2027 IREC competition.**

***Sabre III* is required to have successful ground ejection testing of the drogue and main parachute separation and one successful sub-scale test launch prior to competing at IREC. The ground ejection testing was completed on February 28 and March 1, 2026, followed by a successful flight test in the afternoon of March 1, 2026. An additional round of ground testing was performed on March 13 for the main separation due to a change in payload design. A second sub-scale flight test was conducted on April 11 with a successful flight and recovery. No major design changes or additional tests are required between the second sub-scale launch and IREC, although the airbrakes and payload missions have been descoped from the original goals set at the start of project development.**

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I. Nomenclature

a	=	speed of sound
AR	=	aspect ratio
c	=	root chord length
G	=	shear modulus
P	=	air pressure
T	=	temperature
T_{ground}	=	ground-level temperature
t	=	thickness
V_{flutter}	=	fin flutter critical velocity
Δh	=	change in altitude
λ	=	taper ratio of fin

II. Introduction

A. Project Overview

Sabre III represents the third entry of the Rocketry Team at the University of Virginia—more frequently called “UVA Rocketry”—into the International Rocket Engineering Competition. The team has spent the 2025–26 academic year designing, building, and testing *Sabre III* to compete in the 10k COTS category. The project includes an improved avionics bay design to house both the recovery avionics and live video system, a rover payload to lay the groundwork for future payload deployment, and an active drag system (airbrakes) with an onboard flight computer capable of accurate apogee prediction to within 10’ in simulation.

The team operates out of Lacy Hall at the University of Virginia, where the University’s School of Engineering and Applied Science (SEAS) has dedicated storage space for the team and provides a workshop with waterjet cutting, metalworking, and general fabrication equipment for student use. The team is primarily funded by the SEAS Experiential Learning Fund, which this year funded all materials for *Sabre III* and provided a significant portion of the team’s travel funding. Other important funding sources this year include the UVA Parents Program Grant and the Virginia Space Grant Consortium.

B. Team Organization

UVA Rocketry is an entirely student-run extracurricular program, officially designated as an Experiential Learning Program (ELP) through SEAS. As an ELP, the team is dedicated to providing UVA engineering students the opportunity “to participate in hands-on design, build, and competition teams that span multiple engineering disciplines and give them real-world experience in applying knowledge to solve problems” [1].

Over the course of the past two years, the team went through a major reorganization process to adapt to massive membership growth from 10 to about 75 active members. The current iteration of the team’s organization structure is shown in Fig. 1. This structure has established greater clarity with role responsibilities and led to greater efficiency in accomplishing tasks. This leadership structure will continue next year with one role change on the IREC Team which is described in Section V.B.

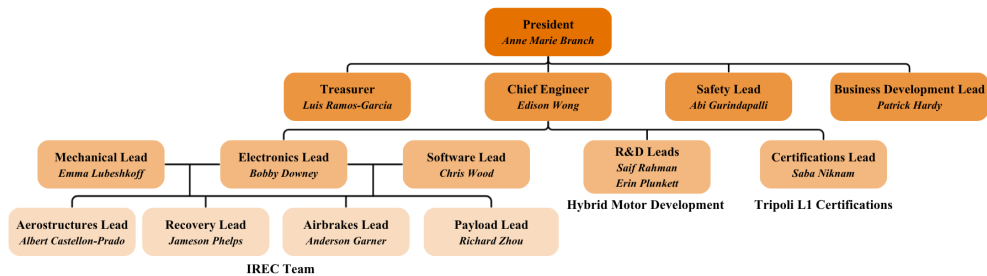


Fig. 1 UVA Rocketry Team structure for the 2025–26 academic year.

UVA Rocketry is run by a President who serves as a project manager, overseeing all facets of team activity including technical projects, finances, safety, and business development. The President is assisted by four executive leads: a Chief Engineer who oversees the design and manufacturing process across all branches of team activity; a Treasurer who manages the team's financial account, funding applications, and sponsorship outreach; a Safety Lead who serves as a liaison between the team and the University's Department of Environmental Health and Safety; and a Business Development Lead who manages the team's social media accounts and organizes events.

The team is broken up into two primary areas of focus: an IREC team which develops a new rocket each year and a Hybrid Motor Research and Development Team, which is working on a multi-year project for use in competition as early as 2028. The IREC Team is run by three specialists who all have at least a year of prior experience competing in IREC. These are the Mechanical, Electronics, and Software Leads. While none of these leads have a dedicated group of student members, they oversee the four IREC sub-teams and provide expertise based on each project's needs. The four IREC sub-teams—Aerostructures, Recovery, Airbrakes, and Payload—each have their own dedicated lead. The team also has an L1 Certification Program to help students achieve their Tripoli Level 1 Certifications, providing kits and motor reload casings to allow students a pathway into high powered rocketry.

C. Project Management

At the beginning of the year, the team decided to place a new emphasis on project management and systems engineering. Throughout the first semester, the team leads held weekly integration meetings to establish objectives and requirements for the project at every level. These objectives and requirements were documented in an Engineering Requirements Document (ERD) which established benchmarks to determine the success of the project. The team's primary and secondary objectives for *Sabre III* are listed below.

- **Primary Objective (SABRE-PO-1):** Successfully launch, fly and recover *Sabre III* in the 10k COTS category at the 2026 IREC, achieving the highest score out of all teams and winning the New Horizons Trophy.
- **Secondary Objective (SABRE-SO-1):** Elevate technical complexity to qualify for a podium presentation and contend for technical excellence awards.
- **Secondary Objective (SABRE-SO-2):** Build team cohesion and technical readiness through hands-on experiences that extend beyond classroom learning, engaging all members in real-world, collaborative challenges.
- **Secondary Objective (SABRE-SO-3):** Increase team recognition and standing within UVA SEAS, among other university teams, and within the broader academic community.

The team held multiple design reviews throughout the Fall semester, including a Preliminary Design Review (PDR) and Critical Design Review (CDR), with the team's faculty advisor, Tripoli L3 advisors, Flier of Record, and other University professors making up the reviewing panel. These design reviews served as important checkpoints for ensuring that the project stayed on track so that manufacturing could begin at the start of the Spring semester to accommodate an early test flight schedule for the month of March. Figure 2 shows a detailed breakdown of how much time was spent on each project phase of *Sabre III*. The team also held a Flight Readiness Review with the team's advisors prior to conducting the first ground test and sub-scale test launch to ensure that all safety standards had been met and that the rocket was ready to launch.

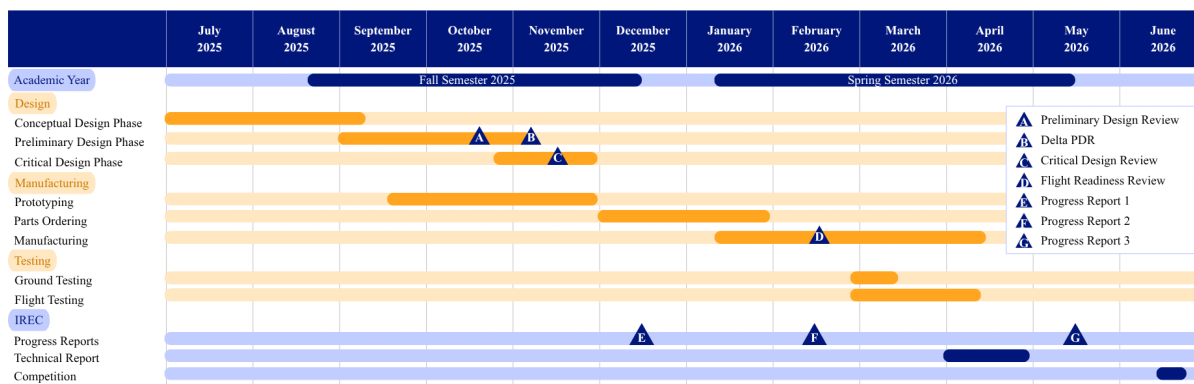


Fig. 2 Sabre III project timeline.

D. Preparation of the Technical Report

This technical report was organized in an Overleaf document using a modified AIAA template for L^AT_EX. The President was responsible for the overall formatting, as well as preparing the Executive Summary, Introduction, Conclusions and Lessons Learned, and Acknowledgments. The division of the System Architecture Overview was as follows: the Aerostructures Sub-Team wrote the Aero-Structures and Propulsion sections; the Recovery Sub-Team wrote the Avionics, Recovery, and Live Video sections; the Airbrakes Sub-Team wrote the Telemetry and Airbrakes sections; and the Payload Sub-Team wrote the Payload section. Each sub-team also prepared their own section of the Appendix E checklists and the Appendix F engineering drawings. The Mechanical Lead prepared the Mission Concept of Operations Overview, Appendix A (System Weights, Measures, and Performance Data), Appendix C (Hazard Analyses), and Appendix D (Risk Assessment). The Chief Engineer wrote Appendix B (Project Test Report) and advised all sections. Team leads and members worked together to edit and revise the report as a whole. Those who made a significant contribution to this document are listed as authors.

III. System Architecture Overview

Sabre III, as shown in Fig. 3, has three main external components: a COTS fiberglass nose cone, an upper airframe, and a booster tube. The booster tube has a permanently attached student researched and developed (SRAD) boat tail motor retainer and four carbon fiber fins that are strengthened with tip-to-tip reinforcement. The nose cone and upper airframe are connected during launch by a payload coupler tube that houses the payload system, while the upper airframe and booster tube are connected by another coupler tube that houses the recovery avionics. The upper airframe contains the main parachute until deployment at an altitude of 1,000' AGL, and the booster tube holds the motor, the airbrakes system, and the drogue parachute.

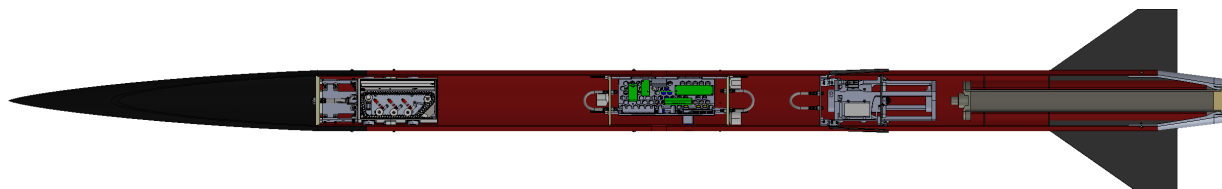


Fig. 3 Section view of *Sabre III* showing (fore to aft) the internal payload, avionics bay, and airbrakes systems.

A. Aero-Structures Subsystems

Sabre III is a modified and improved-upon version of *Sabre II*, which was UVA Rocketry's entry to the 10k COTS category for the 2025 IREC. *Sabre III* is designed to reach a simulated apogee of 10,300' under typical weather conditions for the IREC launch site during mid-to-late June. This would allow the airbrakes to deploy and reduce the apogee to 10,000'. After the second sub-scale launch, the decision was made to descope the airbrakes system and add weight to achieve a new predicted apogee of 10,027'. *Sabre III*'s airframe is designed to be light yet robust. It was carefully prepared through sanding, epoxying, and drilling to eliminate gaps between components and ensure secure coupler tube interfaces. In addition, *Sabre III* features an aluminum boat tail that reduces base drag while serving as a motor retainer, and its four fins maintain a 10% stability margin to ensure vertical flight.

1. Nose Cone and Airframe

The complete airframe consists mainly of three parts: the nose cone, the upper airframe, and the booster tube. These components are manufactured from G12 fiberglass with an outer diameter of 6.17" and an inner diameter of 6". The fully assembled configuration uses screws and shear pins aligned with the four evenly spaced fins to fasten components together (demonstrated in Fig.4.)



Fig. 4 Sabre III fully assembled.

The nose cone is a COTS Von Karman ogive design 36.5" long with a 5:1 profile. This commercial component was chosen to guarantee predictable transonic aerodynamics and surface tolerances, strategically freeing the team's manufacturing bandwidth for other systems. Screw holes are drilled 1.5" from the aft end to secure 5" of the 12.25" long payload coupler within it using four 10-32 screws.

The upper airframe is a 30" long tube that sits flush with the nose cone at the forward end and the the avionics switch band at the aft end. During ascent, the upper airframe is attached to the payload coupler tube with four 4-40 shear pins with 7.25" (1.2 cal) of overlap for this separating joint. The upper airframe is also connected to the avionics bay coupler with four 10-32 screws and has an overlap of 4.25" (0.67 cal) for the fixed joint. The avionics bay coupler tube is 12" long with a 1.5" switch band epoxied 4.25" from the forward end of the coupler.

The longest of the three components, the booster tube, is 49" long and connects to the avionics bay at the forward end using four 4-40 shear pins with an overlap of 6.25" (1.0 cal) for the separating joint. The booster tube also features a camera window with a radius of 0.5" for the live video system. Below the avionics coupler, the booster tube also contains the airbrakes system. Four carbon fiber flaps are attached to the booster tube 90° apart using 10-32 screws, and holes beneath the flaps allow mechanical linkages to extend the flaps. The flaps are offset 45° from the fins so their wake would have a minimal effect on the aerodynamic flow over the fins. Below the flap to the left of the camera, two 1515 rail buttons protrude 25" and 12" away from the aft end of the rocket, reducing the effective rail length to 179". At the aft end of the rocket, four trapezoidal fins extend slightly past the edge of the booster and into the fin slots cut into the boat tail. The boat tail shelf sits flush against the booster's aft end, creating a continuous transition between the booster tube and motor retainer.

2. Manufacturing Process

In preparation for manufacturing, the team waterjetted fins and centering rings out of 1/8" thick, commercially purchased quasi-isotropic carbon fiber plates. Additionally, components were sanded and aligned to fit flush with one another. For *Sabre III*, carbon fiber fins replaced *Sabre II*'s fiberglass construction due to carbon fiber's superior strength-to-weight ratio and rigidity benefits. The fins were waterjetted from a quasi-isotropic plate laminate constructed from alternating 0°/90° and +45°/-45° layers because it provides a balance between torsional stiffness, shear strength, and resistance to twisting, which is especially important for reducing fin twist and improving flutter resistance.

Assembly began by epoxying the centering rings to the motor mount tube. Once cut, the fins were attached to the motor mount tube between the two lower centering rings, where high-strength epoxy was applied around the base of each fin to create a solid connection. Following this, the team designed and 3D-printed jigs to minimize deformation while 11" long fin slots were cut from the aft end of the booster tube. The jig centered the booster tube within a circular cutout inscribed in a square housing, locking the tube in place so that the four fin slots could be cut at 90° intervals by referencing each face of the square jig. This ensured that the fin slots were machined as close to 90° as possible. The motor tube and fin assembly were then guided into the fin slots milled into the booster tube. Sanding the fin slots allowed for a smoother insertion of the motor mount tube and fins, and epoxy fillets were added on the internal and external edge of the rocket to increase structural strength. Both rail button weld nuts were also epoxied at this point. The rail buttons themselves can be changed out between launches depending on their wear.

Next, the team worked to chamfer the inner edges at the aft end of the booster, allowing the use of 10-32 screws to fasten the boat tail to the rocket. Four holes aligned with the fins were drilled in the forward end of the booster tube, the aft end of the avionics bay coupler tube, as well as 3" away from the switch band, enabling 4-40 shear pins to connect the two components. Identically aligned connections for the 10-32 screws were made for the forward end of the payload coupler with the aft end of the nose cone and the aft end of the upper airframe with the forward end of the avionics bay coupler tube. Finally, the team performed two layers of tip-to-tip reinforcement on the fins. This layup used one sheet

each of $0^\circ/90^\circ$ and $+45^\circ/-45^\circ$ carbon fiber cloth spanning from one fin tip to the adjacent fin tip to enhance structural stiffness and help reduce the likelihood of damage due to fin flutter.

3. Boat Tail

Sabre III incorporates a boat tail, shown in Fig.5, designed to reduce base drag, retain the rocket motor, and transfer thrust to the rest of the rocket. The forward end of the boat tail consists of a 3" tall, 0.21" thick hollow cylindrical section that sits flush with the booster tube. Below this section, the geometry transitions into a downward facing truncated cone with a height of 5.76", a forward end outer diameter of 6.17", and a taper angle of 7.23° . At the aft end, the cone flattens into another cylindrical section with external threads for attaching the screw cap and an outer diameter of 4.3". Four 5" long fin slots are evenly spaced at 90° intervals around the forward end of the boat tail. The outer diameter of the cylinder is equal to the inner diameter of the booster tube, and the shelf created by the base of the truncated cone sits flush with the aft end of the booster tube to create a snug fit. In order to secure the boat tail to the booster, two holes are drilled into each of the four sections of the cylinder created by the fin slots. The lower part of the design is a screw cap designed to secure the motor's aft closure. It has vertical threads 0.68" down from the forward end inside to match the upper part and screw in flush. Outside, it is tapered to match the angle of the upper part. There is a shelf 0.29" long next to a 0.47" section of the wall without threads that houses the motor.

The primary objective in designing the boat tail was to optimize aerodynamic efficiency in order to overshoot the 10,000' apogee by a sufficient margin to justify the use of airbrakes. A conical design was selected over other shapes for its greater drag reduction and ease of manufacturing, and research indicates that a taper angle between 5° and 10° is ideal for rockets with a maximum speed of Mach 0.8[2]. Dimensions such as length and width are derived from the boat tail angle, and the screw cap was tapered to match the angle as well. The drag reduction capabilities were verified through Computational Fluid Dynamics (CFD), and a mathematically verified 3.24 N reduction in total force acting against the rocket over *Sabre II*'S design confirmed aerodynamic benefits of using a boat tail outweighed the drawbacks of adding additional mass. A secondary objective of the boat tail is to retain the motor and transfer thrust during flight. To do so, the team created the screw cap design. Aluminum 6061 is lightweight and has a compression strength well above the motor's max thrust of 3,710.9 N, making it optimal for the boat tail design. Finite Element Analysis (FEA) was conducted to validate minimal deformation and stress during motor burn, as well as compare a vertical and tapered thread design.



Fig. 5 *Sabre III* SRAD boat tail.

4. Finite Element Analysis

The team performed Finite Element Analysis (FEA) on the boat tail's motor retention mechanism to ensure negligible deformation and stress on the boat tail. The thrust curve for the Aerotech M2500T indicates a maximum thrust of 3,710.9 N and a total burn time of 3.9 seconds[3]. The aft closure on the motor casing secured by the boat tail has an area of 0.524 in². To establish a factor of safety, a transient analysis simulation was conducted with a constant force of 4,000 N for 5 seconds applied to the area flush with the motor's aft closure. The aluminum alloy preset was selected for the material as it closely mirrors the properties of Aluminum 6061-T6, and the four shelves separated by fin slots that sit flush with the rest of the rocket were declared fixed supports. The results demonstrate that the screw at the aft end has the greatest deformation and stress of 1.9273 micrometers and 1.217×10^7 Pascals. This indicates that the boat tail could withstand the thrust and survive several flights without failure. FEA was also used to compare vertical threads to threads that tapered with the boat tail. Vertical threads were ultimately selected, since both options performed similarly and vertical threads were easier to manufacture. Figure 6 displays the results of the simulations for the vertical thread design.

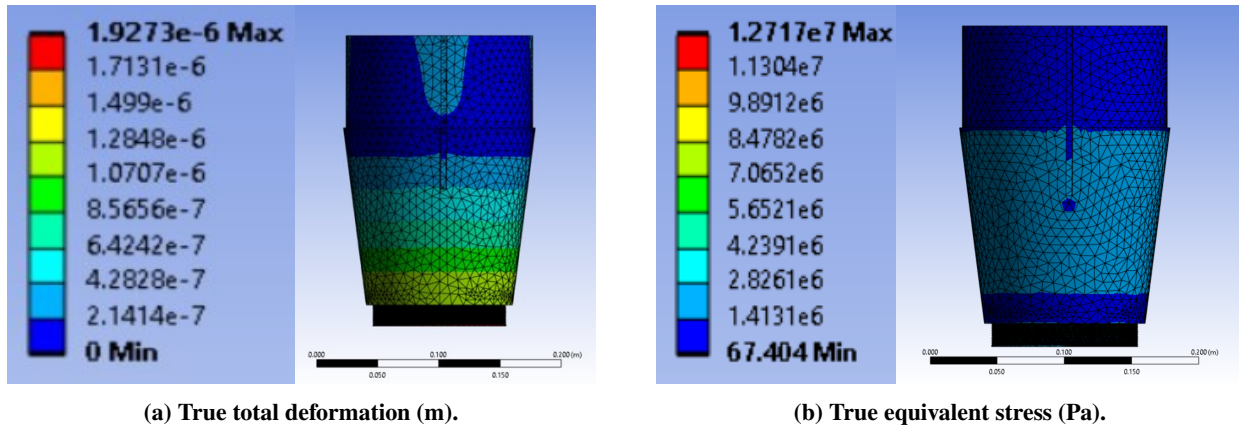


Fig. 6 FEA simulations for boat tail thrust transfer.

5. Computational Fluid Dynamics

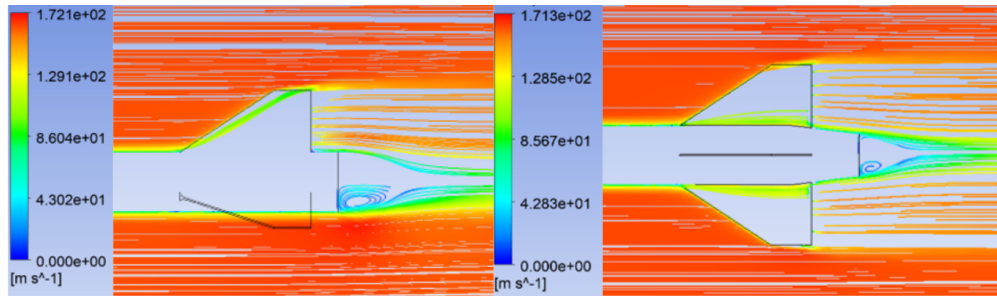
The boat tail is predicted to reduce drag on the rocket by reducing turbulent flow at the aft end of the booster tube. To test this prediction, the team ran Computational Fluid Dynamics (CFD) simulations for both *Sabre II*, which does not have a boat tail, and *Sabre III*, which does, drawing a comparison between the two similarly designed rockets. Simulations for both rockets were computed at a Mach number of 0.4 and 0.8 for comparison of the flight conditions for both a sub-scale and full-scale launch respectively. Both simulations were conducted using the largest cross sectional area of each rocket: 33.674 in² for *Sabre II* and 33.155 in² for *Sabre III*.

Table 2 shows the results from the CFD simulations and calculations. This shows that the coefficient of drag is reduced for both tests of *Sabre III* and therefore results in a higher apogee.

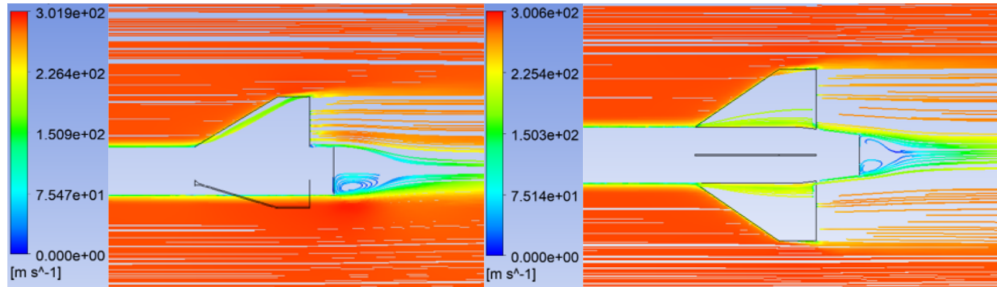
Table 2 Results for CFD simulation

Mach Number	Rocket Type	Coefficient of Drag	Max Apogee (ft)
0.4	<i>Sabre III</i>	0.3818	14,158
0.4	<i>Sabre II</i>	0.4268	13,188
0.8	<i>Sabre III</i>	0.3080	12,541
0.8	<i>Sabre II</i>	0.3468	11,987

In Figs7 and 8 velocity streamlines and pressure contours are shown to visually confirm the analytical results. Figure 7 shows the reduction of turbulent flow at the aft end of the rocket for *Sabre III* versus *Sabre II* which creates less drag on the rocket. Figure 8 shows a decrease in the pressure difference at the aft end of each rocket explaining the reason for less turbulent flow.

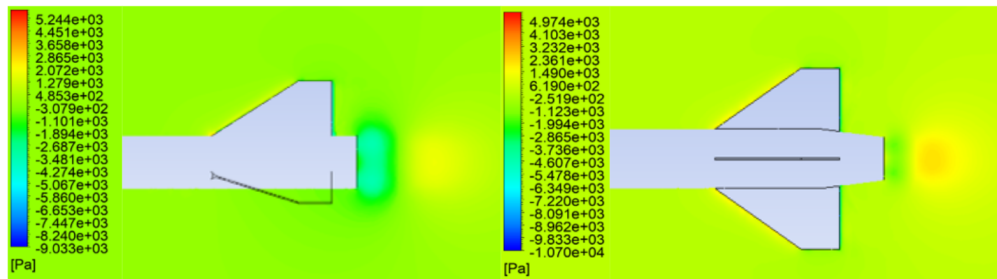


(a) Velocity streamlines for Mach 0.4.

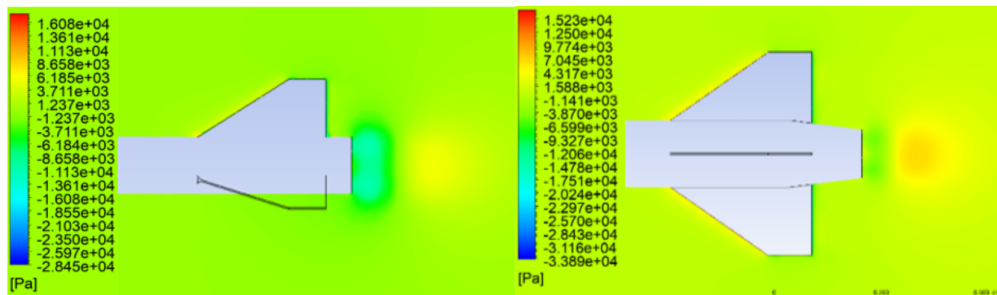


(b) Velocity streamlines for Mach 0.8.

Fig. 7 CFD simulation showing velocity streamlines for *Sabre II* (left) and *Sabre III* (right).



(a) Pressure contours for Mach 0.4.



(b) Pressure contours for Mach 0.8.

Fig. 8 CFD simulation showing pressure contours for *Sabre II* (left) and *Sabre III* (right).

Drag force calculations from OpenRocket simulations at Mach 0.4 and 0.8 resulted in similar trends to the CFD simulations. There were discrepancies between the values of drag force between the OpenRocket and CFD simulations, which was due to holding parameters constant in the CFD and not in the OpenRocket simulations.

6. Fin Flutter

The fin flutter critical velocity was calculated using Equation (1).

$$V_{\text{flutter}} = a \sqrt{\frac{G}{(1.337(AR)^3)P(\lambda + 1)}} \cdot \frac{1}{2(AR + 2) \left(\frac{t}{c}\right)^3} \quad (1)$$

The equation was taken from the Peak of Flight Newsletter Issue 291, which itself is based on the NACA Technical Note 4197 [4]. It incorporates several variables describing the fin geometry, atmospheric conditions, and material properties. The fin geometry is characterized by the aspect ratio (AR), thickness (t), root cord (c), and taper ratio (λ). The atmospheric conditions are represented by the air pressure (P) and speed of sound (a). The material properties are captured by the shear modulus (G). The geometric variables were calculated based on *Sabre III*'s design. The atmospheric conditions were predicted using the following method. In the troposphere, temperature varies approximately linearly with altitude, while pressure and speed of sound depend on temperature.

$$T(^{\circ}F) = T_{\text{ground}} - 0.00356 \cdot \Delta T \quad (2)$$

$$P(\text{lbs/ft}^2) = 2116 \cdot \left(\frac{T(^{\circ}F) + 459.7}{518.6} \right)^{5.256} \quad (3)$$

$$a(\text{ft/s}) = \sqrt{1.4 \cdot 1716.59 \cdot (T(^{\circ}F) + 460)} \quad (4)$$

The ground level temperature and pressure were assumed to be $100^{\circ}F$ and 1 atm at 2,865' above mean sea level (AMSL), corresponding to conditions on a summer day in Midland, TX. OpenRocket simulations predicted that *Sabre III* would reach its maximum velocity at an altitude of 4,539' AMSL. The change in altitude was used to calculate the temperature at maximum velocity, and that temperature was used to calculate pressure and speed of sound.

The shear modulus for the fin material, a quasi-isotropic carbon fiber plate, was estimated by researching values from manufacturer spec sheets and the ANSYS Granta material database. A lower-bound estimate of 2.03×10^6 psi was chosen to yield a conservative safety factor and avoid overestimating structural resilience. Finally, the effect of tip-to-tip reinforcement was factored in by doubling the shear modulus, as advised in the Peak of Flight Newsletter Issue 615 [5]. The fin flutter critical velocity was calculated to be 1,632 ft/s, which has a 1.87 safety factor compared to a maximum rocket velocity of 877 ft/s.

B. Propulsion Subsystems

Sabre III will be flying on a COTS AeroTech M2500T motor. OpenRocket simulations indicate that the off-the-rail velocity is around 88 ft/s, ensuring stable lift off, and that there will be an acceptable maximum acceleration of 8.45 G. Complete motor specifications are included in Appendix A. The M2500 was used for the previous year's *Sabre II* rocket, which also competed in the 10k COTS category, after the team conducted extensive research on various motor options. Since the motor performed well, it was selected once again, leveraging team familiarity with integration practices and with the motor's performance characteristics compared to simulations. Sub-scale launches were performed with a lower-powered COTS AeroTech L2500ST motor due to a first-flight ceiling of 4,000'. The L2500 also has a very similar thrust profile to the M2500, which means that the launch conditions are very similar to what would be experienced with a full-scale launch.

C. Avionics

The primary objective for *Sabre III*'s avionics system is to ensure reliable parachute deployment and a safe recovery that adheres to competition guidelines. For redundancy, two independent GPS trackers and two independent altimeters are utilized to fulfill competition requirements and reduce the likelihood of a recovery system failure. All electronics in the avionics bay are wired using a 22 American wire gauge (AWG) stranded tinned copper wire, and all electronics and screw switches are mounted to the prism using 4-40 brass heat-set threaded inserts. All wires are staked down to the prism to reduce vibration-induced motion and ensure reliable electrical connections.

1. GPS Trackers

The Altus Metrum Telemetrum (v4) was selected as the primary altimeter and GPS as it transmits position data over the 70-cm amateur band and records altitude using an onboard barometric sensor. The board also supports

straightforward frequency changes within the band, providing flexibility for range coordination. The TeleMetrum connects to the ground station's TeleBT module, which relays data over Bluetooth to the AltosDroid phone application, where live altimeter and GPS telemetry can be viewed. The TeleMetrum is powered by a 1S Li-ion 5330 mAh Samsung 58E (21700) cell. Assuming an average system current draw of 200 mA, this provides an estimated 26.6 hours of operation, which is well over what would be required for launch and recovery. The unit is armed via a screw switch, chosen for its vibration resistance and low risk of accidental snagging. The primary drogue and main e-matches connect directly to the TeleMetrum as shown in Fig. 9.

The Eggtimer Quasar was selected as the backup GPS tracker due to its successful and reliable integration in *Sabre II*. The Eggtimer Quasar has a built-in telemetry system that emits data on the 70-cm frequency band to a ground station, which displays real-time GPS coordinates of the rocket. It is powered using a COTS 2S Li-Ion 2600 mAh 18650 battery. Assuming a conservative 200 mA average current draw, this provides approximately 13 hours of runtime, offering substantial margin beyond mission requirements. The Eggtimer Quasar is armed via a screw switch as shown in Fig. 9.

2. Altimeters

In addition to the Altus Metrum Telemetrum, the Featherweight Blue Raven was selected as the backup altimeter due to its compact size, ease of use via the integrated Featherweight smartphone app, and extensive data recording capabilities, including a high-rate accelerometer, gyroscope, and the required barometric sensor. The Blue Raven was also used successfully in *Sabre II*. It is powered using a COTS 2S Li-Ion 2600 mAh 18650 connected to the Blue Raven using a terminal block. Based on a conservative 330 mA average current assumption, this battery can support the Blue Raven for at least 7.8 hours, ensuring continuous operation throughout launch and recovery. The unit is armed via a screw switch, and the backup drogue and main e-matches are routed to the Blue Raven's output pins and terminal block, as shown in 9.

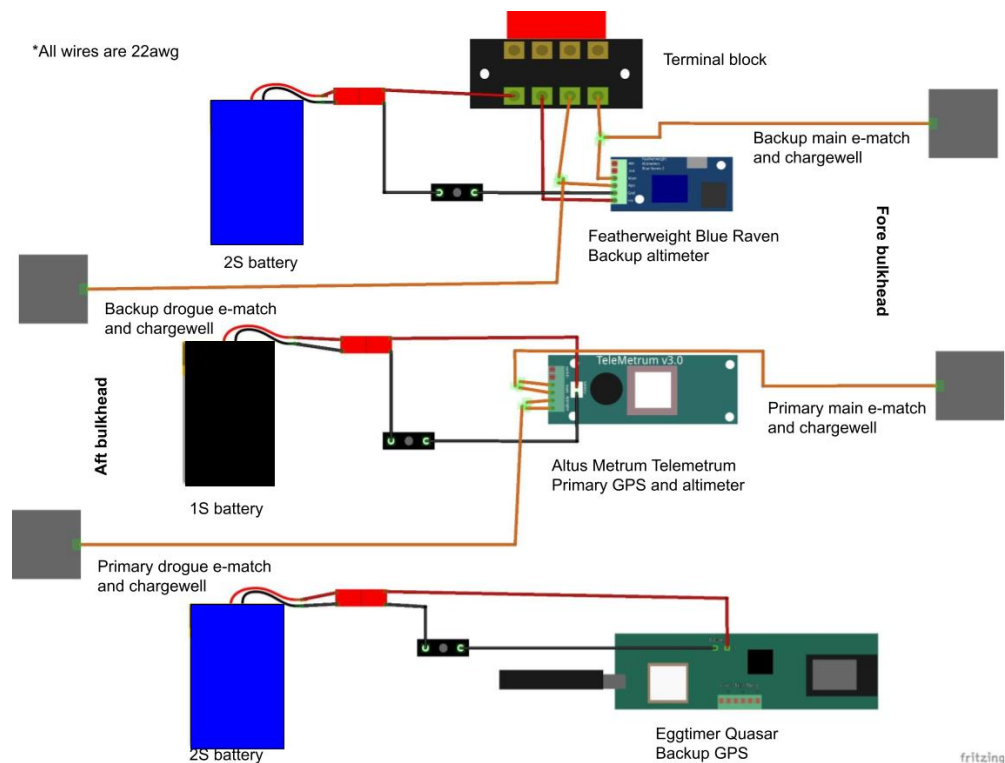


Fig. 9 Sabre III Recovery electronics wiring diagram.

3. Mechanical

The primary mission of the avionics bay prism is to securely house all recovery electronics and the live video system within the avionics bay coupler tube, while remaining lightweight, structurally sound, and resistant to environmental

conditions such as desert heat up to 110°F. The live video system was housed as a separate payload subsystem in *Sabre II*, but this year it was moved into the avionics bay of *Sabre III* to make room for the development of the new scientific payload described in Section III.F.

The avionics bay coupler tube is 12" long with an inner diameter of 5.75" and an outer diameter of 6". In order to access the screw switches and pull pin switch for arming the electronics, a 1.5" switch band is epoxied to the coupler tube 4.25" from the forward end.

The avionics bay mounting structure consists of three panels that assemble into a triangular prism connected by three 3/8" threaded rods. The threaded rods are 6061 aluminum and were cut to be 14" long. The panels are 3D printed using ABS plastic at 100% infill. The temperature inside of the rocket is expected to reach around 120°F to 130°F, which is below the glass transition temperature of ABS (approximately 220°F). One of the panels includes a raised switch band arc, which serves as a mount for the screw switches and pull pin used in arming the avionics and live video system. This design minimizes the distance between the screw switches and the external switch band on the coupler tube, reducing angle error during assembly and increasing the ease of arming the avionics on the launch pad. This panel also houses the Altus Metrum Telemetry, Featherweight Blue Raven, EggTimer Quasar, and terminal block. The next panel contains the fan for cooling the live video system and three battery casings. The final panel contains the live video camera system and the battery casing for the live video camera system and fan. Pictures showing each panel can be found in Fig. 10. In each panel, hexagonal holes are included throughout the prism to reduce the overall mass of the avionics bay and to allow wires to connect to each other and pass through the interior and exterior of the prism.

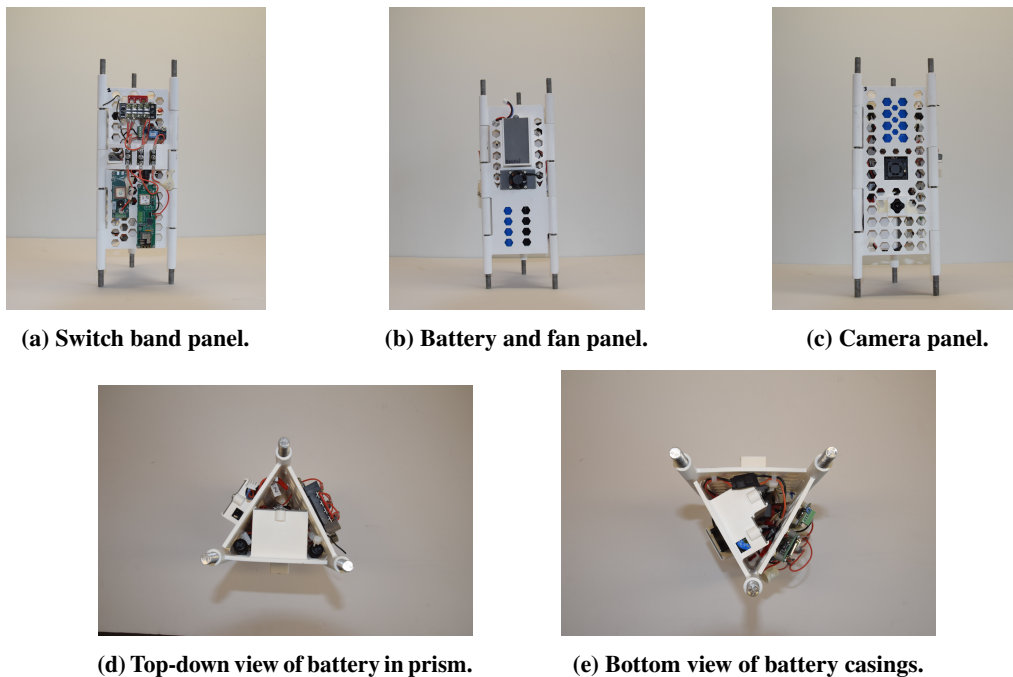


Fig. 10 Avionics Bay panels and internal views.

On either end of the coupler tube, stepped fiberglass bulkheads retain the avionics bay via the threaded rods passing through the avionics prism. The coupler tube and two bulkheads are shown in Fig.11. The aft bulkhead is epoxied to the coupler tube using Proline 4500P to prevent internal rotation of the avionics bay. The threaded rods are then secured using 3/8" nuts and washers on either end of the coupler tube. Each bulkhead also has two 1/2" PVC caps that are screwed and then epoxied in place to act as the charge wells for each parachute. Next to each charge well is a 3/8" hole for the ejection charge matches to be slid through from the avionics bay's altimeters to the charge wells. In addition, at the center of each bulkhead is a 5/16" stainless steel U-bolt for attachment to recovery equipment, described further in III.D.



Fig. 11 Avionics bay coupler tube with bulkheads.

D. Recovery Subsystem

Sabre III uses a dual-deployment recovery system with a 3' drogue parachute and a 14' main parachute that are deployed at apogee and 1,000' AGL, respectively, using black powder ejection charges. The drogue will slow the descent rate to 91.1 ft/s to reduce drifting for the first 9,000' of descent, while the main parachute will slow the descent rate to 19.3 ft/s for a softer landing. These descent rates were found using an OpenRocket simulation and were confirmed by two sub-scale launches described in Appendix B.1.3. The flight vehicle is recovered as a single unit of three main parts connected by shock cords as shown in Fig. 12. One section has the nose cone and payload, the middle section has the upper airframe and avionics bay, and the aft section has the booster tube and airbrakes. The flight vehicle will be recovered using the two redundant GPS trackers within the avionics bay system, as was described in Section III.C.1.

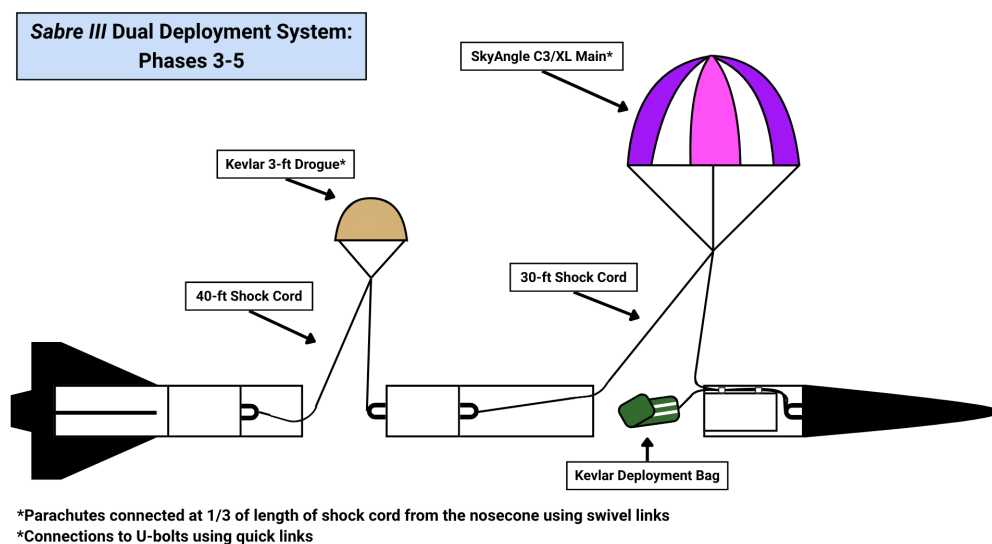


Fig. 12 *Sabre III* Dual deployment phases diagram.

The main parachute, a SkyAngle C3/XL, is made of ripstop nylon with nylon shroud lines, and it is packed in a SkyAngle C3/XL Kevlar deployment bag to protect against the black powder ejection charges. The main uses a 0.5" wide, 30' long, tubular Kevlar shock cord, which connects to a U-bolt at the forward end of the payload system, passes through clamps anchored to the outside of the payload's retention structure, and connects to a U-bolt at the forward end of the avionics bay.

The drogue chute is made of Kevlar with Kevlar shroud lines, and it uses a 0.5" wide, 40' long, tubular Kevlar shock cord, which connects to a U-bolt at the aft end of the avionics bay system and to a U-bolt at the forward end of the airbrakes system. The U-bolt is rated for 950 lbs of force, which is below the expected maximum of 920 lbs of force that the rocket will experience. Both the main and the drogue parachutes are connected to their respective shock cords at one-third from the forward end. The shock cords are connected to the U-bolts with 9/32" stainless steel quick links rated for 1,400 lbs. The parachutes are attached the the shock cords with identical quick links and an additional 5/16" swivel link rated for 1,100 lbs to allow free rotation of the rocket during descent under the parachute. All recovery harnesses are expected to experience a maximum of 814 lbs, which is calculated from an expected 8.45 G-forces on *Sabre III* with a safety factor of 1.5. These expectations are founded on OpenRocket simulations, ground tests, and two sub-scale launches as described in Appendices B.1.1 and B.1.2.

E. Telemetry

Sabre III uses telemetry, as seen in Fig. 13, to acquire real-time data and video of the flight on an external ground station. The rocket's telemetry capabilities are present in three of its internal systems: airbrakes, payload, and avionics. Communications from these systems to the ground station are unidirectional, meaning that the ground station receives only. This ensures that *Sabre III*'s internal systems can act independently without failure.

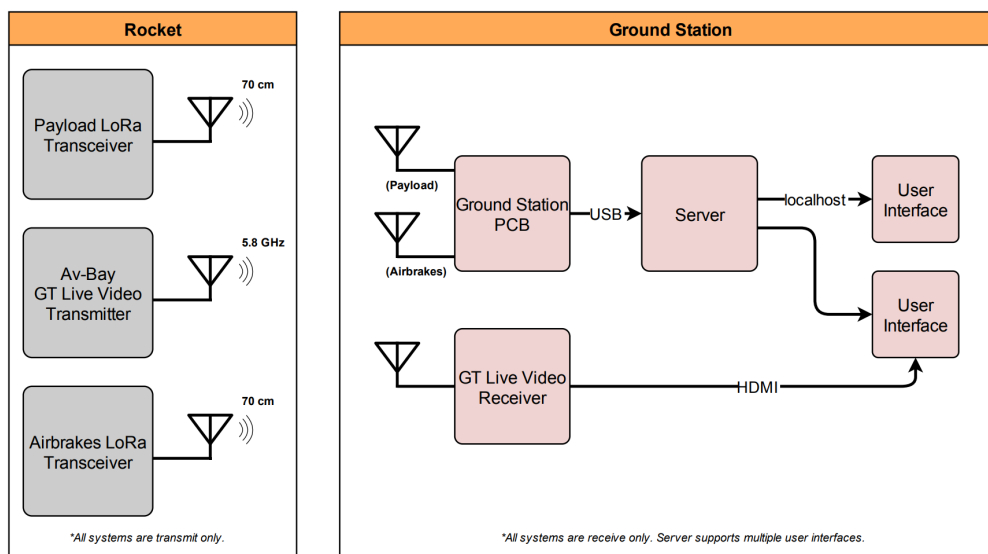


Fig. 13 *Sabre III* telemetry block diagram.

The airbrakes flight computer logs all sensor data at 100 Hz throughout the flight. The program is written as a pure function of the logged data, enabling reconstruction of the program state at any point in flight. All values are stored as 32-bit floats, creating an immutable record of the system state at each timestep. Sensor readings are buffered in RAM before being written to flash storage, and the logging pipeline is optimized to minimize CPU overhead so the flight-control loop can run without interruption. After recovery, the flight data is extracted from flash and exported to CSV for post-flight analysis.

Airbrakes telemetry to the ground station is transmitted over LoRa in the 70-cm band. Because bandwidth is limited, only a subset of the logged data is transmitted. Each field is manually compressed using domain-specific knowledge of expected value ranges. For example, battery percentage requires only an 8-bit integer (0-100%), whereas accelerometer data uses 16-bit signed integers. Since the simulated maximum acceleration is below 9g, a 15-bit signed integer provides several decimal places of useful precision in the UI. This compression scheme is implemented via

compile-time code generation, where field names encode the conversion parameters (e.g., `obAcc_mps2_z__i16_S334`) reducing the chance of conversion errors.

For the remaining internal systems, the payload subsystem uses the same telemetry and compression scheme as the airbrakes. The avionics bay, however, uses an off-the-shelf GT video transmitter for live video telemetry, operating in the 5.8 GHz band.

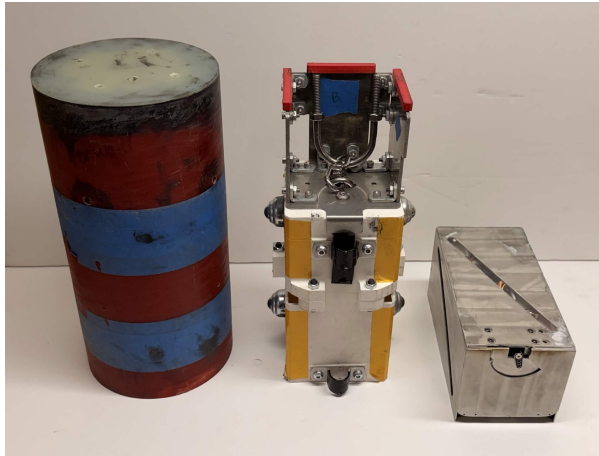
The ground station receives all of *Sabre III*'s telemetry, hosts it on a server, and distributes it to multiple user interfaces. A custom PCB receives airbrakes and payload telemetry via two LoRa transceivers and a Teensy 4.1. A JavaScript server running on the host computer listens for serial data from the Teensy over USB, and multiple user interfaces connect to the server over localhost to visualize rocket status. For live video, a GT video receiver provides an HDMI feed to the same computer running the UI.

F. Payload Subsystems

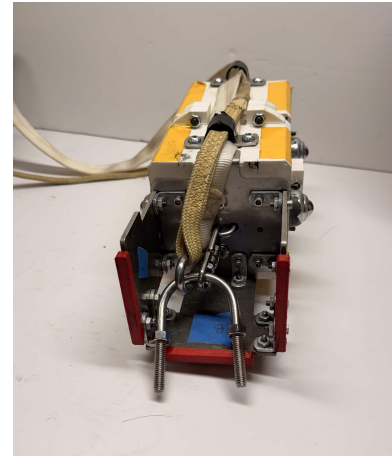
Sabre III features a scientific, non-deploying payload that meets a 2U CubeSat form factor in order to be eligible for the Payload Bonus described in Section 2.8.1.7 of the Rules and Requirements Document [6]. The payload system, excluding the retaining structure that connects it to the rocket, weighs 4.5 lbs in compliance with the minimum weight requirement defined in Section 2.3.1 [6]. The original payload mission was to deploy a rover from the rocket after landing, have it drive a few yards away from the rocket, and drop a LEGO astronaut figure—all while videoing the process with an onboard camera. Due to complications during the second flight test, the payload mission has been descope'd to have the rover remain in the rocket post-flight. The new mission is for the payload to collect atmospheric data while testing the rover structure and orientation system to provide a strong foundation for continuing this project next year. The payload will be submitted to the Utah State Space Dynamics Laboratory's SDL Payload Challenge.

1. Payload Retention and Orientation System

The payload is housed inside of the coupler tube connecting the nose cone and upper airframe. Due to a loose fit between the COTS coupler tube and upper airframe, a few rounds of tape are added to the coupler tube to ensure a snug fit. A mounting structure consisting of 3D-printed ABS casing and 6061 aluminum panels is used as an adapter between the payload and the coupler tube. The mounting structure acts as a passive orientation system to ensure that the payload always lands with the rover's tracks down. The coupler tube, mounting structure, and CubeSat payload are shown below in Fig.14a, along with different views of the system in Fig. 14.



(a) Coupler tube, orientation system, 2U CubeSat.



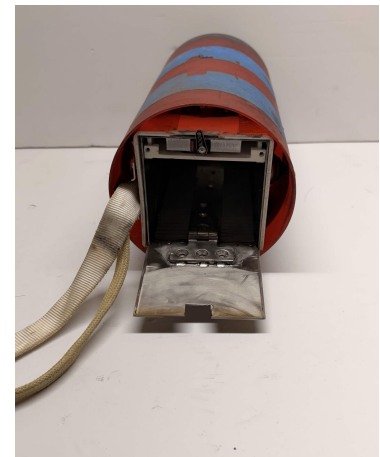
(b) Connection between u-bolt, swivel, shock cord, and parachute bag, orientation system.



(c) Inverted u-bolt connection to payload upper bulkhead.



(d) Orientation system bearings and clamps.



(e) Depiction of secured payload post ejection charge.

Fig. 14 Payload assembly, U-Bolt connections, and shock cord/parachute bag cord mounting.

The CubeSat payload is bolted into the mounting structure to keep it in place during flight. The mounting structure is connected to the forward bulkhead of the coupler tube with two U-bolts joined by a swivel link (Fig. 15). This swivel link allows proper rotation of the payload casing without tangling the shock cord. The aft end of the payload coupler tube is left open to allow the door on the CubeSat to open and the rover to drive out. To ensure that the main parachute shock cord and deployment bag do not interfere with the orientation system, they are secured to one side of the mounting structure with two metal routing clamps.

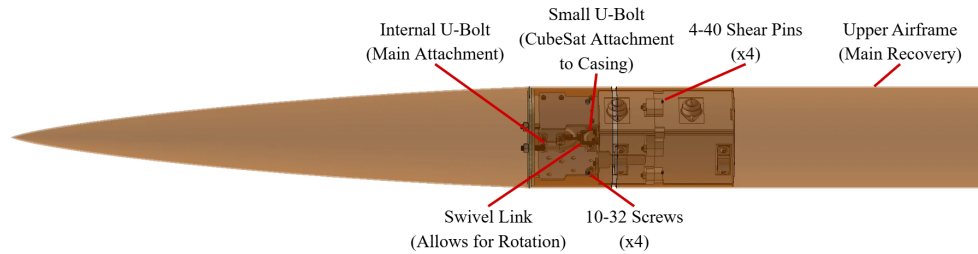


Fig. 15 Payload assembly in the rocket.

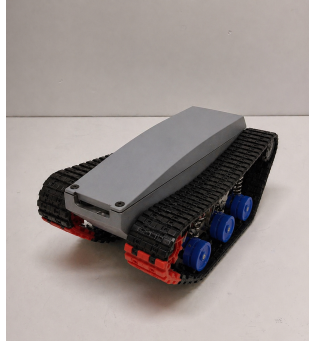
The payload orientation system incorporates ball bearings epoxied onto the outside of the 3D-printed part of the mounting structure. The payload was designed to be slightly heavy on the bottom side without compromising the weight distribution of the entire rocket. This allows the mounting structure to rotate after landing so that the rover is oriented with the tracks facing down and can properly exit the CubeSat structure.

2. The Payload: CubeSat, Shelf, and Rover

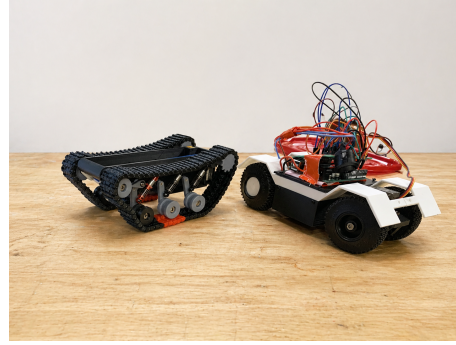
The 2U CubeSat is made of 316 stainless steel plates welded together to form the CubeSat structure. The back of the CubeSat has a square sheet of metal welded to it, while the other side features a door with a hinge. One end of the hinge is screwed into a CubeSat panel, while the other end is welded to the square door panel, as shown in Fig. 14d. To keep the door panel closed, there is a swivel door hook attached to a servo motor that only turns to open the door when the rocket is on the ground. This servo is held in place by a metal case that is bolted directly to the CubeSat which creates a full metal connection between all load bearing parts. These design choices prevent the rover from prematurely falling out of the CubeSat during launch and main parachute deployment. However, due to the descoped mission for the payload, the door will be screwed shut and the rover will not come out of the rocket.

The top of the CubeSat houses a 3D-printed shelf made of ABS plastic such that it fits over the rover with some clearance. The shelf slides into two rails epoxied to the top of the CubeSat and screws into these rails once slid all the way in to prevent it from sliding out during launch. This shelf houses the servo motor, electronics PCB board, and batteries necessary for proper rover deployment.

The rover, as shown in Fig. 16a, uses a tank-style tread design, in which treads are placed on either side of the rover chassis. Each tread is driven by a sprocket attached to a D-shaft motor. A design study was conducted between a treads and a wheels design, as seen in Fig. 16b. Using treads as opposed to wheels allows for greater efficiency when changing directions due to its mechanical simplicity, since steering only requires the motors to turn in opposite directions, rather than a more complex steering system. The tread tracks are guided and supported by a series of wheels mounted on articulated wheel arms. Each wheel arm is connected to the chassis through bearings, allowing controlled rotation, and is coupled with shock absorbers to form a compliant suspension system. This configuration helps absorb impact loads during landing and improves terrain adaptability by maintaining consistent ground contact over uneven surfaces. Additionally, the leading wheel arm is mechanically linked to a track tensioning system. When the suspension is engaged, motion of this wheel arm actuates a tensioner lever, which drives the front tensioning wheel forward. This mechanism actively maintains proper track tension, reducing the risk of track slippage or derailment under dynamic loading conditions. The chassis is made out of PA6-GF25 Nylon Glass Fiber.



(a) Payload rover: Gurney.



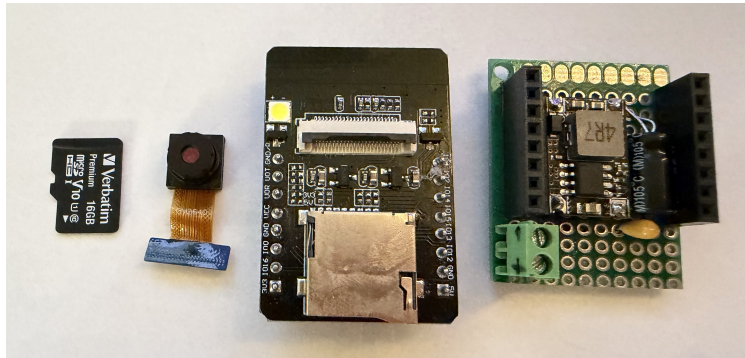
(b) Tracked vs wheeled rover prototype side-by-side during preliminary design review (Nov 2025).

Fig. 16 Rover design and drivetrain comparison.

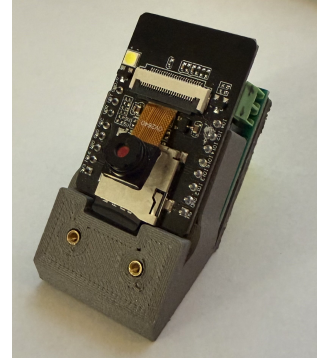
To carry out the scientific mission, the rover is equipped with an onboard imaging and sensing system. An ESP32-CAM is integrated into the front section of the chassis, providing real-time video capture of the surrounding environment. In parallel, the rover records altitude data throughout operation. Together, these systems enable both visual observation and quantitative characterization of unfamiliar terrain. The back of the rover contains a positional servo that switches between two angles and deposits a LEGO astronaut figure.

3. Rover and Deployment Electronics

In order to control these complex systems, the rover and the door control system are powered through separate electronics. As shown in Fig. 17a and 18b, the rover has a custom PCB board with a Teensy 4.1 microcontroller, an Emax9052md servo, a motor driver, and two N20 right angle motors. The motor driver and the N20s control the translational motion of the rover while the microcontroller and servo deposit the LEGO figure after the rover is deployed. Additionally, the rover is equipped with an ESP32-cam camera module, as seen in Fig. 17b allowing it to survey its surroundings after deployment, capturing video recordings with the on-board SD card.



(a) Rover video system and PCB.



(b) Video system mount.

Fig. 17 Rover video system and mounting configuration.

The door control system is mounted on an electronics shelf that is housed above the rover in the CubeSat. As shown in Fig. 18a, the shelf utilizes a Teensy 4.1 and a servo to open the CubeSat door to release the rover after landing. Both PCB boards, supporting Teensy 4.1s, carry an LSM6DSVTR IMU and an MS5607 barometric pressure sensor in order to detect the rocket's state. Additionally, each board hosts an HNB09A03 speaker to briefly buzz during system resets indicating successful startups, in addition to a radio.

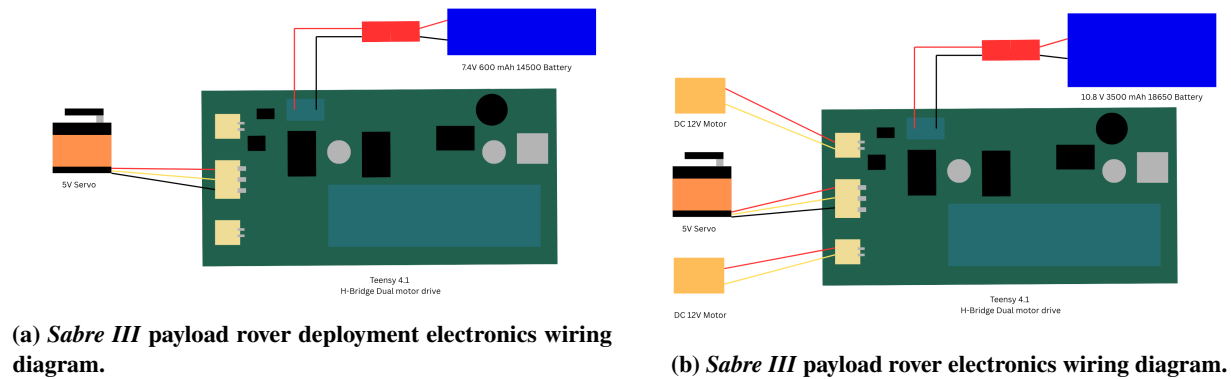


Fig. 18 Payload electronics architecture and wiring diagrams.

4. Decision to Descope

During the initial ground testing, the payload mounting structure was made up entirely of ABS plastic and broke during main parachute ejection. Consequently, a boilerplate mass payload was flown for the first sub-scale launch. The mounting structure was rebuilt with aluminum and steel at the failure points and successfully held up during additional ground testing. However, when the payload was flown during the second sub-scale launch, the door opened early and the rover fell out of the rocket during main parachute deployment. The servo was screwed into mounts on the ABS shelf, which broke during flight. To securely attach the servo, a metal mount now fully encases the servo and is screwed directly into the CubeSat.

Since the payload was unable to complete a successful launch and deployment prior to competition, the leads decided to descope the project by screwing the door shut to prevent loss of the rover at IREC. This decision allows the team to continue to collect altitude and pressure data while minimizing the risk to the overall success of *Sabre III*.

G. Airbrakes Subsystems

An airbrakes subsystem was developed to enable altitude control during flight by actively increasing aerodynamic drag during the coast phase. This system helps the rocket reach an apogee as close as possible to 10,000', in accordance with the altitude requirement set by the IREC 10k COTS category [6]. Due to the variability in motor performance and atmospheric conditions, passive trajectory planning alone is insufficient to guarantee precise altitude control. Therefore, an active drag system is implemented to better target an apogee of 10,000'.

This section documents the design, structural layout, and integration of the airbrakes subsystem. The design approach prioritized mechanical reliability and weight reduction. Challenges were encountered throughout development, including changes to the winder system and servo configuration, along with manufacturing limitations. It was ultimately decided not to launch the system in competition this year, and the rationale for this decision is detailed in Section III.G.7.

1. System Requirements

The airbrakes system's design requirements start with compliance with the IREC DTEG. A minimum safety factor of 1.5 was decided based on FAA and typical aerospace engineering standards. The weight budget set for the airbrakes system is 5 lbs. The final weight of the airbrakes system is 3.8 lbs. Less emphasis was made on manufacturing complexities than last year. However, the design would still be made entirely in-house using the machines available to minimize cost. The assembly includes 3D-printed, water-jetted, lathe-machined, and 3-axis milled components.

2. System Integration

A priority for developing the airbrakes system is minimizing weight. The rationale for minimizing weight is to necessitate airbrakes deployment since the rocket's apogee would exceed 10,000'. While a coupler tube makes assembly and system integration easier, it is deemed unnecessary in accordance with weight reduction. As a result, the airbrakes system is integrated with the rest of the rocket via brackets and hinges that were screwed in from outside the rocket's booster tube.

The airbrakes system consists of the following main subsystems: base plate, top electronic shelf, bottom electronic shelf, bulkhead, and flaps. Refer to Fig. 19 for a visual of the plate and electronic shelves assembly. The base plate, bottom electronic shelf, and top electronic shelf connect to each other by screw holes on the base plate that align with pillars of both electronic shelves. The bulkhead has holes that align with the top-facing holes with the hinges

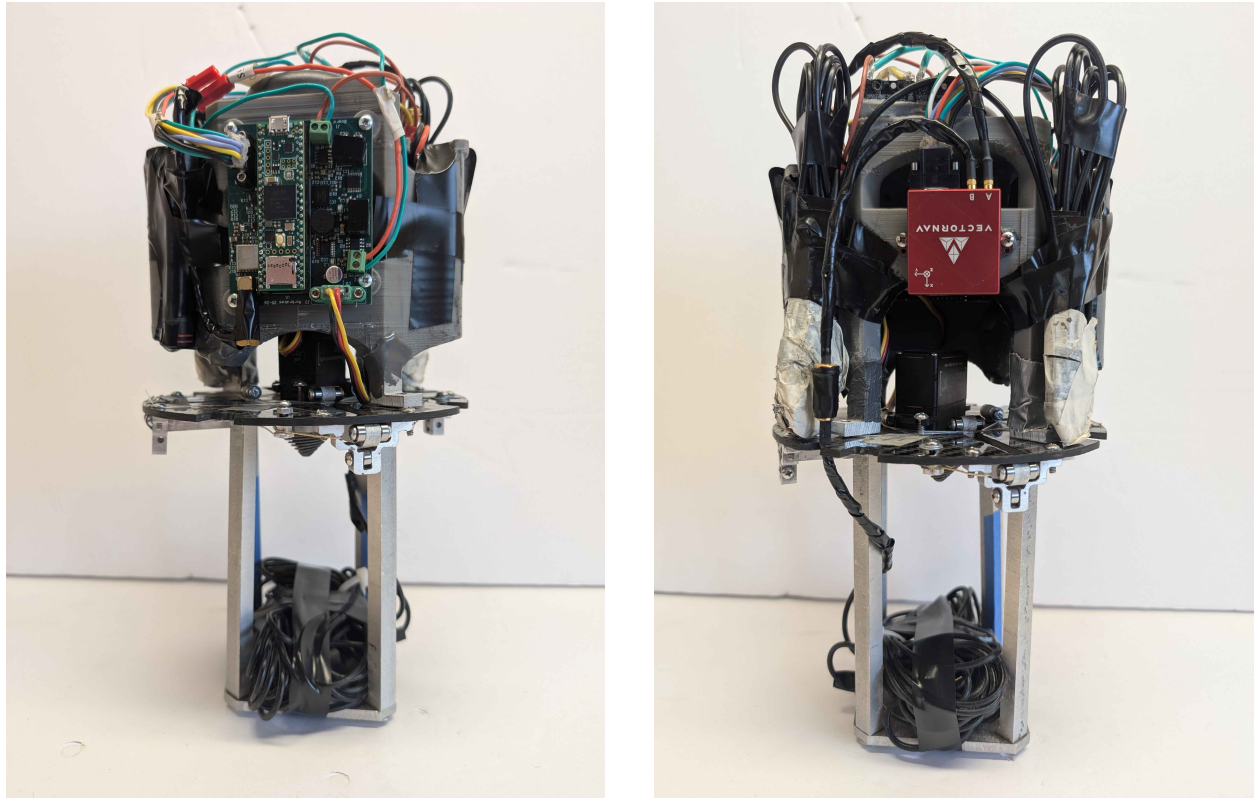


Fig. 19 Front (left) and back (right) views of the airbrakes electronics shelf.

The top electronic shelf was entirely 3D printed using PA6-GF25 due to manufacturing limitations and how tailored it is to fit all electrical components. On the other hand, the lower antenna shelf only needed to hold one GNSS Antenna, meaning an easier design to manufacture, so aluminum 6060 was the best material choice. The shelf also includes two battery box cases located on the sides of the shelf, which are used to house the batteries. The feet of the top shelf are made from aluminum 6060 and epoxied on to the lower part of the top shelf to provide a stronger connection between the shelf and base plate. For the mounting of the PCB and the VectorNav, four holes are included on one side of the top shelf to serve as a point to screw in the PCB. On the opposite side, two holes were included to mount on the VectorNav. The top of the upper electronics shelf stores the other GNSS Antenna, which is screwed into the shelf from the bottom. Additionally, the top of the upper shelf stores the limit switches that are epoxied onto its own compartment enclosure. Figure 20 shows a wiring diagram for the integrated airbrakes electronics.

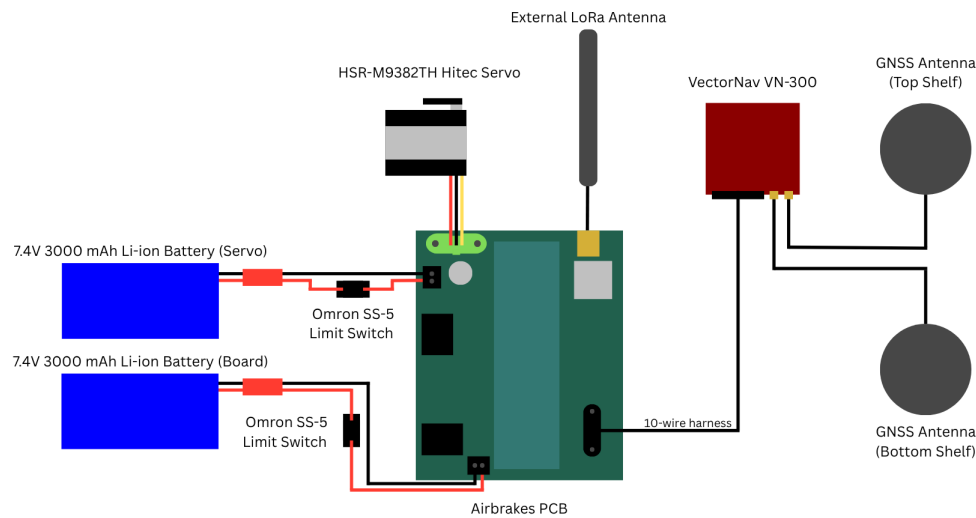


Fig. 20 Sabre III airbrakes electronics wiring diagram.

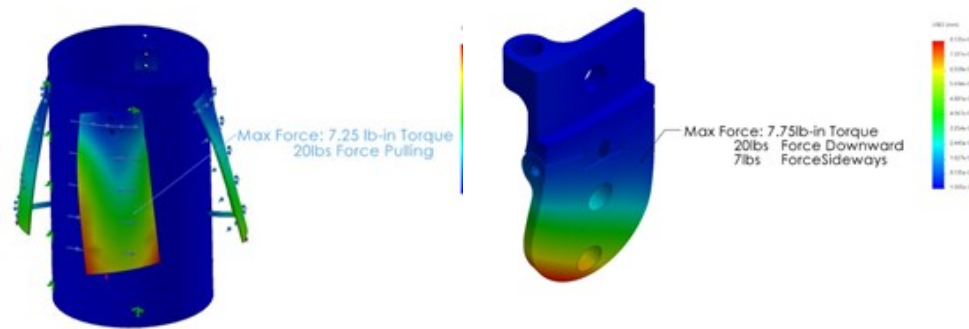
3. Aerodynamic Analysis

Aerodynamic analysis was initially conducted using a flat plate model to estimate the maximum angle of deployment at maximum speeds. Using analysis results, a servo was selected that maximized energy output. This allowed an expected maximum angle of deployment of approximately 984 ft/s.

Wind tunnel testing was considered for measuring expected drag. However, Reynolds numbers representative of flight conditions would not have been possible at available facilities. Airbrake performance is highly dependent on Reynolds number, particularly regarding boundary layer and flow separation behavior. While extrapolation using scaling laws would be possible, fidelity was expected to be limited, and resources were instead allocated toward improving CFD capabilities.

Using CFD, the change in drag force at 984 ft/s was determined to be 62 lbs, which would result in a maximum change in apogee of 1,148 ft under the most ideal conditions. This study also confirmed that the flat plate analysis deployment angles were correct.

After an initial design phase was completed, it was then determined that the system should be subjected to force simulations to determine the structural integrity of the most vulnerable components. Upon analysis, it was determined that the most likely points of failure on the system were the carbon fiber flaps, as well as the aluminum hinges attaching them to the body of the rocket. After reading previous years' technical reports, speaking with advisors, and performing estimations that the system should be capable of sustaining the cumulative following forces: 20 lbs axial, downward force in addition to a 7.75 lbs torque applied to the airbrakes flaps; a 20 lbs axial downward force, a 7.75 lbs torque, and a 7 lbs axial sideways applied to the airbrakes hinges. The Airbrakes Team performed FEA on these system components, shown in Fig. 21, evaluated the data, and determined the results indicating a displacement of hundredths of millimeters that were within the team's requirements.



(a) FEA of forces on airbrakes flaps.

(b) FEA of forces on airbrakes hinges.

Fig. 21 Airbrakes FEA results.

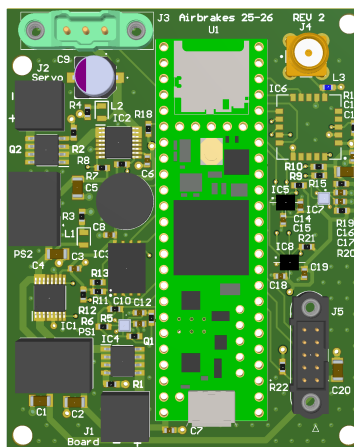
4. Airbrakes Electronics Hardware

The airbrakes printed circuit board (PCB), seen in Fig. 22, provides a common interface for sensing, data logging, apogee prediction, and servo control during *Sabre III*'s flight. In the PCB design, component selections factor in cost and performance in avionic applications. Furthermore, judiciously placed components reduce the dimensions of the board while isolating noisy components from sensitive systems (e.g., sensors, transceivers, signal buses) and optimizing trace routing.

The PCB is a four-layer stackup with two outer signal layers and two internal ground layers. It houses a Teensy 4.1 which handles all data processing and control logic for the airbrakes. To provide sensing capabilities, there are dual barometers and IMUs on-board and a connector for the VectorNav VN-300. Note, all connectors are screw-in, so connections are mechanically secure throughout flight.

In addition to the sensors and Teensy, the PCB has a 4 G-bit flash chip and a LoRa transceiver for logging data and transmitting to the ground station. An impedance matched trace, which minimizes reflections, connects the LoRa to an SMA port for an external antenna. For deploying the airbrakes, the PCB provides a connector for a Hitec servo, giving the Teensy control with pulse-width modulation.

To power these systems, one 7.4 V 3000 mAh battery supplies the servo and a second powers the remaining components through on-board DC-DC converters.



5. Airbrakes Software

Extreme consistency and reliability are the primary mission of airbrakes software as the system must operate flawlessly throughout the entirety of the flight. It must store and transmit all necessary information regarding its operation for the duration of the flight, retaining key statistics until recovery is possible.

Current airbrakes software gathers data from a multitude of sensors within the VectorNav including the barometer, 3D axis gyroscope, and 3D axis accelerometer. Values from all sensors are run through a Kalman filter to adjust for noise, minimizing measurement inaccuracy. Following the filtration, sensor data is sent to an apogee predictor that estimates the distance by which the rocket will overshoot its target apogee of 10,000'.

6. Design Iterations

Two primary airbrakes systems were initially evaluated: rotating flaps mounted to the airframe exterior and retractable petals embedded within the body tube. Petal-style flaps, although mechanically simpler and easier to manufacture, would introduce more issues concerning the weight budget and rocket stability due to turbulent airflow. On the other hand, deployable flaps would require difficult space optimization and further testing to assess airflow and drag as flaps are deployed. Ultimately, a flap-style configuration was adopted for the airbrakes design, shown in Fig. 23. This design integrates four carbon fiber flaps that extend outward from the rocket's booster tube. The flap design maintains the rocket's smooth aerodynamic profile during the thrust phase and produces an even drag distribution, having less turbulent flow than a petal design would. The use of four flaps, which correspond to *Sabre III*'s four fins, ensures dynamic stability and symmetry in deployment. Furthermore, the internal components of the airbrakes system are stowed inside the body tube, without a coupler tube, maximizing space efficiency, minimizing structure vulnerability, and minimizing the total weight of the system.

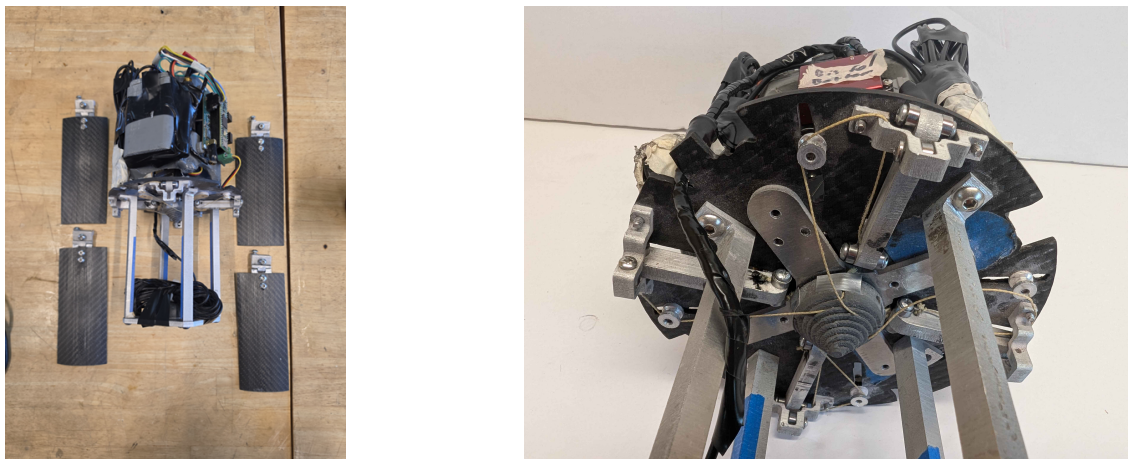


Fig. 23 Umbrella-style airbrakes (left) and winder assembly (right) views of the airbrakes subsystem.

After the selection of the rotating flaps, several methods of moving the flaps were considered. Rack and pinion gear mechanisms, linkage based mechanisms, and a novel Kevlar micro cord winder were considered. While the rack and pinion and linkage systems are widely used and probably more mechanically reliable than the winder, the winder brought a significant weight advantage and the greatest ability to match the changing aerodynamic forces on the flaps with the torque from the servo, in order to not waste energy.

During manufacturing, there were several problems with the winder: pusher retraction and consistency. Initial testing on flap deployment proved that the winder functions, but with inconsistency. One problem concerned pushers deviating from their intended horizontal path during deployment since the contact between the flap and pushers often caused the pusher to go sideways. To fix this, a guide piece was installed under the base plate towards the edge for each pusher. This piece provided a rigid structure that prevented the pusher from slipping to one side, ensuring horizontal motion. A second problem occurred with the winder. During retraction, the Kevlar lines often got snagged by the winder's groove, preventing uniform retraction for the pushers. This problem is attributed to the low print quality in manufacturing the winder, causing its grooves to inevitably have inconsistent bumps along the lines' paths. To remedy this problem, the winder was further modified using a soldering iron to melt the inconsistencies within the grooves and

sanding the interiors, making the lines' path smoother. This proved effective as the retraction of the pushers became more reliable.

7. Decision to Not Deploy

In April of 2026, it was ultimately decided for the airbrakes subsystem to not be deployed during competition. Multiple launch days were delayed due to inconsistencies with the mechanical system, specifically with the flap retraction. By the time the retraction mechanism was fixed, there were no launch sites available to test the airbrakes system at the maximum speeds. A subscale flight was conducted with the intention of testing the airbrakes during flight, but a software issue prevented deployment. With unproven results, the decision was made to not to deploy the airbrakes system during competition. As a result, the function of the system will shift to flight data collection during competition. This data will be used to further improve the apogee predictor for future competitions.

Since *Sabre III* is designed to overshoot 10,000' for the purposes of airbrakes deployment, an alternative method of altitude targeting is being developed that will use accurate weather data and different sized weight additions.

H. Live Video Subsystems

Sabre III houses an onboard live video system inside the avionics bay coupler tube in order to provide in-flight video for review and to participate in the IREC Live Video Challenge. The system uses a Walksnail Avatar HD Pro camera and GT Video Transmitter (VTX) chosen based on its small size and successful launches onboard *Sabre II*. The system is designed to transmit a live video feed to the ground for real-time monitoring and analysis during test launches, while also recording to an onboard 128GB microSD card during IREC 2026 to meet competition radio band limitations.

This camera system is marketed as a drone camera, so the transmitter is not equipped to deal with the excessive heat experienced from being isolated inside of a rocket exposed to little internal airflow. To compensate for this, the system includes a Surpass Hobby RC cooling fan pointed directly at the VTX unit. This fan can reach speeds of 27,000 rpm and is aligned with two venting holes that direct air outside of the rocket. This fan is intended to keep the motors of RC cars under 80°C and can cool the unit by 20-30°C.

The entire system is powered by a custom 4S 14.4V Li-ion battery made from 4 COTS Samsung 58E 5330mAh 10.7A Batteries purchased from 8650 Battery Store. The battery is connected to a pull-pin switch, as shown in Fig. 24, allowing the system to remain powered off until *Sabre III* is on the rail and the 'Remove Before Flight' pin is pulled. The batteries have sufficient capacity to ensure that the system remains operational until after landing.

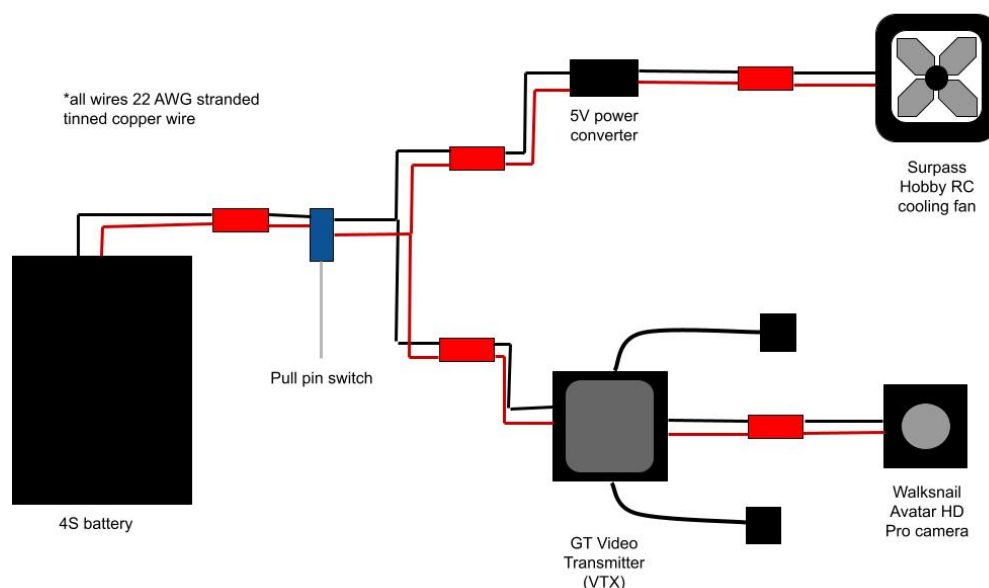


Fig. 24 *Sabre III* Live Camera System Wiring Diagram

IV. Mission Concept of Operations Overview

Figure 25 depicts the descoped mission plan that will be implemented at the 2026 IREC. Figure 26 shows the full intended mission, including airbrakes and payload rover deployment. Only the concept of operations in Fig. 25 will be defined since *Sabre III* will not be deploying the airbrakes or rover during competition.

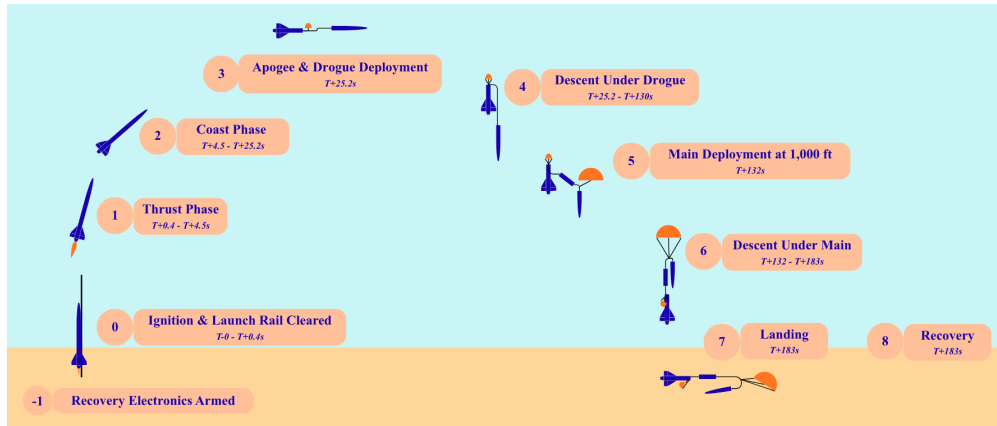


Fig. 25 *Sabre III* descoped IREC ConOps diagram.

Phase -1: Recovery Electronics Armed

Electronics are powered on (including the payload video camera system, recovery avionics, and flight computer) and team members verify connectivity. For each system, this process will look different. Team members will verify that each system has charge continuity and appropriate battery voltage. All electronics are connected to the ground station.

Phase 0: Ignition & Launch Rail Cleared

A signal is sent to the igniter, causing it to spark and ignite the rocket motor. Pressure builds in the motor, causing it to lift off the ground. This phase concludes once the first rail button clears the end of the 17' launch rail.

Phase 1: Thrust Phase

After *Sabre III* clears the launch rail, the motor will burn for approximately 4 more seconds, providing the thrust necessary to propel the rocket upwards. Motor burnout indicates the end of this phase.

Phase 2: Coast Phase

Once the motor has burned out, *Sabre III* will continue to travel upwards as gravity decreases its velocity. The coast phase concludes once the rocket reaches apogee, the maximum altitude where the instantaneous vertical velocity is zero.

In a launch with the airbrake system activated, the system remains in a neutral state until the coast phase begins. This adheres to competition guidelines which permit active control only after the launch vehicle's boost phase has ended or upon the vehicle reaching a specified altitude. At this point, the flight computer, which is already recording, filtering, and processing sensor data, utilizes its apogee prediction algorithm to estimate the expected maximum altitude. Based on this prediction, the flight computer determines the necessary deployment extent and actuates the servo controlling the airbrakes.

Phase 3: Apogee & Drogue Deployment

At apogee, the primary Altus Metrum Telemetry altimeter will send a signal to the primary drogue ejection charge, causing it to fire. This will force the electronics bay to separate from the booster, breaking the shear pins and allowing the drogue parachute to deploy. The redundant charge fired by the backup Featherweight Blue Raven will ignite one second later.

Phase 4: Descent Under Drogue

This phase of the flight begins with the fully deployed drogue parachute and covers the rest of the descent until main parachute deploys. Deployment of main parachute at 1,000' AGL marks the end of the phase.

Phase 5: Main Deployment at 1,000'

At an altitude of 1,000', the primary Altus Metrum Telemetrum altimeter will send a signal to the primary main ejection charge, causing it to fire. This will force the avionics bay to separate from the nose cone and payload, breaking the shear pins and allowing the main parachute to deploy. The redundant charge fired by the backup Featherweight Blue Raven altimeter will ignite at an altitude of 900'. The fully deployed main parachute will indicate the end of this phase.

Phase 6: Descent Under Main

This phase of the flight begins with the fully deployed main parachute and covers the rest of the descent until *Sabre III* reaches the ground. Impact with the ground marks the end of the phase.

Phase 7: Landing

Sabre III safely lands. Upon inspection, there should be no damage to the rocket, and it will be in a condition to perform future flights.

Phase 8: Recovery

After landing, *Sabre III* will be recovered by team members using data from the GPS relayed to the ground station, and then returned for inspection. In this phase, the electronics for the live video camera and the airbrakes IMU will be turned off.

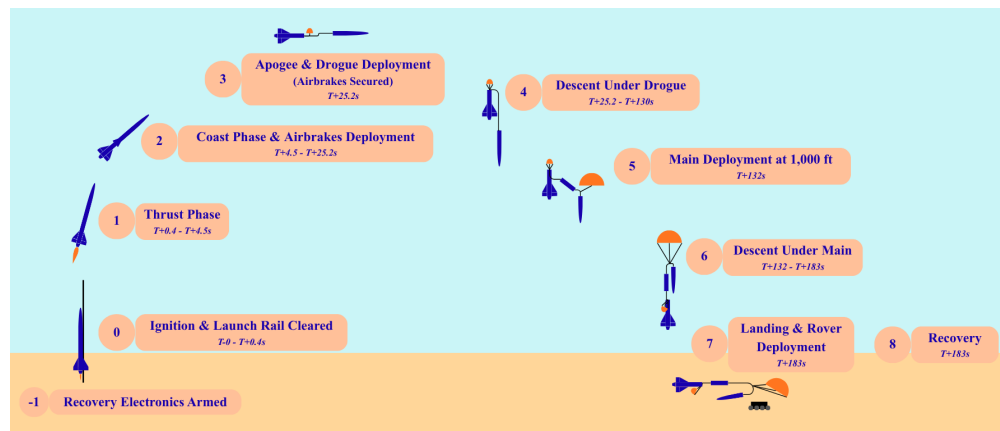


Fig. 26 *Sabre III* original full ConOps diagram.

V. Conclusions and Lessons Learned

A. Successful Implementation of Last Year's Lessons

Main takeaways from last year included the need for an improved team structure, earlier project planning, and an establishment of a more rigorous design process. The team successfully implemented a new leadership structure that shifted some of the responsibilities away from higher level team leads onto specific project sub-leads who are better able to focus on issues with their systems. Another important addition was a more standard design process with a PDR and CDR. These two presentations helped team members to take a step back from their particular designs to see how everything fit together as a whole, and it gave the team opportunity to collect invaluable feedback from the team's advisors and professors on everything from particular design considerations to project management. Finally, the team also began the conceptual design process much earlier this year compared to last, with the Payload Team especially narrowing down the project objective before the start of the fall semester.

B. Importance of Systems Engineering and Integration

While much progress was made to improve the team's systems engineering and integration (SE&I) process with the addition of the ERD, PDR, and CDR, the main takeaway is that there is still a lot to be learned. While members and leads did an excellent job with their technical designs, some sub-teams lacked clear objectives and requirements at the

start of the semester which led to a slow start and continued confusion as the project progressed. Many team members were not aware of the overall team objectives and did not understand the importance of SE&I. One idea for improvement in this area is to add a Mission Concept Review at the start of the year as part of new member onboarding and to hold a Systems Requirements Review soon after to help members become more involved in the SE&I process.

This year the team had hoped to hold a System Acceptance Review (SAR) to close out the SE&I process, but due to postponed launches, the volume of final deliverables, and an early final exam schedule, the SAR never happened. Next year the team will need to begin planning for the SAR earlier in the year to ensure adequate time for delivering the presentation at the end of the Spring semester.

One final change that will be made to further reinforce the team's commitment to a robust SE&I process is the re-designation of the Mechanical Lead role to a Systems Lead role. Many responsibilities of the Mechanical Lead are redundant to either the Chief Engineer or the IREC Sub-Leads, so the leads decided that it would make more sense to change the role so that the team will have a lead specifically responsible for SE&I moving forward.

C. Planning for Adversity

The past two years, the team has tried to conduct a full-scale test launch in Bayboro, North Carolina and both times the launch was canceled due to statewide burn bans. Moving forward the team will attempt to conduct the full-scale launch earlier in the year to avoid launch cancellation without a backup plan.

Technical Report Appendices

Appendix A—System Weights, Measures, and Performance Data

Table 3 Overall Rocket Parameters and Measurements

Overall Rocket Parameters	Measurements
Stages	1
Airframe Length	124 in
Airframe Diameter	6.17 in
Motor Case Weight	10.39 lbs
Vehicle Weight (Dry)	53.3 lbs
Liftoff Weight	71.1 lbs
Number of Fins	4
Fin Span	16.62 in
Fin Semi Span	6.3 in
Fin Tip Chord	4 in
Fin Root Chord	13 in
Fin Thickness	0.125 in
Payload Class	Attached CubeSat
Payload Weight	4.5 lbs
Center of Pressure	92.85 in
Center of Gravity	81.13 in
Launch Rail Length	204 in
Launch Rail Effective Length	179 in
Solid Motor	Aerotech M2500T
Propellant Type	COTS Solid
Total Impulse	9671 N _s
Average Thrust	2500 N
Motor Burn Time	3.9 s
Total Motor Weight	17.78 lbs
Propellant Weight	10.39 lbs
Liftoff Thrust/Weight Ratio	8.795
Launch Rail Departure Velocity	88 ft/s
Minimum Static Margin	2.03
Maximum Acceleration	8.45 G
Maximum Velocity	877 ft/s
Fin Flutter Critical Velocity	1632 ft/s
Target Apogee	10,000 ft
Predicted Apogee	10,027 ft

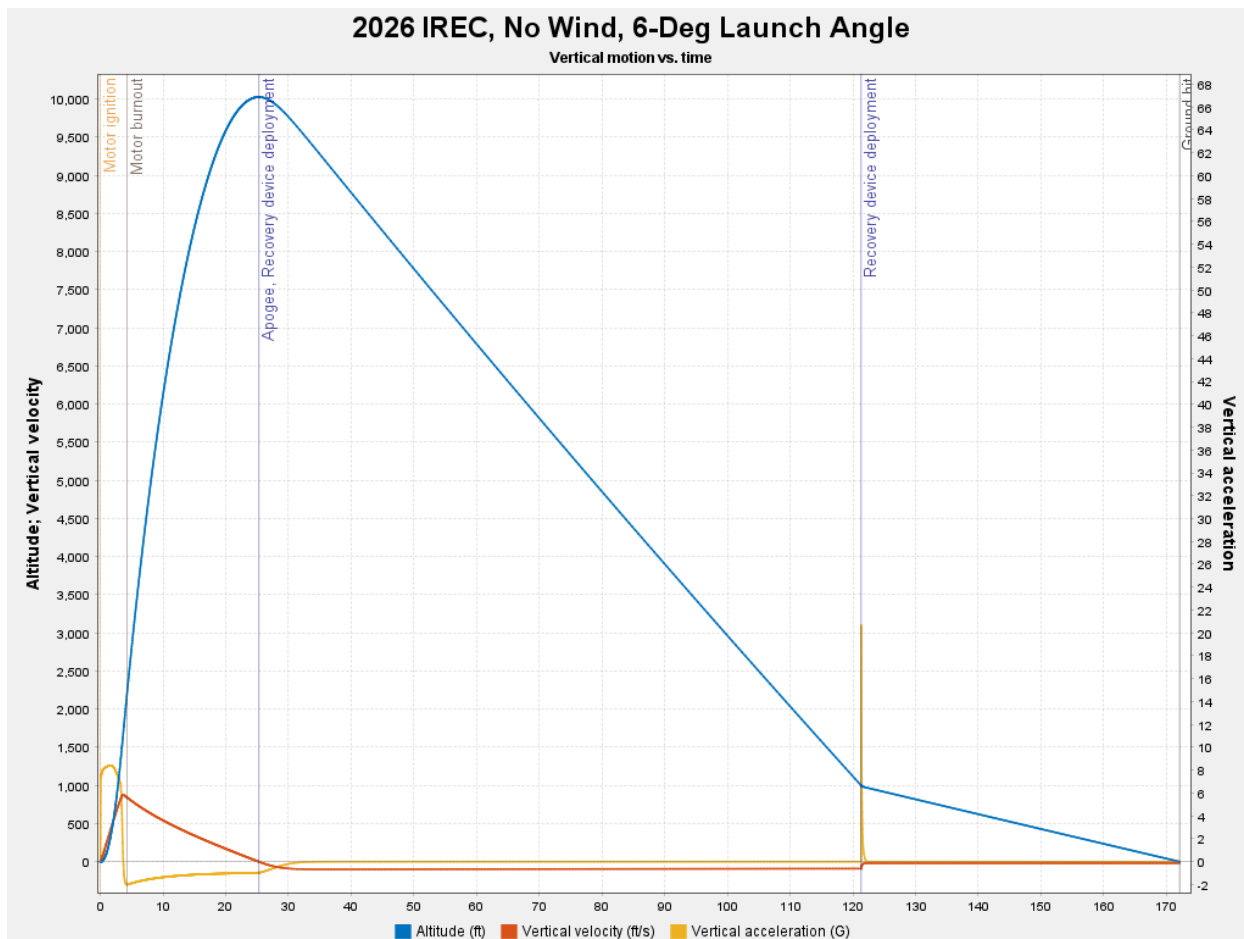


Fig. 27 Flight path plotted from OpenRocket model of *Sabre III*.

Table 4 Recovery System Specifications and Charges

Specification	Value
COTS Altimeters Used	Altus Metrum Telemetrum v4.0
Redundant Altimeters Used	Featherweight Blue Raven
Recovery Deployment	Black Powder Ejection
Drogue Primary Charge	5 g
Drogue Backup Charge	6 g
Drogue Deployment Altitude	Apogee
Drogue Descent Rate	91.1 ft/s
Main Primary Charge	6 g
Main Backup Charge	7 g
Main Deployment Altitude	1000 ft AGL
Main Descent Rate	19.3 ft/s
Shock Cords (OneBadHawk 1/2" tubular kevlar)	7200 lbs rating
Quick Links	1400 lbs rating
Swivel Links	3000 lbs rating

Appendix B—Project Test Report

B.1 Recovery System Testing

B.1.1 Recovery System [DTEG 6.13]

As detailed in the System Architecture Overview, *Sabre III* utilizes a dual-deployment recovery system with events occurring at apogee (drogue) and 1,000 feet AGL (main). This appendix outlines the testing campaign conducted to empirically verify the nominal operation of this system. Ground and flight test demonstrations were executed to validate ejection charge sizing, shear pin failure parameters, and the sequencing of the recovery events in strict compliance with IREC DTEG Section 6.13.

B.1.2 Ground Test Demonstration [DTEG 6.13.4]

Test Report: Ground Testing

Sub-Team(s):	Aerostructures, Recovery	Date(s):	2/28/26 – 3/13/26
Location:	Tripoli Central Virginia (TCV)	Result:	Success
Testers:	Anne Marie Branch, Edison Wong, Emma Lubeshkoff, Albert Castellon-Prado, Jameson Phelps		

Objective & Success Criteria

The primary objective is to verify deployment charge size calculations, confirm body tube separation, and validate recovery system release. A test is deemed successful if it meets the following criteria:

- Instantaneous, clean failure of all 4-40 nylon shear pins.
- A minimum visual separation distance of 4 feet between airframe sections.
- **Drogue:** Full unfurling of the Kevlar drogue parachute between the booster and avionics bay sections.
- **Main:** Complete extraction of the main parachute from its deployment bag between the avionics bay and upper airframe.

Materials

Table 5 Ground Test Materials

Component	Details
Drogue Recovery System	Kevlar Drogue Parachute, Tubular Kevlar Shock Cord, Quick links (4), Swivel Link, 4-40 Size Shear Pins (4)
Main Recovery System	Main Parachute, Deployment Bag, Tubular Kevlar Shock Cord, Quick links (3), Swivel Link, 4-40 Size Shear Pins (4)
Black Powder	Stored in sealed and labeled container
E-Matches	Stored in sealed and labeled container
Firing System	Tripoli Central Virginia Firing System

Procedure & Observations

Table 6 Ground Test Procedure

Step	Action	Expected Outcome	Actual Outcome / Comments
1	Assemble rocket according to Ground Testing Checklist and calculated ejection charge values.	Assembled Rocket.	Nominal.
2	Route e-matches through body tube holes and attach to alligator clips of motor firing system.	E-matches connected, continuity verified.	Nominal.
3	Ensure test area is clear of personnel and flammable materials.	Safe test environment established.	Nominal. All personnel cleared to safe minimum distance.
4	Initiate the motor firing system to fire the specified (drogue/main) charge.	The specified charge ignites, generating pressure to separate the body tubes and eject the recovery system.	Nominal. Audible report from charge ignition. Separation observed.

Results & Data

Table 7 Ground Test Data & Iteration Timeline

Date	Phase	Charge	Comments & Outcome
2/28	1 (Drogue)	5 g	Nominal separation and parachute release.
2/28	1 (Main)	6 g	Payload recovery connection structural failure. Retest required.
2/29	2 (Main)	6 g	Tested with interim boilerplate mass and bulkhead for Subscale 1 schedule. Good separation, but parachute did not fully extract from deployment bag.
2/29	3 (Main)	6 g	Repacked parachute and adjusted bag orientation. Nominal extraction.
3/13	4 (Main)	6 g	Tested with final, strengthened payload recovery connection. Nominal.
3/13	5 (Main)	6 g	Secondary verification test of updated connection design. Nominal.



Fig. 28 Successful drogue charge separation (2/28).



Fig. 29 Successful main parachute separation utilizing boilerplate mass and bulkhead (2/29).



Fig. 30 Final successful main deployment verification with updated payload connection (3/13).

Conclusion

The ground testing campaign successfully met the objectives of verifying deployment charge calculations and validating the dual-deployment recovery sequence. Initial testing on 2/28 confirmed nominal drogue deployment at 5g; however, main deployment testing revealed structural inadequacies in the payload recovery connection. To maintain the testing schedule for the first subscale flight, an interim boilerplate mass and bulkhead were successfully integrated and tested on 2/29. This iteration also allowed the team to optimize the parachute deployment bag orientation, to ensure complete extraction. Subsequent testing on 3/13 validated a redesigned, strengthened payload connection. Consistent nominal deployments across these final tests confirmed the structural integrity and sequencing reliability of both recovery systems, deeming the hardware ready for competition flight operations.

B.1.3 Flight Test Demonstration [DTEG 6.13.5]

Test Report: Subscale Flight 1

Sub-Team(s): Aero-Structures, Recovery, Payload, Airbrakes **Date:** 3/1/26
Location: Tripoli Central Virginia (TCV) **Result:** Success
Testers: Anne Marie Branch, Edison Wong, Emma Lubeshkoff, Albert Castellon-Prado, Jameson Phelps

Objective & Success Criteria

The primary objective of Subscale Flight 1 was the rigorous in-flight validation of the dual-deployment recovery system (electronics, software, and hardware). Secondary objectives included aerodynamic structural validation (specifically the boattail/motor retainer) and passive flight data collection for the airbrakes system. Due to issues discovered during ground testing, a boilerplate mass was substituted for the active payload.

Success Criteria:

- Nominal ignition and ascent on an L2500 motor.
- Primary and backup flight computers accurately detect apogee.
- Nominal deployment of drogue at apogee and main at 1,000 ft AGL.
- Successful firing of both primary and backup ejection charges.
- Safe recovery of the vehicle with zero structural damage to the airframe or boattail.

Materials

Table 8 Subscale Flight 1 Materials

Component	Details
Propulsion	AeroTech L2500 Motor
Airframe	Fully assembled subscale structure, including boattail and motor retainer
Avionics & Recovery	Flight computers, primary/backup ejection charges, drogue, main, shock cords
Payload System	Boilerplate mass equivalent to flight payload
Airbrakes System	Mechanical assembly and control PCB configured for passive data collection

Procedure Summary

The flight test execution followed the standardized *Sabre III* operational procedures detailed in **Appendix E**. The procedural flow was executed in the following standard phases:

- **Final Assembly:** Subsystem assembly, motor integration, airframe mating, and shear pin installation.
- **Preflight:** Pad loading and rail alignment.
- **Arming:** Mechanical actuation of avionics screw switches and dual-verification (audible and telemetric) of active pyrotechnic channels and RF/GPS transmission.
- **Launch:** Pad clearance, countdown, and motor ignition.
- **Recovery:** RF/GPS tracking, visual acquisition, and post-flight safing (power down).

Results & Data

Table 9 Subscale Flight 1 Data Summary

System / Metric	Outcome & Comments
Flight Profile	Nominal. Apogee reached at 3,468 ft.
Recovery System	Nominal. Both primary and backup charges fired successfully. Dual-deployment sequence executed flawlessly.
Aero-Structures	Nominal. Airframe, boattail, and motor retainer recovered with no damage.
Airbrakes	Nominal (Passive). System successfully recorded and saved flight data.



Fig. 31 Full descent of *Sabre III* under both drogue and main parachutes during Subscale Flight 1 (3/1).

Test Report: Subscale Flight 2

Sub-Team(s): Aero-Structures, Recovery, Payload, Airbrakes **Date:** 4/11/26
Location: Tripoli Central Virginia (TCV) **Result:** **Partial Success (Recovery Nominal)**
Testers: Anne Marie Branch, Edison Wong, Emma Lubeshkoff, Albert Castellon-Prado, Jameson Phelps, Richard Zhou, Anderson Garner

Objective & Success Criteria

Subscale Flight 2 aimed to re-verify the recovery system while introducing active testing for the sub-teams. Objectives included validating the live video transmission system, testing the automated payload door opening (with a boilerplate rover), and executing a timed airbrake deployment (programmed to open 3 seconds post-liftoff, following the 1.9s motor burnout, and immediately close).

Materials

Table 10 Subscale Flight 2 Materials

Component	Details
Propulsion	Aerotech L2500 Motor
Airframe	Fully assembled subscale structure
Avionics & Recovery	Flight computers, pyrotechnics, parachutes, live video transmission suite
Payload System	Automated payload door assembly, boilerplate rover mass
Airbrakes System	Mechanical assembly and control PCB configured for active deployment

Procedure Summary

The flight test execution followed the standardized *Sabre III* operational procedures detailed in **Appendix E**. The procedural flow was executed in the following standard phases:

- **Final Assembly:** Subsystem assembly, Motor integration, airframe mating, and shear pin installation.
- **Preflight:** Pad loading and rail alignment.
- **Arming:** Mechanical actuation of avionics screw switches and dual-verification (audible and telemetric) of active pyrotechnic channels and RF/GPS transmission.
- **Launch:** Pad clearance, countdown, and motor ignition.
- **Recovery:** RF/GPS tracking, visual acquisition, and post-flight safing (power down).

Results & Data

Table 11 Subscale Flight 2 Data Summary

System / Metric	Outcome & Comments
Flight Profile	Nominal boost. Apogee reached at 3,437 ft.
Recovery System	Nominal. All charges fired. Vehicle landed in a tree but was successfully retrieved with zero damage to the recovery hardware. Live video transmission was successful.
Airbrakes	Failure to Deploy. A software bug prevented actuation at the 3-second mark.
Payload System	Mechanical Failure. Post-flight analysis confirmed the automated door structurally failed in-flight, allowing the boilerplate rover to fall out of the payload bay. Lack of visual/telemetry data precludes identifying the exact phase of failure. Software functioned nominally.



Fig. 32 Visual confirmation of nominal parachute deployment for Subscale Flight 2 (4/14).



Fig. 33 Onboard live video transmission feed demonstrating the integrated telemetry UI and sensor readings in-flight (4/14).

Subscale Testing Conclusion & Competition Impact

The subscale flight testing campaign was highly successful from a systems-integration and vehicle-safety standpoint. Across two flights, the dual-deployment recovery system performed flawlessly, accurately detecting apogee, firing all primary and backup pyrotechnics, and safely returning the vehicle. The airframe and structural components proved robust under flight loads.

Crucially, the subscale campaign fulfilled its purpose by exposing edge-case flaws in the experimental sub-systems before the competition flight. The mechanical failure of the payload door during the main-separation event, alongside the airbrake software timing bug, provided critical data. Given the lack of schedule margin to conduct a third full-scale verification flight for these complex systems, the team made the engineering decision to descope both for the IREC competition flight. The airbrakes will fly in passive data-collection mode only, and the payload rover will be mechanically secured within a strengthened door assembly without deployment. These changes ensure that a safe launch and successful recovery is not compromised by secondary payload complexities.

B.1.4 Dual Redundancy of Recovery Electronics [R&R 2.6.2.10.a.]

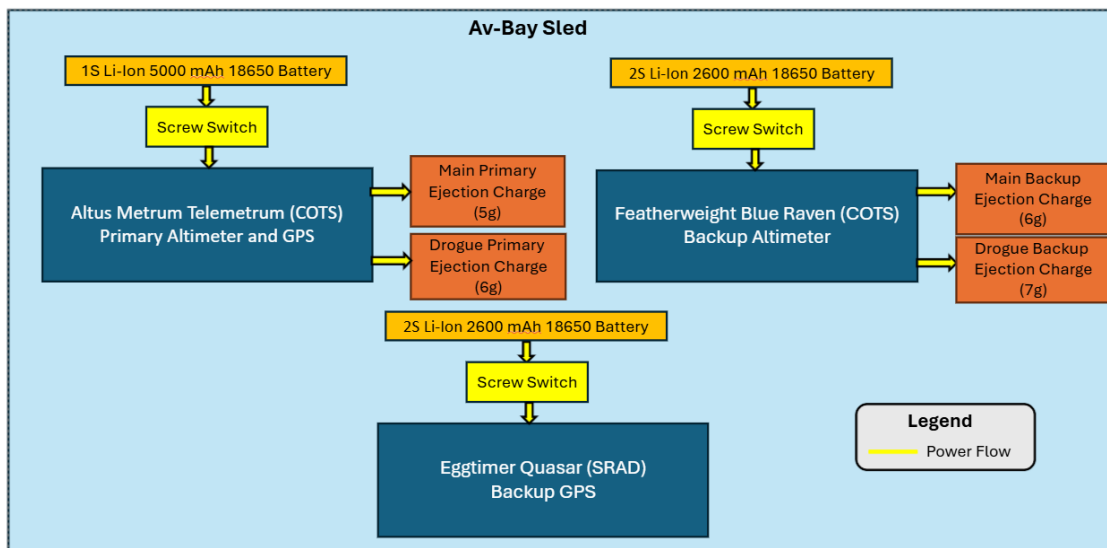


Fig. 34 *Sabre III* avionics bay power flow and dual redundancy block diagram.

To comply with R&R 2.6.2.10.a, the *Sabre III* avionics architecture features complete electrical and logical isolation between the primary and backup recovery systems, as illustrated in Fig. 34.

The primary altimeter (Altus Metrum Telemetry) is powered by a dedicated 1S Li-Ion 5000 mAh battery, while the backup altimeter (Featherweight Blue Raven) is powered by an independent 2S Li-Ion 2600 mAh battery. Power flow to each flight computer is controlled by separate, externally accessible screw switches. Furthermore, the primary and backup systems trigger entirely separate e-matches connected to independent ejection charges. To ensure successful deployment in the event of a primary system failure, the backup ejection charges are intentionally oversized (7g drogue, 6g main) compared to the primary charges (6g drogue, 5g main). This architecture guarantees that no single point of failure within the power supply, arming mechanism, flight computer, or pyrotechnic system can prevent nominal recovery deployment.

B.1.5 Stored-Energy Devices – Energetic Device Safing and Arming [DTEG 6.14]

All energetic pyrotechnic devices are mechanically and electrically isolated from power sources until the vehicle is raised on the launch rail. As dictated by the **Final Assembly** and **Preflight** checklists (see Appendix E), e-match leads are kept physically shunted during transport and motor integration. Power from the internal Li-Ion batteries to the flight computers remains completely severed by exterior-accessible screw switches located on the avionics bay switchband, ensuring the vehicle is fully safed during all handling phases prior to launch.

B.1.6 Arming Devices [DTEG 6.15]

The physical arming mechanism consists of high-current screw switches mounted directly to the avionics bay sled. These switches are accessible through designated alignment ports on the avionics bay switchband. Any Phillips head screwdriver can be used to manually actuate the switches, bridging the circuit. This flush-mounted mechanical design prevents accidental arming from snags or bumps during handling and pad loading.

B.1.7 Arming Device Verification [DTEG 6.16]

Verification of the live recovery system is performed strictly during the **Arming** phase on the launch pad (see Appendix E). To ensure absolute confirmation of system readiness prior to clearing the pad, the team utilizes a multi-system telemetric verification process tailored to each specific avionics unit:

- **Primary Altimeter & GPS (Altus Metrum Telemetrum):** System status is verified via a 70 cm RF downlink to the Telemetrum ground station receiver, which relays the data via Bluetooth to a mobile device running the *AltOS Droid* application. This interface is used to visually confirm primary e-match continuity and a positive GPS lock. The standard audible beep sequence emitted by the altimeter serves as a secondary, redundant confirmation of continuity.
- **Backup Altimeter (Featherweight Blue Raven):** System status is verified via a direct Bluetooth connection to a mobile device running the *Featherweight UI* application. This serves as the primary method to confirm backup e-match continuity and verify nominal flight settings. The standard audible beep sequence emitted by the altimeter serves as a secondary, redundant confirmation of continuity.
- **Backup GPS (EggTIMER Quasar):** System status and telemetry are verified via a dedicated RF ground station receiver, with positive GPS lock confirmed directly on the unit's integrated LCD screen.

Only after positive continuity and GPS lock are confirmed across all three independent interfaces is the pad cleared for the Launch.

B.2 SRAD Propulsion System Testing

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Sabre III utilizes a Commercial Off-The-Shelf (COTS) Aerotech solid rocket motor. No SRAD propulsion systems are used; therefore, this testing requirement is not applicable.

B.3 SRAD Pressure Vessel Testing

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Sabre III does not utilize an SRAD pressure vessel; therefore, this testing requirement is not applicable.

Test Report: Eggtimer Quasar GPS Function and Range Test

Sub-Team(s): Recovery
Location: Tripoli Central Virginia (TCV)
Testers: Edison Wong, Betrand Ngong, Jameson Phelps

Date: 4/5/25
Result: Success

Objective & Success Criteria

Verify the functionality, signal penetration, and telemetry range of the Eggtimer Quasar (SRAD) GPS unit and its handheld LCD ground station receiver.

Success Criteria:

- Successful initialization and acquisition of a positive GPS lock by the flight unit.
- Continuous, readable display of transmitted GPS coordinates on the handheld LCD receiver.
- Maintain a nominal telemetry link (consistent coordinate updates) at a minimum ground distance of 5,000 ft. *Note: The Eggtimer Quasar system does not output Received Signal Strength Indicator (RSSI) values; therefore, signal integrity is evaluated strictly on the successful reception and display of coordinates at measured ground distances.*

Materials

Table 12 Quasar GPS Test Materials

Component	Details
Avionics Bay (AV) Sled	Pre-wired with mounted Eggtimer Quasar GPS unit
Ground Station	Eggtimer Quasar Handheld LCD Receiver Unit
Batteries	7.4V 2000 mAh 18650 Li-Ion Battery (AV Sled Power)
Tracking Devices	GPS-enabled mobile devices used for personnel distance tracking

Procedure & Observations

Table 13 Quasar GPS Test Procedure

Step	Action	Expected Outcome	Actual Outcome / Comments
1	Connect batteries to the Eggtimer Quasar GPS system power input on the sled.	GPS unit powers on, emits startup signals.	Nominal. Audible beeps and LED indicators confirmed power.
2	Turn on and connect the Quasar Handheld Ground Station (GS).	GS powers on, LCD displays status, attempts satellite lock.	Nominal. System initialized.
3	Establish initial communication link between GPS unit and GS at close range.	Position lock achieved and telemetry (coordinates, altitude) displayed on LCD.	Nominal. Initial lock and data received clearly.
4	Have one team member carry the AV sled away from the GS, maintaining line of sight where possible.	Continuous telemetry updates on GS LCD.	Nominal.
5	Monitor signal reception quality and GPS data integrity on the GS as distance increases.	Stable reception expected within specified range.	Nominal initially.
6	Continue increasing distance, recording status periodically, until connection is lost.	Determine maximum reliable ground range under test conditions.	Reception remained nominal up to approx. 5,500 ft. Signal became intermittent by 6,300 ft.

Results & Data

Table 14 Eggtimer Quasar GPS Radio Range Data

Distance (ft)	Signal Status
700	Nominal
1,700	Nominal
2,200	Nominal
2,700	Nominal
3,000	Nominal
3,300	Nominal
3,700	Nominal
4,000	Nominal
4,500	Nominal
5,300	Nominal
5,500	Nominal
6,300	Dropping Out
7,700	Dropping Out

Conclusion

The Eggtimer Quasar GPS system's functionality was successfully verified during ground testing. The GPS unit and handheld ground station performed according to expectations during power-up, initialization, satellite lock, and close-range communication checks. In addition to this standalone test, the Quasar's functionality was successfully verified in-flight during the subscale testing campaign.

The ground range test demonstrated nominal signal reception up to approximately 5,500 feet. Beyond this distance, signal quality degraded, resulting in intermittent data reception at the ground station. It should be noted that the ground test conditions at Tripoli Central Virginia were not ideal for maximizing RF range due to significant environmental obstructions (trees and terrain) interfering with direct line of sight.

Despite these ground-level obstructions, the Eggtimer Quasar, which operates in the 70 cm frequency band, demonstrated excellent reliable range, aligning with the engineering expectation that lower-frequency radio waves offer superior penetration and diffraction around physical obstacles. Based on this robust telemetry performance and successful function verification, the Eggtimer Quasar GPS is deemed fully flight-ready for competition operations.

B.5 Payload Recovery System Testing

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The *Sabre III* payload is a rover that will remain mechanically secured within the airframe during the entire flight and recovery sequence. Because it is not deployed mid-air, it does not utilize an independent payload recovery system; therefore, this testing requirement is not applicable.

B.6 Additional Project Testing

B.6.1 Composite Tensile and 3-Point Bending Tests

Sub-Team(s):	Aero-Structures	Date:	2/25/26
Location:	UVA Mechanical Testing Lab	Result:	Success
Testers:	Albert Castellon-Prado, Magen Wauer, Julian Guzman, Matthew Walls		

Objective

Characterize and compare the mechanical performance of G10 fiberglass and 45-degree carbon fiber composites through Instron tensile testing and PASCO 3-point bending tests. The objective was to quantify maximum load capacity, evaluate relative ultimate strength (ksi), and justify material selection for aerodynamic fin components.

Materials

Table 15 Composite Material Testing Equipment

Component	Details
Universal Testing Machines	Instron (Tensile) and PASCO ME-8237 (3-Point Bending)
G10 Fiberglass Samples	3/16" thick flat composite ASTM D3039 specimens
Carbon Fiber Samples	1/8" thick 45-degree carbon fiber plate ASTM D3039 specimens
Measurement System	Load cells and displacement sensors for force measurement

Procedure & Observations

Table 15 Composite Material Testing Procedure

Step	Action	Expected Outcome	Actual Outcome / Comments
1	Prepare and measure composite specimens prior to testing.	Specimens have uniform geometry and are ready for testing.	Samples prepared successfully with consistent dimensions.
2	Mount specimens in the Instron machine for tensile testing.	Proper alignment ensures accurate load application.	Alignment achieved with minimal slippage.
3	Perform tensile test until material failure.	Maximum load and failure mode recorded.	Common failure observed across samples.
4	Install specimens into the PASCO 3-point bending fixture.	Proper support and centered load- ing achieved.	Fixture setup completed successfully.
5	Apply load gradually until failure in bending.	Peak force and deformation behavior recorded.	Loading observed with clear failure points.
6	Record and compile data for analysis.	Data is complete and usable for comparison.	Data collected successfully for all trials.



Fig. 35 Three-point bending test of a 1/8" carbon fiber coupon utilizing the PASCO ME-8237 Materials Bending Accessory.

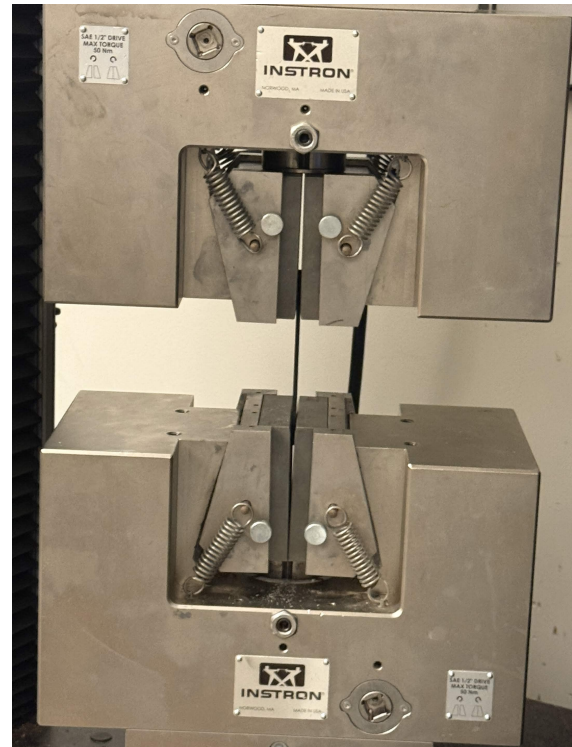


Fig. 36 Tension test of 1/8" carbon fiber coupon utilizing the Instron 6800 Series Universal Testing Systems.

Results & Data

Table 16 G10 Fiberglass Tensile (3/16")

Test	Max Force (lbf)
Test 1	4538.00
Test 2	4745.50
Test 3	2911.00
Test 4	5113.84
Test 5	5116.05
Mean	4484.88

Table 17 Carbon Fiber Tensile (1/8")

Test	Max Force (lbf)
Test 1	4098.28
Test 2	3970.60
Test 3	3691.62
Test 4	4127.56
Test 5	4047.07
Mean	3987.03

Table 18 G10 Fiberglass 3-Pt Bending (3/16")

Test	Max Force (N)
Test 1	1585
Test 2	1601
Test 3	1376
Test 4	1540
Test 5	1521
Mean	1524.6

Table 19 Carbon Fiber 3-Pt Bending (1/8")

Test	Max Force (N)
Test 1	656
Test 2	674
Test 3	539
Test 4	642
Test 5	630
Mean	628.2

To properly compare the disparate thicknesses (1/8" CF vs 3/16" G10), the raw force data was normalized by cross-sectional area to calculate the ultimate stress (ksi) for each material, summarized below.

Table 20 Calculated Stress Statistics Summary (ksi)

Test Category	Mean Stress (ksi)	Standard Deviation (ksi)
Carbon Fiber (1/8") Tensile	53.16	2.34
G10 Fiberglass (3/16") Tensile	23.98	4.89
Carbon Fiber (1/8") Bending	67.79	5.66
G10 Fiberglass (3/16") Bending	44.11	2.58

Conclusion

The testing campaign successfully characterized the mechanical differences between the two composite materials. Looking strictly at the raw force data, the 3/16" G10 samples withstood higher overall forces than the 1/8" carbon fiber samples. However, normalizing these forces by their respective cross-sectional areas revealed carbon fiber's vast superiority in material efficiency.

The calculated stress results showed that the 1/8" carbon fiber had a mean ultimate tensile strength of 53.16 ksi (std dev: 2.34 ksi), compared to 23.98 ksi (std dev: 4.89 ksi) for the thicker G10 fiberglass. This demonstrates that the 45-degree carbon fiber is approximately 122% stronger in tension per unit area. For the three-point bending test, the carbon fiber yielded a mean flexural strength of 67.79 ksi compared to 44.11 ksi for G10, representing a 54% advantage in bending stress.

It was noted that "Test 3" was consistently low across multiple datasets for both materials, which points to a likely specimen manufacturing defect or alignment issue during those specific trials rather than a baseline material property. Ultimately, this normalized testing data explicitly justifies the team's material selection strategy: utilizing the significantly stronger 1/8" 45-degree carbon fiber for the aerodynamic fins to reduce mass and profile thickness, while reserving the thicker, more cost-effective fiberglass for the main airframe tubes where raw structural volume is prioritized over strength-to-weight optimization.

B.6.2 SRAD Telemetry Ground Station Function and Range Test

Test Report: Airbrakes RF Telemetry Link Validation

Sub-Team(s): Airbrakes
Location: Lacy Hall (UVA)
Testers: Edison Wong, Chris Wood

Date: 3/27/26
Result: Success

Objective & Success Criteria

Verify the functionality, signal strength, and maximum ground range of the upgraded simplex (one-way) RF telemetry link between the SRAD Airbrakes (AB) transmitter and the SRAD Ground Station (GS) receiver.

Success Criteria:

- Successful transmission of data packets using the newly integrated 22 dBm 70cm LoRa transceivers.
- Maintain a consistent packet reception rate at a minimum ground distance of 5,000 ft.
- Detectable signal out to at least 7,500 ft before total dropout, demonstrating significant improvement over the previous 33cm band architecture.

Materials

Table 21 Airbrakes Telemetry Test Materials

Component	Details
Airbrakes (AB) PCB	SRAD PCB equipped with flight sensors, a 22 dBm 70cm LoRa module (Transmit Only), and an omnidirectional antenna.
Ground Station (GS) PCB	SRAD PCB equipped with a 22 dBm 70cm LoRa module (Receive Only) and a directional Yagi antenna.
Power Supply	7.4V 2000 mAh 18650 Li-Ion Battery packs (x2).
Tracking Devices	GPS-enabled mobile devices used for distance estimation and tracking.

Procedure & Observations

Table 22 Airbrakes Telemetry Test Procedure

Step	Action	Expected Outcome	Actual Outcome / Comments
1	Power on the Ground Station (GS) PCB.	Normal startup sequence; GS ready to receive.	Nominal. Status indicators active.
2	Power on the Airbrakes (AB) PCB.	Normal startup sequence; AB begins transmitting telemetry packets.	Nominal. Status indicators active.
3	Point the GS Yagi antenna at the AB PCB and verify link at close range (100 ft).	GS PCB emits audible tones and registers data, indicating successful packet reception.	Nominal. Consistent reception and strong RSSI established.
4	Have one team member carry the powered AB PCB away from the stationary GS PCB.	GS continues to log data, signaling ongoing radio reception.	Nominal. Link maintained as distance increased.
5	Monitor reception quality (packet consistency and reported RSSI) as distance increases. Maintain Yagi alignment.	Record distance and signal strength periodically to map attenuation.	Reception quality monitored successfully. See Table 23.
6	Continue increasing distance until signal becomes intermittent or is lost completely.	Identify the approximate ground range limit of the hardware.	Intermittent dropout observed near terrain features, with complete hardware LOS occurring near 9,200 ft.

Results & Data

Table 23 Airbrakes RF Telemetry Range & RSSI Data

Distance (ft)	RSSI (dBm)	Signal Status / Comments
1,000	-62 dBm	Nominal (100% packets received)
2,500	-76 dBm	Nominal
4,000	-89 dBm	Nominal
5,000	-104 dBm	Intermittent (Signal degraded due to line-of-sight obstruction from terrain dip)
6,000	-96 dBm	Nominal (Line of sight recovered, signal strength improved)
7,500	-109 dBm	Nominal
8,500	-116 dBm	Intermittent (Dropping 15% of packets)
8,900	-119 dBm	Dropping Out (Partial data sequences only)
9,200	-122 dBm	Complete Loss of Signal (LOS)

Conclusion

The ground testing campaign successfully verified the upgraded RF telemetry link between the custom Airbrakes (AB) and Ground Station (GS) PCBs. Both boards initialized nominally, and the GS successfully received data packets from the AB board.

The quantitative range data demonstrates a massive performance improvement over the previous year's architecture. By migrating to the 70cm frequency band, utilizing high-power 22 dBm LoRa transceivers, and integrating a highly directional Yagi antenna on the receiving end, the team extended the highly reliable telemetry range from 3,700 ft (previous iteration) to over 7,500 ft, with complete signal dropout not occurring until approximately 9,200 ft.

It is important to contextualize this data within the realities of ground-level RF testing. The temporary signal degradation observed at 5,000 ft was directly attributed to a local dip in the terrain and heavy tree coverage, which temporarily broke the direct line of sight between the AB PCB and the Yagi antenna. Once clear of the obstruction at 6,000 ft, the signal strength successfully rebounded. During actual flight operations, the launch vehicle will maintain a largely unobstructed, high-elevation direct line of sight to the ground station. Because the system successfully pushed telemetry through over 9,000 ft of ground clutter and foliage, the team is highly confident that this hardware configuration will comfortably maintain a robust telemetry link throughout the vertical profile of the 10,000 ft AGL competition flight.

Appendix C—Hazard Analyses

The hazard analysis section will assess risk levels, which are defined by Table 24. The risk matrix is defined using two criteria: Consequence Severity, as defined in Table 25, and Probability, as defined in Table 26.

Table 24 Risk assessment matrix.

		Likelihood				
		1 Rare	2 Unlikely	3 Possible	4 Likely	5 Almost Certain
Consequences	5 Catastrophic	5 Moderate	10 High	15 Extreme	20 Extreme	25 Extreme
	4 Major	4 Moderate	8 High	12 High	16 Extreme	20 Extreme
	3 Moderate	3 Low	6 Moderate	9 High	12 High	15 Extreme
	2 Minor	2 Low	4 Moderate	6 Moderate	8 High	10 High
	1 Negligible	1 Low	2 Low	3 Low	4 Moderate	5 Moderate

Table 25 Consequence severity definitions.

Consequence Level	Definition
Catastrophic	Total loss of the rocket or major systems, severe damage to property, serious risk of injury, or loss of human life.
Major	Damage or failure that results in loss of critical components, serious flight performance issues, or substantial delays; may cause partial mission failure but does not threaten life or total vehicle loss.
Moderate	Damage that requires component replacement or significant repair, may impact subsystem performance, and can cause measurable but recoverable schedule delays.
Minor	Damage that slightly affects performance or requires minor repair but does not compromise safety or significantly impact the project schedule.
Negligible	Damage that does not affect flight performance, is easily repairable, and causes no scheduling delays.

Table 26 Risk definitions.

Level	Percent Probability
Rare	0–5%
Unlikely	6–19%
Possible	20–59%
Likely	60–89%
Almost Certain	90–100%

Table 27 Hazard analysis.

Team	Rocket/Project Name	Date		
99	<i>Sabre III</i>	4/26/2026		
Hazard	Possible Causes	Risk of Mishap and Rationale	Mitigation Approach	Risk of Injury after Mitigation
Black powder ignites during handling and results in personnel injury	Mishandling, improper storage	Moderate; rare, major; Black powder is a division 1 explosive and has inherent risks to handling	Sterile environment Detailed checklist procedure Flier of Record involved in handling of black powder Charge wells not filled with black powder until after all electronics have been wired, secured, and turned off	Low
Explosion (not ignition) of solid propellant motor, creating debris that could cause harm to personnel or participants	Cracks in propellant grain. Debonding of propellant form wall. Gaps between propellant sections and/or nozzle. Chunk of propellant breaking off and plugging nozzle. Motor case unable to contain normal operating pressure. Motor end closures fail to hold.	High; unlikely, catastrophic; M class motors are highly energetic and could cause extreme damage to personnel or property	Examine components of COTS motor before assembly Carefully follow manufacturer assembly instructions Allow for sufficient time for components to cure and bond before launch	Moderate

Recovery systems prematurely deploy and set off ejection charges during handling or assembly	Recovery electronics prematurely detect launch conditions. Improper wire connection, electronics triggered early. Bad or uncharged batteries	Moderate; rare, major; Black powder is a division 1 explosive and has inherent risks to handling Recovery electronics are wired by students and could be subject to human error	Sterile environment Detailed checklist procedure Recovery electronics are only turned on after the rocket is loaded on vertically on launch rail Flier of Record involved in handling of black powder Charge wells not filled with black powder until after all electronics have been wired, secured, and turned off Face shield worn when activating recovery electronics on launch pad.	Low
Rocket deviates from nominal flight path, comes in contact with personnel at high speed	Insufficient airbrakes flap securement Unexpected high velocity wind gusts Anomaly in COTS motor	High; unlikely, catastrophic; Rocket speed and weight mean contact with personnel would cause significant damage or death	Airbrakes securely in place during flight Observe weather data and discuss with competition personnel Properly examine COTS motor components during build	Moderate
Recovery system fails to deploy or only partially deploys, rocket or payload comes in contact with personnel at high speeds	Recovery electronics failure Shear pins fail to shear Charge well covers broken and black powder spilled into recovery compartment Payload attachment failure	High; unlikely, catastrophic; Rocket and payload speed during freefall and weight mean contact with personnel would cause significant damage or death	Sterile environment implemented when assembling avionics bay Shear pins appropriately sized for launch vehicle and tested in ground tests Black powder in charge wells covered with dogbarf and tape to ensure that it does not spill Design updates so that any failure in the payload system should not effect the recovery equipment	Moderate

Main parachute deploys at apogee, rocket drifts onto highway or oil rig	Extreme pressure difference within the rocket Premature shearing of shear pins Off-nominal flight causes main to deploy at low-altitude apogee	Moderate; rare, major; Rocket could cause disruption to roadway Recovery from highway or oil rig may be dangerous or impossible	Pressure relief hole included in each recovery section Appropriately sized and tested shear pins Small piece of masking tape placed over shear pins to ensure none fall out during handling or flight	Low
Failure to ignite motor on rail, but ignition when personnel are near for troubleshooting	Faulty igniter Improper attachment of igniter	High; unlikely, catastrophic; M class motors are highly energetic and could cause extreme damage to personnel or property	Examine igniter before leaving for pad Have spare igniters packed Consult Flier of Record and launch personnel during key igniter phases	Moderate
Rocket falls from launch rail during prelaunch procedures and causes injury	Rail button failure: failed epoxy bond, loose screw. Launch rail failure: rail buttons not inserted into rail, weak point in rail	Low; rare, moderate; Rocket weight and rail height mean that fall could cause significant personnel injury	Checklist procedure to check rail button tightness and integrity before launch. Checklist procedure to inspect and clean launch rail prior to loading	Low
Some black powder charges fail to ignite and cause injury during rocket recovery	Electronic failure Faulty electronic match	High; unlikely, major; Black powder is a division 1 explosive and has inherent risks to handling and human error	During recovery, the first step is to carefully check if all charges have gone off. If yes, then proceed. If no, then consult ESRA officials and the recovery checklist	Low
Injury from toxic materials handling (epoxy, fiberglass, carbon fiber)	Contact and fumes Improper PPE worn	Moderate; unlikely, moderate; Fiberglass and carbon fiber are known carcinogenics, and epoxy can irritate skin significantly on contact	Require disposable gloves, eye protection, and a source of ventilation while handling uncured epoxy Fiberglass or carbon fiber sanding required to occur outdoors, and require gloves, long sleeves, safety glasses, and N95 masks	Low

Injury from machine tool hazards	Equipment malfunction Improper use of equipment or improper PPE Untrained team members	High; unlikely, major; The machines used for rocket construction can cause significant injury or death if misused	Require safety training before equipment use Have multiple members observe the machining activity to double check and catch mistakes	Low
Injury due to sharp edges or points of the rocket	Lack of spacial awareness when handling rocket Airbrake flaps or fins thin edges Point nose cone tip	Low; rare, minor; Sharp edges can cause small cuts and scrapes	Train members in proper handling of rocket, particularly when fully assembled Have spotters for the rocket carriers to help guide them and protect both the rocket and others Add soft protective cover to nose cone tip (crocheted carrot)	Low
Thermal runaway of batteries	Overcharging or lead shorting	High; unlikely, major. LiPo batteries are significant fire hazards if charged unsupervised	Charge batteries only under active supervision Use manufacturer-approved chargers	Low
Terrain and wildlife hazards	Difficult terrain (holes, thorns, soft soil) Dangerous wildlife (snakes, scorpions, etc) Risk of dehydration or sunburn	Moderate; possible, minor; Could cause minor injury or delay	Wear appropriate footwear and clothing (thick soled boots, long sleeves and pants, hat) Carry appropriate water and practice hydration Discuss with launch officials regarding safe travel in the desert terrain	Low

Appendix D—Risk Assessment

The risk assessments below will be defined using the concept of operations phases. The risk levels in Table 24 will be defined using two criteria: Consequence Severity, as defined in Table 25. and Probability, as defined in Table 26.

Table 28 Risk assessment.

Phase	Failure Mode	Possible Causes	Risk of Mishap and Rationale	Mitigation Approach	Mitigated Risk
-1	Failure to ignite	Faulty igniter Improper igniter attachment	Moderate; possible, minor; Igniters are occasionally faulty and igniter attachment is prone to human error but would cause little to no damage	Examine igniter integrity Consult ESRA officials during key phase	Low
-1	Premature separate on pad	Gyro sensors detecting tilt as horizontal Faulty wiring Altimeter short	High; unlikely, major; The altimeters are COTS and well tested, could cause significant rocket damage	Deactivate avionics power of use safe mode until vertical on rail Check wiring continuity Test altimeter function	Low
-1, 8	Battery thermal runaway / Fire	Overcharging, short circuit, or physical damage to batteries	High; unlikely, major; Batteries are well tested, however LiPo battery fires are fairly common and difficult to contain	Follow proper charging procedures Inspect batteries for damage before and after flight	Low
0, 1	Catastrophe at take off (CATO)	COTS motor failure (see Table 27 above)	High; unlikely, catastrophic; A CATO would be rare but cause significant damage to rocket and lead to a launch score of 0	Follow proper assembly procedures	Moderate

1	Airframe structural failure due to damage	Cracks in airframe from handling, transportation, or prior launches. Epoxy failure on fin fillets. Loose structural screws. Damage to fins causing off-nominal behavior.	High; unlikely, catastrophic; COTS fiberglass tubes are unlikely to fail but could cause a non-nominal flight path or descent	Checklist procedure to examine airframe before and after transportation and flights. Checklist procedure to have team member who did not attach all sections to double check their security.	Moderate
1	Structural failure on liftoff due to loads experienced	Thrust loads exceed component strength, poor construction (fin attachment, body tube joints), material defects	High; unlikely, catastrophic; COTS fiberglass tubes are unlikely to fail, however this would cause significant damage to rocket and likely result in 0 launch score	Use high-strength materials (fiberglass, carbon fiber, aluminum), commercial motor retainer, structural and fin-flutter analysis, quality construction practices	Low
1	Rail button binding or failure	Misaligned, damaged, of incorrectly sized rail buttons	Moderate; unlikely, moderate; Structural epoxy was used on all external rocket components, falling from rail could cause minor damage to rocket	Inspect buttons and rail before mounting, ensure smooth movement, proper fit	Low
1, 2	Instability or veering off course	CG/CP margin too low (understability), fin misalignment, asymmetric drag, fin damage, thrust misalignment	Moderate; unlikely, moderate; A non-nominal flight path could cause significant rocket damage or recovery issues	Verify stability margin (Open-Rocket/Simulations), careful alignment during assembly, inspect fins before flight, robust motor retention	Low
1, 2	Avionics power system loss	Battery failure (depletion, internal fault), wiring connection failure, switch malfunction	High; unlikely, major; Could cause failure to deploy or improper deployment of recovery system, or cause difficulty in locating rocket for recovery	Use new/tested batteries, redundant power sources/batteries for critical systems, secure wiring connections (soldered, locking connectors), reliable switches	Low

2	Sensor data inaccuracy or failure	Sensor malfunction, calibration error, noise interference, damage, GPS signal loss	High; unlikely, major; Could cause significant difficulty in rocket recovery and scoring	Use reliable sensors, perform calibrations, redundant sensors, data filtering algorithms, shielding, pre-flight checks (GPS lock)	Low
2	Airbrakes flap failure	Insufficient attachment of airbrakes flaps result in rocket turning	High; possible, major; Could result in complete loss and destruction of rocket, loss of control in flight	Strongly fix and secure airbrakes flaps before flight, or remove them altogether (de-scoping for 2026 IREC)	Low
3-6	Recovery Equipment Failure	Frayed or torn equipment Loose or forgotten connection points Tangled shock cords or shroud lines Improper attachment orientation Main parachute charred by deployment charges in flight	High; unlikely, major; Failure of recovery harness could cause all or parts of rocket to fall from apogee and cause significant damage	Recovery equipment inspected before and after transportations and flights All attachment points are observed and reviewed by multiple team members during assembly Shock cords are labeled with proper location, orientation, and identifying details Both parachutes protected with dogbarf for extra insulation	Low
3-6	Recovery equipment fire	Improperly protected recovery equipment Black powder spillage in recovery equipment areas	Moderate; rare, major; Failure of recovery harness could cause all or parts of rocket to fall from apogee and cause significant damage Fire could cause significant damage to rocket internal components	Specific storage and checklist procedures for all equipment Refolding of parachutes during assembly and before every launch Kevlar drogue chute and shock cords Dogbarf padding between parachutes and black powder	Low

5	Payload casing attachment failure, payload free-falls from rocket and interferes with recovery equipment	Failure of metal payload casing Failure of small ubolt or swivel link connecting payload to rocket	High; possible, major; Payload falling from apogee would severely damage or destroy payload Interference with recovery equipment could cause rocket to freefall from 1000', causing significant damage	Payload attachment secured with all-metal connections, tested previously using grounds tests and a subscale launch.	Low
5-6	Payload deployable door failure at main parachute deployment, door opens prematurely or falls off Loss of rover mid-descent, potential hazard to personnel from falling rover or door	Weak door hinge connection, weak servo arm If applicable, more reliable rover securement	High; possible, major; Payload falling from apogee would severely damage or destroy payload	Stronger door hinge and servo arm Strong attachment of rover within the payload to prevent it from falling out of the rocket	Low
8	GPS signal loss, resulting in inability to recover rocket	Ground station disconnection Altimeter or GPS electronics failure Bad battery or wiring Environmental factors, reflectivity	High; possible, major; Inability to recover rocket would result in significant financial loss and a 0 recovery score	Redundant COTS altimeters and GPS Checklist procedure to check battery power and wire connectivity Members holding ground station trained in handing and directioning	Low
7	Inability to recover rocket due to landing site	Tree, power line, private property, house, hazardous location	Moderate; unlikely, moderate; Inability to recover rocket would result in significant financial loss and a 0 recovery score	Deploy main at 1,000' AGL to avoid long drift distance If rocket does land in a difficult recovery location, discuss best recovery method with launch officials	Low

8	Live charges still in rocket upon recovery	Recovery electronic failure, e-match failure	High; unlikely, major; Charges going off unexpectedly could cause damage to rocket or recovery equipment failure to deploy recovery equipment would cause the rocket to freefall from apogee and cause significant damage	Sterile environment Checklist procedures	Low
All	Extreme weather	Weather and natural events, unavoidable circumstances	Moderate; possible, minor; Out of team's control but would likely not cause significant issues beyond potential launch delay	Check weather before traveling to launch site Consult competition officials and informational update channels	Low

Appendix E—Checklists

This appendix contains the detailed step-by-step procedures for the integration and flight operations of *Sabre III*.

A. Final Assembly

A.1 Rocket Assembly

A.1.1. Update simulations before assembly

A.1.1.1. Turn on VectorNav to measure accurate temperature and pressure conditions on site

A.1.1.2. Compare VectorNav data with data and predictions from local weather reports. Consider both historical trends and current day's predictions

A.1.1.2.1. Estimate temperature and pressure for expected launch time (typical estimate is two-four hours in advance)

A.1.1.3. Download multilevel wind data from <https://gpsdriftcast.com/orwind/> for current date and expected time of launch

A.1.1.4. Use phone compass to find current altitude ASL

A.1.1.5. Update OpenRocket launch conditions for expected time of launch (temperature, pressure, multilevel winds, altitude)

A.1.2. Assemble Airbrakes system (see item A.2)

A.1.3. Assemble Avionics Bay (see item A.3)

A.1.4. Assemble Payload (see item A.4)

A.1.5. Gather Nose Cone, Upper Airframe, Booster Tube, Payload Coupler Tube, Avionics Bay, Airbrakes System, and Recovery equipment.

A.1.6. Pop out all shear pins from previous flights. Check Upper Airframe, Booster Tube, and Coupler Tubes.

A.1.7. Tape z-folds on both shock cords, making bundles with about 4-6 z's. Make a small tear in each piece of tape to ensure that it will rip.

A.1.8. Fold and pack the main parachute (see item A.3.1) into the deployment bag.

A.1.9. Airbrakes Recovery Equipment Attachment

A.1.9.1. Attach aft end (longer section) of 40 ft drogue shock cord to the u-bolt on the airbrakes fore bulkhead. Wrench tighten. Electrical tape.

A.1.9.2. Pass bulkhead off to airbrakes team.

A.1.9.3. Attach airbrakes bulkhead to the airbrakes assembly using 4 10-32 screws.

A.1.10. Payload Recovery Equipment Attachment

A.1.10.1. Attach the fore end (short side) of 30 ft main shock cord and main parachute bag lines to the clamps on the payload. Ensure that all sharp edges are covered.

A.1.10.2. Attach quick link to the loose payload u-bolt. Wrench tighten and electrical tape it. Use 1 quick link for both lines.

A.1.10.3. Pass u-bolt connection assembly to payload team to connect to the coupler and bulkhead.

A.1.10.4. Attach payload swivel link to the payload u-bolt.

A.1.10.5. Attach payload u-bolt to payload fore bulkhead using fishing line to pull it through.

A.1.10.6. Ensure nuts and washers are attached on the inside first.

A.1.10.7. Attach washers and nuts of the fore side of the bulkhead after u-bolt is passed through.

A.1.11. Payload Coupler to Nose cone Attachment

A.1.11.1. Screw the four 10-32 7/16" screws to connect the Payload Coupler Tube and the Nose Cone.

A.1.11.2. Start the screws by hand (no Allen wrench) on opposite sides of the body tube (Start, 180°, 90°, 180°).

A.1.11.3. Following the same pattern, tighten all the screws down with the Allen wrench.

A.1.12. Payload Coupler to Upper Airframe Attachment

A.1.12.1. Slide main parachute bag and shock cords into the upper airframe, ensuring the flap still covers the parachute.

A.1.12.2. Attach upper airframe to payload coupler tube using 4 4-40 shear pins.

A.1.12.3. Pick one side to start, then flip 180°, then go 90° from that then end at another 180°.

A.1.12.4. Place a strip of white masking tape over each shear pin to keep them in.

A.1.13. Av-Bay Main Parachute Recovery Equipment Attachment

A.1.13.1. Receive armed avionics bay.

A.1.13.2. Attach the quick link at the aft (long) end of the 30 ft main shock cord to the av-bay fore u-bolt.

A.1.13.3. Wrench tighten, electrical tape, and blue masking tape.

A.1.14. Av-Bay and Upper Airframe Attachment

- A.1.14.1. Ensure all recovery equipment is properly packed into the upper airframe, except for the length of shock cord connected to the av-bay.
- A.1.14.2. Stand up nose cone, payload, and upper airframe assembly so that the nose cone is pointing down at the ground. Ensure that someone is holding the avionics bay up off the ground.
- A.1.14.3. Stuff at least two handfuls of dogbarf into the upper airframe, ensuring that the recovery equipment is protected.
- A.1.14.4. Place Av-bay coupler tube into upper airframe, with the nose-cone still pointing to the ground.
- A.1.14.5. Attach av-bay to upper airframe with four 10-32 screws.
- A.1.14.6. Lay nose cone to av-bay assembly back on the ground.

A.1.15. Av-Bay Drogue Parachute Recovery Equipment Attachment

- A.1.15.1. Attach quick link at the fore (short) end of the 40 ft drogue shock cord to the av-bay aft u-bolt.
- A.1.15.2. Wrench tighten, electrical tape, and blue masking tape.

A.1.16. Av-Bay and Booster Tube Attachment

- A.1.16.1. Ensure all recovery equipment is properly packed into booster tube, except for the length of shock cord connected to the av-bay.
- A.1.16.2. Stand up booster tube so that the boat tail is resting on the ground and the tube is vertical. Ensure that the nose cone to av-bay assembly is held off the ground by several people.
- A.1.16.3. Stuff at least two handfuls of dogbarf into the booster tube, ensuring that the recovery equipment is protected.
- A.1.16.4. Place av-bay coupler tube into the booster tube.
- A.1.16.5. Attach av-bay to booster tube using four 4-40 shear pins.
- A.1.16.6. Pick one side to start, then flip 180°, then go 90° from that then end at another 180°.
- A.1.16.7. Place a strip of white masking tape over each shear pin to keep them in.
- A.1.16.8. Lay whole assembled rocket back on the ground.

A.1.17. Final Checks

- A.1.17.1. Someone who did not attach any screws will check that all screws are properly tightened.

A.1.18. Motor Attachment

- A.1.18.1. Unscrew boat tail retaining ring. Slide motor into rocket. Screw boat tail retaining ring back on. Use belt-wrench to tighten.

A.2 Airbrakes Assembly

A.2.1. Electronics

- A.2.1.1. Ensure that all screws mounting down electronics are tight and secure
- A.2.1.2. Connect the main pcb battery and then connect the servo battery.
- A.2.1.3. Listen for the initialization beeps, once GPS has gotten a location fix, the buzzer should output 3 beeps on a minute interval. This usually takes up to a minute or two.

A.2.2. Assembly After Electronics

- A.2.2.1. Screw top electronic shelf (bigger one) to top of plate.
- A.2.2.2. Screw bottom electronic shelf (smaller one) to bottom of plate (antenna only).
- A.2.2.3. Align metal rectangle pieces on edge of plate. **Note:** Follow numbering exactly (except number 4 which may be flipped) and ensure solid face is pointing outwards.
- A.2.2.4. Once everything is attached to the plate, slide the plate down the tube.
- A.2.2.5. Align metal rectangle pieces with aft airbrakes holes (holes on the side at the very bottom below hinge cutouts).
- A.2.2.6. Screw in [INSERT] 4 holes around tube to attach plate.
- A.2.2.7. Screw in hinges through hole cutouts. Only the top screw will be screwed to the tube, leaving two empty towards holes for flaps. Ensure hinges are facing the correct way.
- A.2.2.8. Slide in fore bulkhead (with u-bolt) and align holes.
- A.2.2.9. Screw in with 10-32 screws and washers to connect with top electronic shelf and hinge.

A.3 Recovery Assembly

A.3.1. Main Parachute Folding

- A.3.1.1. On the ground, lay out parachute so that it makes a “W” shape
- A.3.1.2. Ensure shroud lines are straight and not tangled
- A.3.1.3. Fold the “W” in half so that it makes a “V” shape

- A.3.1.4. Drape shroud lines across the parachute, ensuring that they still come out on the bottom
- A.3.1.5. Fold the non-straight edge over, letting the point meet about where the fabric changes color
- A.3.1.6. Fold the straight edge over just a little bit
- A.3.1.7. Fold the top down slightly. It should look like it fills in the triangle shaped “gap”
- A.3.1.8. Tightly roll parachute, starting from the top and rolling down to the shroud lines. It should be longer rather than wider (in terms of length and diameter)
- A.3.1.9. Pack main parachute into deployment bag. Tuck shroud lines and the quick link attachment into the bag. Tuck some of the yellow shock cord in as well.
- A.3.1.10. Close the deployment bag’s flap. Ensure that all white fabric on the bag is covered.
- A.3.1.11. Make sure the orange tape part is tucked in well.
- A.3.2. Drogue Parachute Folding**
 - A.3.2.1. Lay out the drogue parachute so it is folded in a semi-circle
 - A.3.2.2. Fold the drogue parachute in half 1-2 times.
 - A.3.2.3. Z-fold the shroud lines and place near the bottom of the drogue parachute
 - A.3.2.4. Fold the drogue parachute in half once more
 - A.3.2.5. Fold the drogue parachute from the top of the parachute to the bottom in thirds
 - A.3.2.6. If using nylon drogue: Repeat same folding process from main parachute to pack into deployment bag
- A.3.3. Av-Bay Assembly**
 - A.3.3.1. Verify the set-up of the Av-Bay: check the epoxy on the bulkheads, three threaded rods, U-bolts, nuts, and washers to make sure there are no cracks, ensure that electronics are turned off.
 - A.3.3.2. Insert threaded rod between T3 and T2. Insert threaded rod between T3 and T1. (no threaded rod between T1 and T2: panel with camera is in the middle)
 - A.3.3.3. Ensure all screw switches are unscrewed.
 - A.3.3.4. Insert Charged Batteries into the 4 Battery Holders. Screw lids on. Connect the Batteries with the JST connectors.
 - A.3.3.5. Connect camera system first (fan and camera unit). Insert pull pin for camera system.
 - A.3.3.6. Connect Blue Raven. Connect EggTIMER Quasar. Connect Altus Metrum Telemetry.
 - A.3.3.7. Ensure all wires are securely connected to the terminal blocks. Ensure that wires on screw switches do not wiggle. If they do, tighten.
 - A.3.3.8. Connect prism completely via the three threaded rods. It should close without resistance, do not crush wires! This will be the threaded rod between T1 and T2 panels.
 - A.3.3.9. Connect e-matches to primary altimeter and terminal block on prism.
 - A.3.3.10. Take tape/camera cover OFF the camera lens.
 - A.3.3.11. Insert 4 total e-matches through the bulkhead wire holes, each one going into the ejection canisters.
 - A.3.3.12. Shorten e-matches with wire cutters if necessary. Label each e-match with masking tape as primary/backup main and primary/backup drogue. Put label close to e-match.
 - A.3.3.13. Connect the ends of the e-matches onto their respective altimeter ports (primary main, primary drogue, backup main, backup drogue).
 - A.3.3.14. Altus is primary – connect e-matches directly to the component. Blue Raven (terminal block) is back-up – connect e-matches to the terminal block.
 - A.3.3.15. Remove pull pin switch for camera system (be ready to re-insert once the prism is inside the coupler tube).
 - A.3.3.16. Insert the Avionics Bay prism through the three threaded rods into the Avionics Bay coupler. One of the threaded rods might get caught, just have another person look at it from the outside to direct you where to shove it.
 - A.3.3.17. Ensure that the orientation is correct by checking the access ports. The screw switches should line up, and the GPS antenna is pointing towards the forward end.
 - A.3.3.18. Set one washer on each of the threaded rods. There should be approximately equal amounts of rod on each side.
 - A.3.3.19. Attach the nuts onto the washers of each threaded rod. (threaded rods are 3/8”)
 - A.3.3.20. Tighten nuts with a wrench. Ideal technique: have one person hold the coupler tube and another person use one wrench on one nut on each side of the prong (two wrenches going opposite directions) and tighten at the same time.
 - A.3.3.21. Mark the nuts with a sharpie line to keep track of alignment.
 - A.3.3.22. Wrap nuts and exposed threaded rods with the weird orange-y clear tape (called Kapton tape). Can use

- electrical tape, too, the Kapton is just easier to remove post-flight and will not leave residue.
- A.3.3.23. Apply sticky putty to the wire holes to seal the holes.
 - A.3.3.24. Insert the appropriate amount of black powder into each canister. Prof. Mike has it.
 - A.3.3.25. Apply dog-barf and blue painter's tape to seal up the ejection charge canisters, while ensuring that the e-match is buried in the black powder.

A.4 Payload Assembly

A.4.1. Rover Assembly

- A.4.1.1. Insert camera module into the rectangular hole at the front of the rover, with the camera lens sticking out.
- A.4.1.2. Insert battery into main chassis compartment in the middle of the rover
- A.4.1.3. Connect two motor JST connectors from the right and left rear corners of the rover into motor ports on PCB
- A.4.1.4. Connect servo JST connectors from the rear of the rover into servo port on PCB
- A.4.1.5. Connect the battery JST connector/camera module wiring to PCB, the PCB should light up when connected.
- A.4.1.6. Insert PCB into main chassis compartment to the left of the battery. Make sure to keep the various wire untangled when inserting PCB.
- A.4.1.7. Attach roof of rover using screws.

A.4.2. CubeSat Assembly

- A.4.2.1. Take the flat metal casing liners labeled A, B, C. Lay them in alphabetical order with letters facing up.
- A.4.2.2. Bolt together the 3 pieces using two L-brackets in each upper corner using 8-32 1/2" bolts and one 8-32 washer and nut for each bolt, only hand tighten. The brackets should be on the inside.
- A.4.2.3. Bolt two L-brackets on the bottom outer holes of each plate A, B, C using 8-32 1/2" bolts and one 8-32 washer and nut for each bolt, only hand tighten.
- A.4.2.4. Orient the fore casing so that the side with two screws is on the left. Orient the CubeSat so that the uncut plate is on the bottom. Put the CubeSat into the fore casing so the open end is sticking out.
- A.4.2.5. Place the bent metal plate onto the fore end of the casing with the bend end going down the middle of the two threaded inserts on the left side of the CubeSat.
- A.4.2.6. Take the assembled, "ABC" metal plates and place them on top of the bent metal plate. Line up the holes so that the open side aligns with the bent metal
- A.4.2.7. Using 6 8-32 7/8" bolts, go through the CubeSat and bolt each L-bracket to the casing. Have the washer side inside the CubeSat. Attach one 8-32 washer and one 8-32 nut to each bolt. IF LAUNCHING: Apply blue Loctite to the nuts.
- A.4.2.8. Use a hex key and wrench to tighten each L-bracket bolt.
- A.4.2.9. Loop the 1/4" U-bolt through the swivel link. Then place the U-bolt through the holes of the metal casing, with the prongs going into the CubeSat. Use a 1/4" washer and 1/4" nut on each end of the U-bolt. IF LAUNCHING: Apply blue Loctite to the nuts.
- A.4.2.10. Tighten the nuts using a 1/4" socket wrench and the 15" extender.
- A.4.2.11. Loop 2ft long "cert rocket shock cord" (NEED NAME) to rover and through the back of the CubeSat and double knot.
- A.4.2.12. **Assemble Shelf:**
 - A.4.2.12.1. Place battery into compartment with wires coming out of right-hand side where the hole is
 - A.4.2.12.2. Place PCB into compartment with the servo and motor ports on the back end
 - A.4.2.12.3. Screw PCB into shelf through bottom using 3 M2x6 screws and place two M2 nuts and washers on each screw. Ensure washers are on top.
 - A.4.2.12.4. Place servo inside metal servo holder. Line up servo holder on the shelf to match holes with the holes in the CubeSat
 - A.4.2.12.5. Connect the battery JST connector to the servo JST connector. The PCB should light up. Steps A.4.2.12.5 to A.4.2.13 must take place in 5 minutes before the servo closes
 - A.4.2.12.6. Slide shelf into the casing. Use two M2x6 bolts to secure the shelf into the holders.
- A.4.2.13. Close CubeSat door and tape it closed until servo turns into place. Once servo turns you might have to push door in to allow servo to fully rotate.
- A.4.2.14. Bolt the aft casing to the forward using five M6x30 bolts. Put one M6 washer and one M6 nut on each bolt. Tighten using a hex key and a wrench.
- A.4.2.15. Tape all exposed bolts and sharp edges.
- A.4.2.16. Screw one 5/16" nut onto each side of the 5/16" U-bolt. Tighten with a wrench all the way and place a

- washer on each nut.
- A.4.2.17. Tie one piece of 2ft long fishing line to each prong on the 5/16" U-bolt
- A.4.2.18. Attach main parachute shock cord quick link and parachute bag quick link to 5/16" U-bolt. Loop U-bolt through end of swivel link that is not already attached to the 1/4" U-bolt.
- A.4.2.19. Place both shock cords inbetween the threaded inserts on the casing. Using four M6x1 bolts with one M6 washer for each bolt, screw down the two routing clamps.
- A.4.2.20. Thread one end of the fishing line through each of the middle holes in the fore bulkhead.
- A.4.2.21. Slide the coupler tube over the payload, ensuring that the bearings do not hit the weld nuts. Using the fishing line guides the U-bolt through the holes.
- A.4.2.22. Holding on to the U-bolt. Take the fishing line off each side by spinning it along the threads.
- A.4.2.23. Holding onto one side of the U-bolt place a 5/16" washer and 15/16" nut onto the other side of the U-bolt and tighten. Repeat for the other side of the U-bolt. Tighten with a wrench. IF LAUNCHING: Apply blue Loctite to the threads

B. Preflight Pad Procedures

- B.1.1. Apply WD-40 to the launch rail
- B.1.2. Load rocket onto rail. Ensure rail buttons are properly loaded
- B.1.3. Remove all three remove-before-flight tags while rocket is still horizontal.
- B.1.4. Ensure all proper electronics checks are performed
- B.1.5. Raise launch rail to specified angle (currently 85 deg)
- B.1.6. Push both motor igniters through the nozzle of the motor with a dowel until the e-matches reach the top. Do it slowly until you feel resistance after a reasonable length.
- B.1.7. Follow instruction of launch personnel for more details/assistance on checking for continuity, connecting leads, etc.
- B.1.8. Take pictures for social media. Set-up camera for video, if available.
- B.1.9. Clear area of non-essential personnel

C. Arming

- C.1.1. Climb ladder with a face shield and the designated screwdriver for arming electronics (multitool OR red screwdriver)
- C.1.2. Plug the TeleBT into the antenna, turn on. On a phone with the AltusOS installed, press the 3 dots menu, select connect a device, then select the TeleBT with 16670 serial number. Check for green light on all settings (looking at GPS lock). Hold antenna pointing in general direction of rocket.
- C.1.3. Screw in the screw switch for the Altus Metrum Telemetry.
- C.1.4. Turn on phone with Featherweight app downloaded and turn on Bluetooth.
- C.1.5. Screw in the screw switch for Blue Raven.
- C.1.6. Connect to Blue Raven via Bluetooth. The connection will turn green on the app.
- C.1.7. Turn on the groundstation for Eggtimer Quasar.
- C.1.8. Screw in the screw switch for the Eggtimer Quasar.
- C.1.9. Wait for lock on the Eggtimer Quasar ground station. It will show the rocket's coordinates. Hold in direction of the rocket.
- C.1.10. Turn on Airbrakes PCB: Wait 5s. If five sets of 3 beeps occurs, change main battery. If five sets of 2 beeps occurs, change servo battery. Wait for two short beeps (about 5s).
- C.1.11. If there are 2s beeps separated by 1s, either the vectornav or barometer is not connected. RESTART THE AIRBRAKES PCB
- C.1.12. Once vectornav is tracking GPS, there will be a long 1s beep followed by silence. At this point, the program is fully initialized and running
- C.1.13. Leave launch field. Prepare for launch

D. Launch

- D.1.1. Wait for launch personnel to verify rocket is good for launch before sending launch command
 - D.1.1.1. Requires go/no go from all three sub-teams: structures, avionics, and flight performance/recovery
- D.1.2. For no ignition, see checklist f. Off-Nominal (Motor Misfire)
- D.1.3. For Motor CATO, see checklist f. Off-Nominal (CATO)
- D.1.4. Qualitatively observe important flight events:
 - D.1.4.1. Launch rail departure
 - D.1.4.2. Airbrakes deployment (if applicable)
 - D.1.4.3. Drogue & main deployment
 - D.1.4.4. Rocket touchdown on the ground
- D.1.5. Once fields are clear, recover rocket as per checklist F. Recovery. Report back to advisors and launch personnel
- D.1.6. Acquire all flight data from rocket. Examine rocket for any damages. Write down observations and create plans for improvement

E. Recovery

- E.1.1. Wait until field is clear and safe, in accordance with launch regulations
- E.1.2. Ensure that the Featherweight and BlueRaven GPS Systems still have enough battery life, with green or yellow bars in the tracker tab of the app
- E.1.3. With the recovery team, ensure all members have adequate water, clothes, and equipment to go and recover the rocket
- E.1.4. Utilize the Featherweight GPS tracker app to locate the rocket, following the compass in the tracker tab
- E.1.5. When arriving at the recovery location, ensure that all parts have been picked up and electronics are still on, return to the launch personnel
 - E.1.5.1. If the main did NOT deploy, record the beeping frequency/cadence and then disarm electronics before handling the rocket in case of a misfire
 - E.1.5.2. If rocket lands in a hazard area, recover when there is a break in launches
- E.1.6. Allow the launch personnel to collect the apogee, post-flight inspection of the rocket
- E.1.7. Return to the prep area and turn off the electronics after the post-flight inspection
- E.1.8. Record or take a picture of the change in the sharpie line

F. Off-Nominal

F.1 Motor Misfire Checklist

- F.1.1. Wait until field is clear and safe
- F.1.2. Unscrew the screw switches for both altimeters
- F.1.3. Take the rocket off the launch rail and return to prep area.
- F.1.4. Check for cause of error(s). Fix the error(s)
 - F.1.4.1. If ignitors did not ignite the motor, replace the ignitors
 - F.1.4.2. If avionics do not detect continuity, disassemble the electronics bay, and redo checklist A.3.3
 - F.1.4.3. Otherwise, any other error requires disassembly of that subsystem and correction of the issue
- F.1.5. Reassemble the rocket through checklist A-D again

F.2 CATO Checklist

- F.2.1. Wait until field is clear and safe
- F.2.2. Disarm the two altimeters with the screw switches, if possible
- F.2.3. Gather the motor remains, if possible
- F.2.4. Examine rocket and act according to the severity of the damage:
 - F.2.4.1. Minor Damage (Does not affect flight): Recycle through all the above checklists
 - F.2.4.2. Major Damage (Significantly affects flight): If possible, repair damaged areas then recycle through all the above checklists
 - F.2.4.3. Critical Damage (Unable to fly): Disassemble rocket. Pack up for transportation

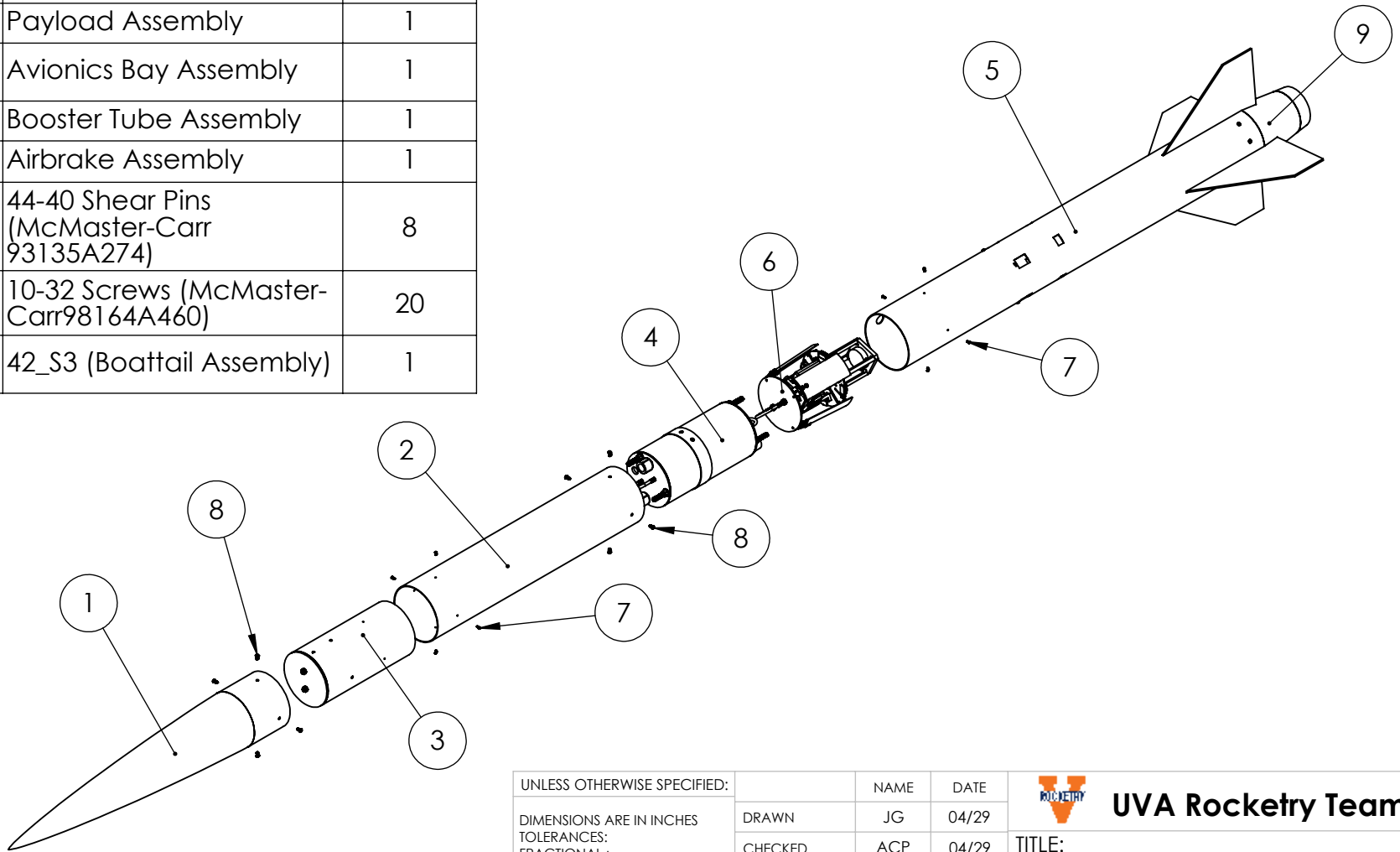
Appendix F—Engineering Drawings

F.1 Aero-Structures Drawings

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Drawings for the components of the Aero-Structures Subsystems are found starting on the next page.

ITEM NO.	PART NUMBER	QTY.
1	Nose Cone	1
2	Upper Airframe	1
3	Payload Assembly	1
4	Avionics Bay Assembly	1
5	Booster Tube Assembly	1
6	Airbrake Assembly	1
7	44-40 Shear Pins (McMaster-Carr 93135A274)	8
8	10-32 Screws (McMaster-Carr98164A460)	20
9	42_S3 (Boattail Assembly)	1



UNLESS OTHERWISE SPECIFIED:

DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL $\pm$
ANGULAR: MACH $\pm$ BEND $\pm$
TWO PLACE DECIMAL $\pm$
THREE PLACE DECIMAL $\pm$

INTERPRET GEOMETRIC
TOLERANCING PER:

MATERIAL

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DO NOT SCALE DRAWING

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CHECKED	ACP	04/29
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MFG APPR.		
Q.A.		
COMMENTS:		



UVA Rocketry Team

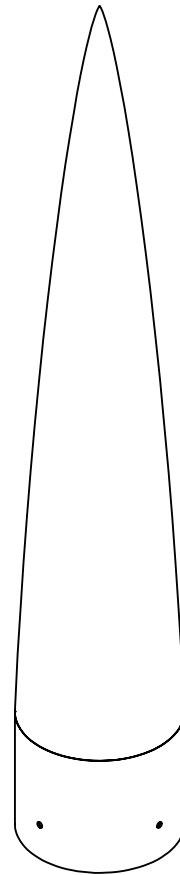
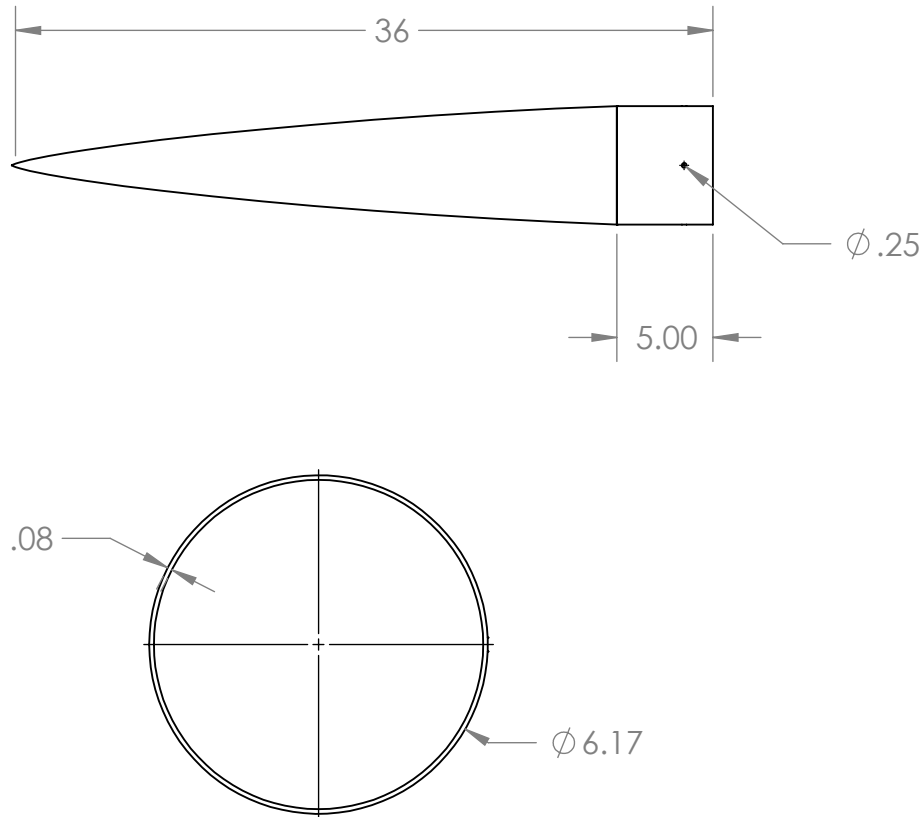
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ASSEMBLY**

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B

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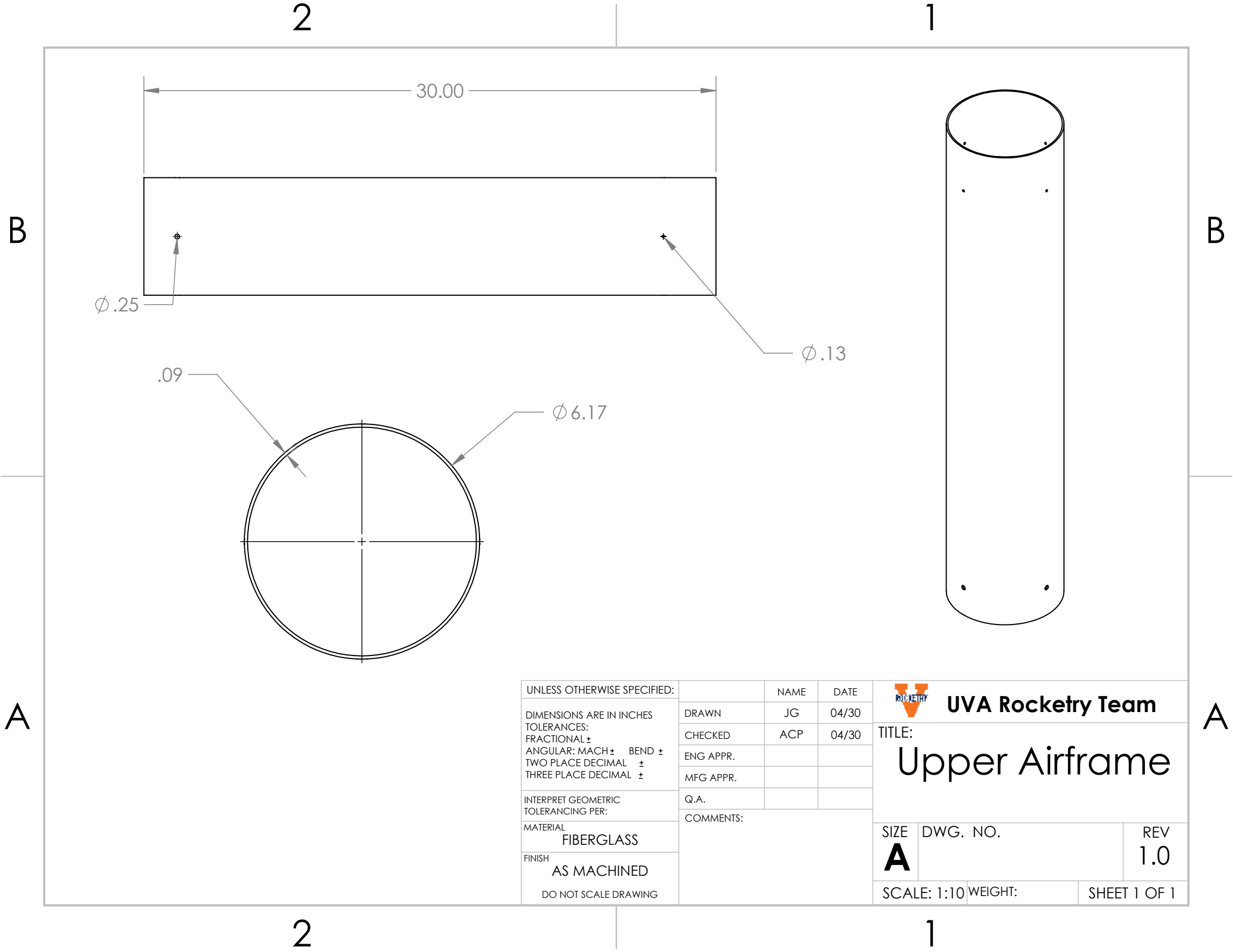
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MATERIAL
FIBERGLASS

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ACP

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ENG APPR.

MFG APPR.

Q.A.

COMMENTS:



UVA Rocketry Team

TITLE:

Upper Airframe

SIZE

DWG. NO.

REV

A

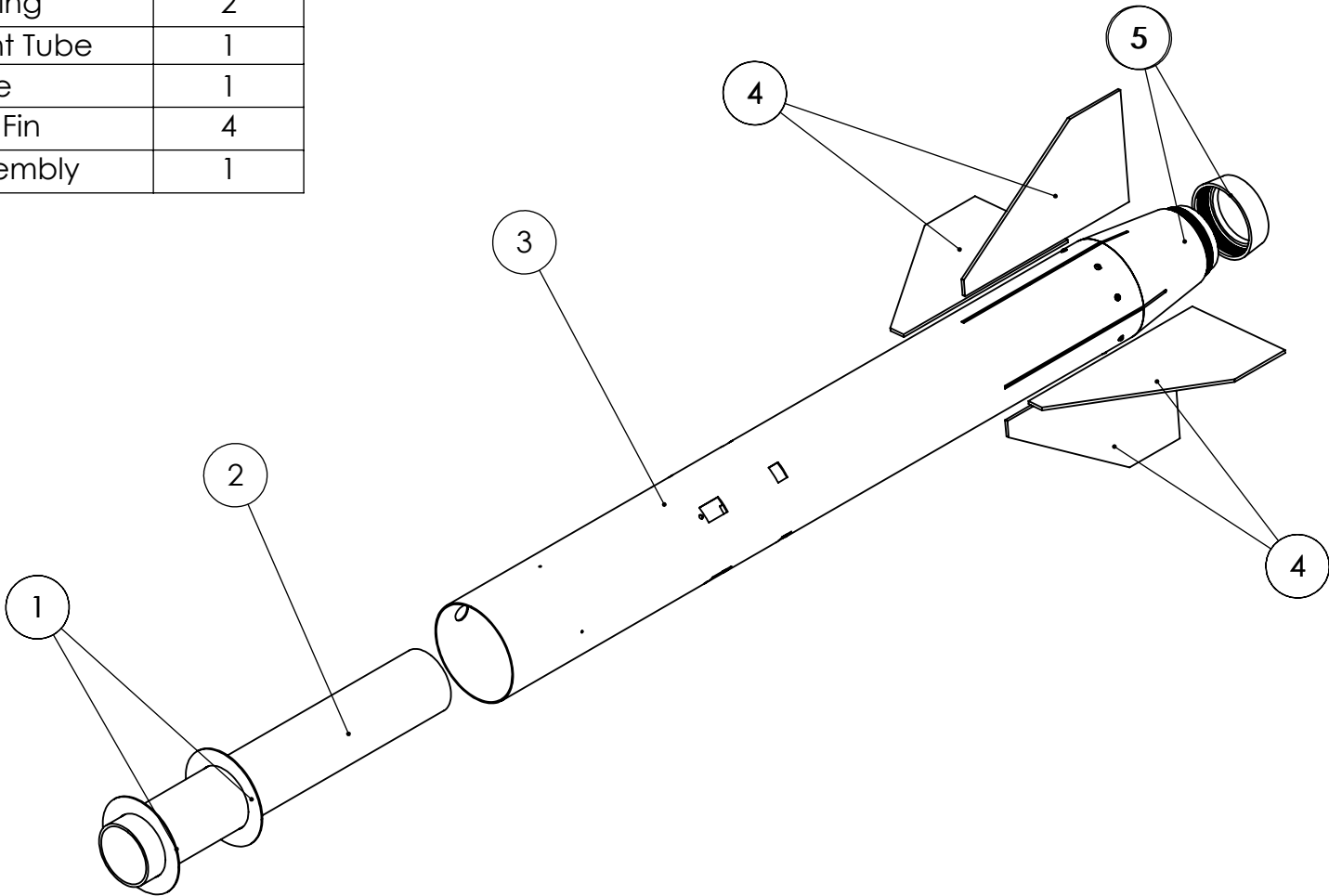
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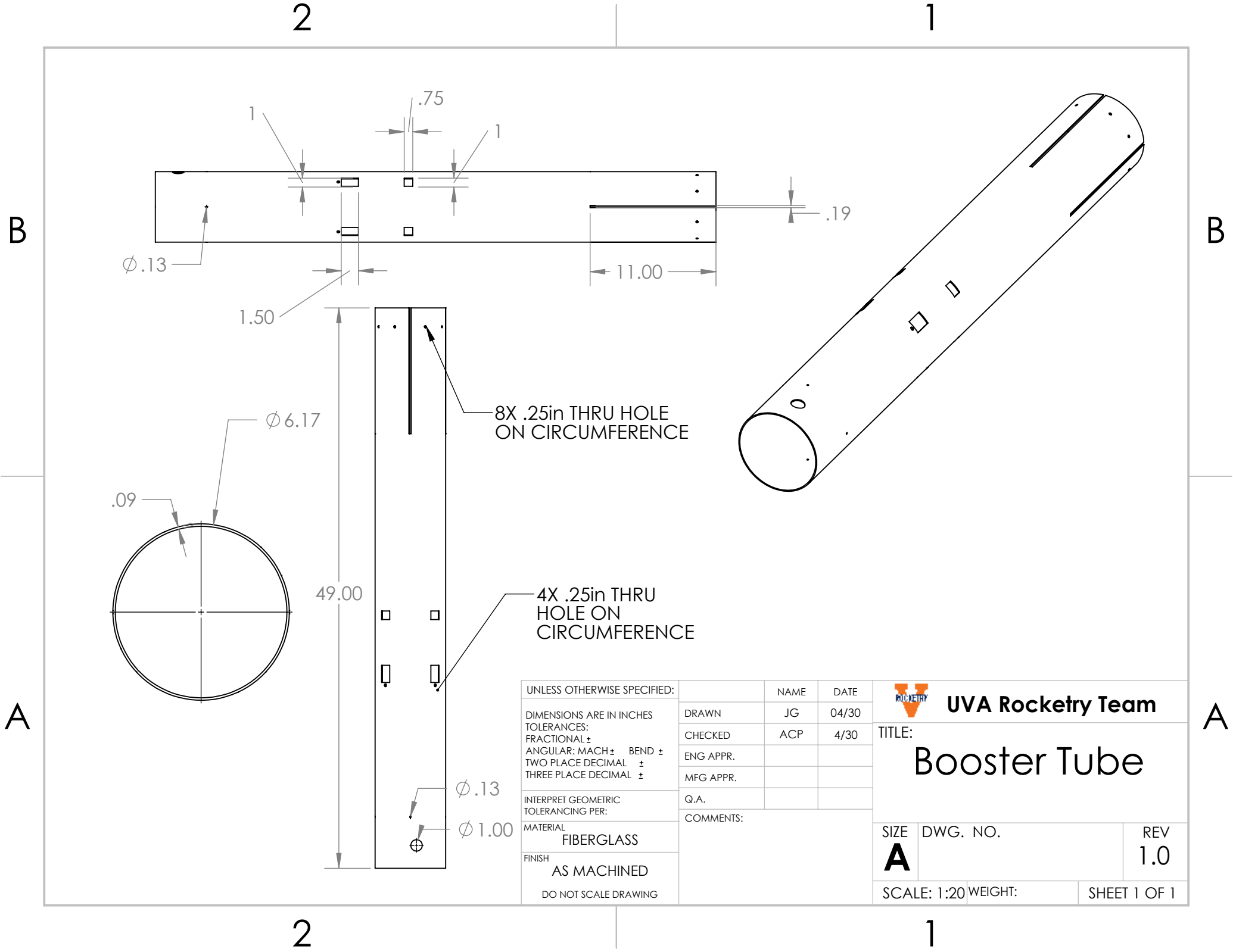
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ITEM NO.	PART NUMBER	QTY.
1	Centering Ring	2
2	Motor Mount Tube	1
3	Booster Tube	1
4	Trapezoidal Fin	4
5	Boattail Assembly	1



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THREE PLACE DECIMAL ±		COMMENTS:		SIZE A	
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				SHEET 1 OF 1	



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ANGULAR: MACH $\pm$ BEND $\pm$
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INTERPRET GEOMETRIC
TOLERANCING PER:

MATERIAL
FIBERGLASS

FINISH
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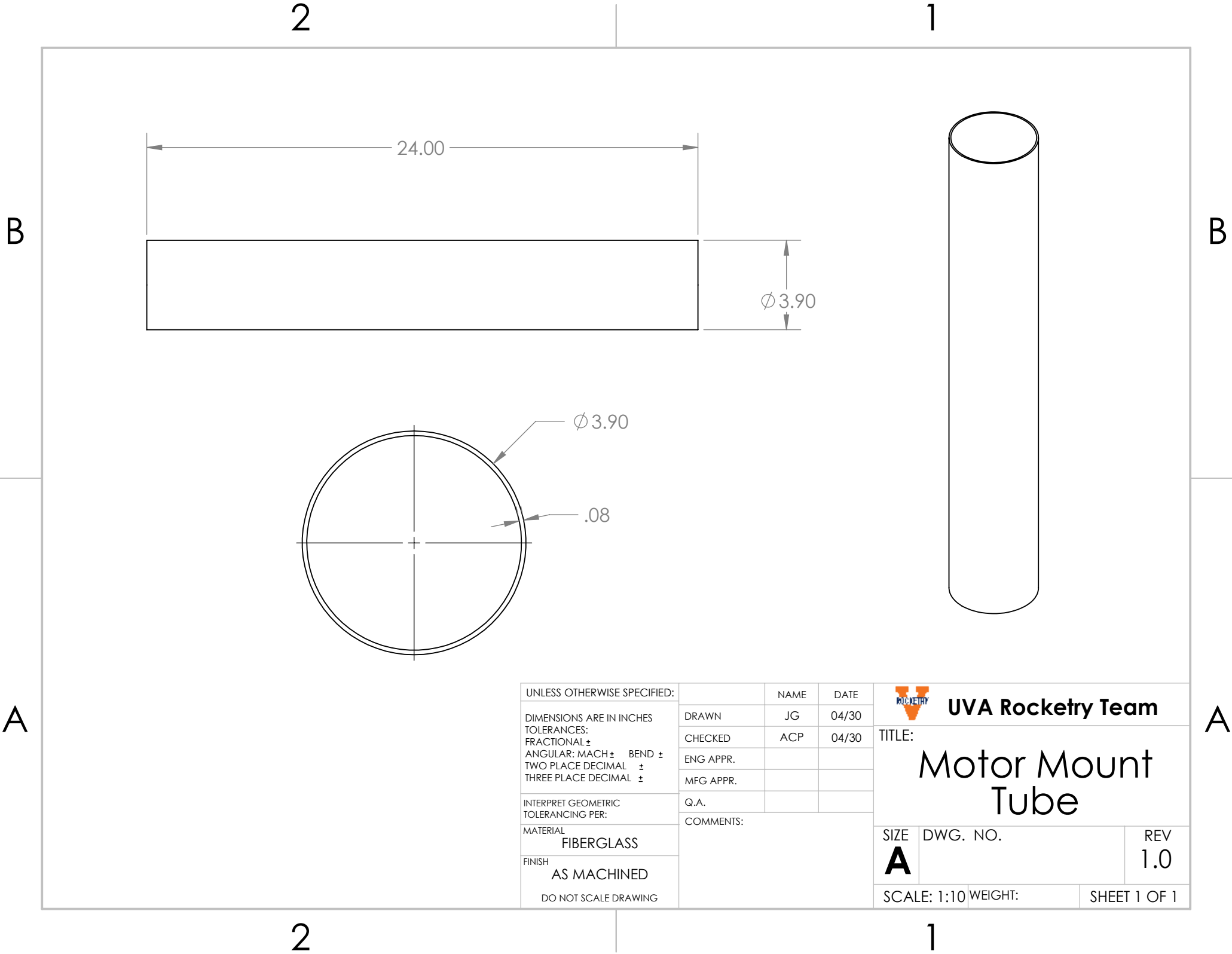


UVA Rocketry Team

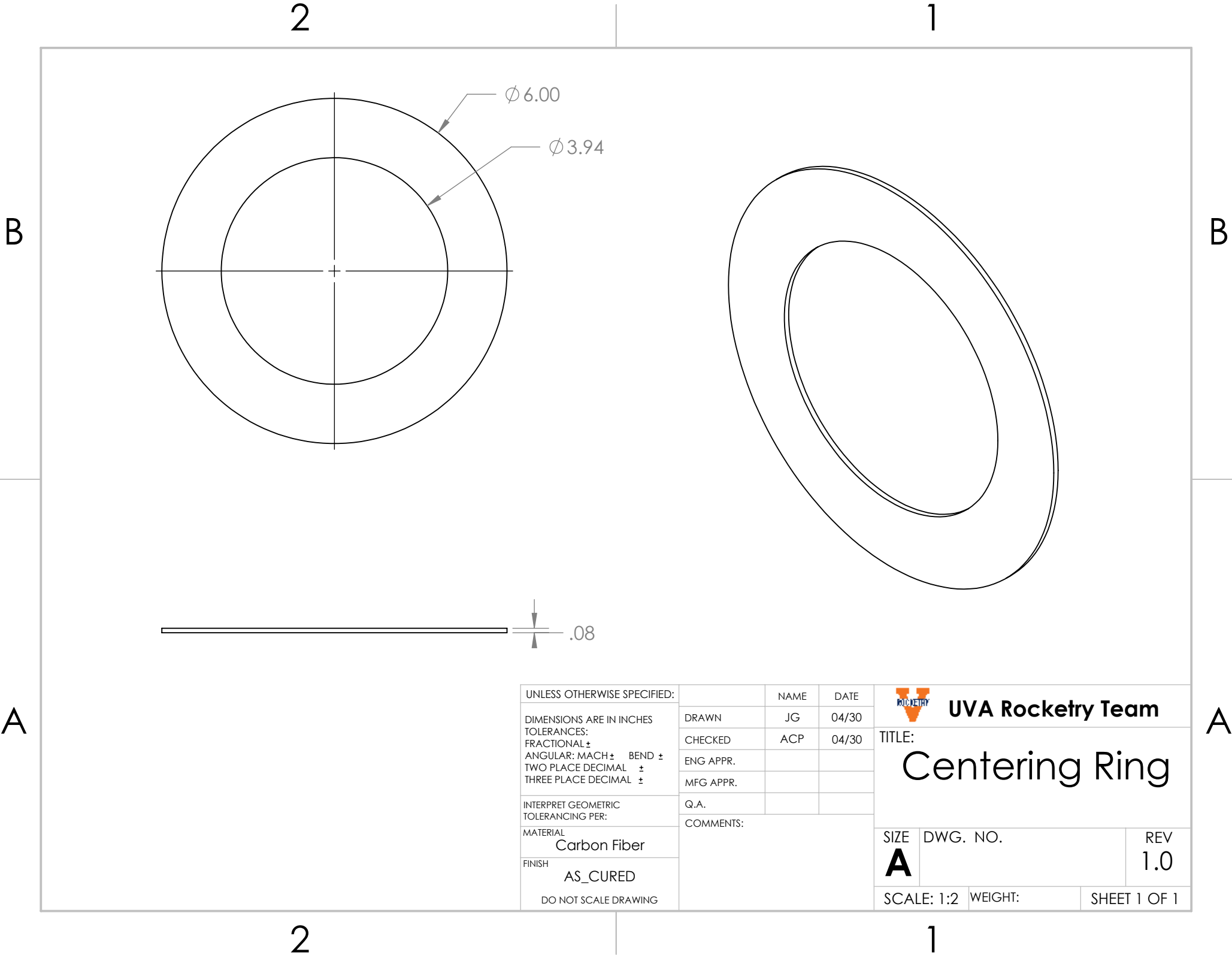
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Booster Tube

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	Q.A.			
	COMMENTS:			



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THREE PLACE DECIMAL $\pm$

INTERPRET GEOMETRIC
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MATERIAL
Carbon Fiber

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UVA Rocketry Team

TITLE:

Centering Ring

SIZE

A

DWG. NO.

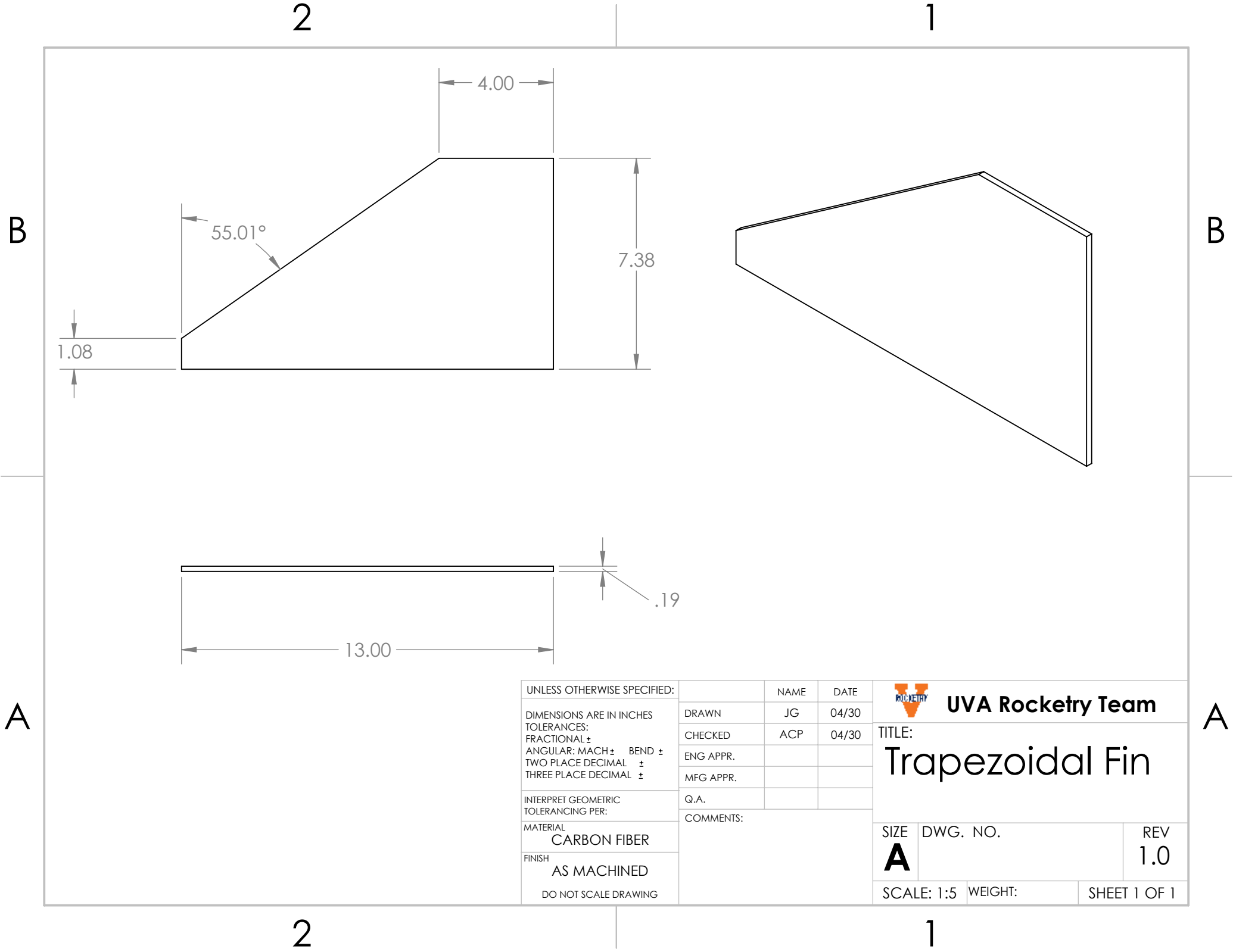
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SHEET 1 OF 1



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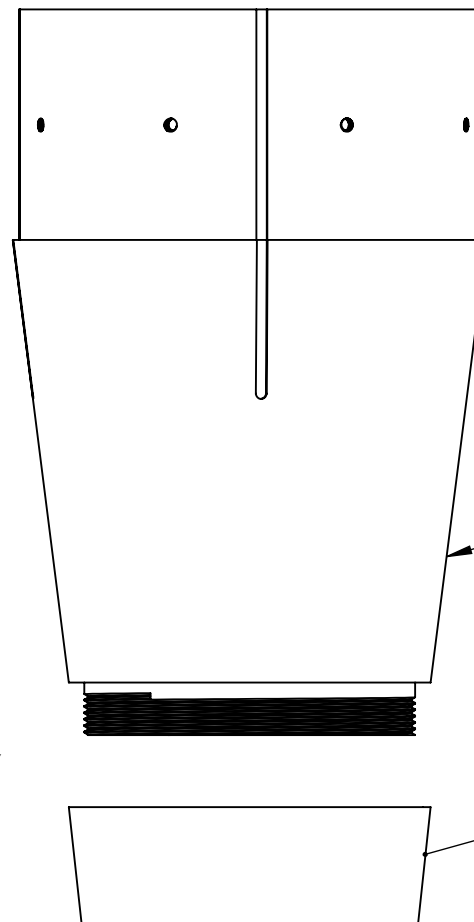
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2

1

ITEM NO.	PART NUMBER	QTY.
1	41_S3 (Boattail Upper)	1
2	40_S3 (Boattail Lower)	1



NOTE: VENDOR TO PHYSICALLY ASSEMBLE PARTS 41_S3 Boattail Upper and 40_S3 Boattail Lower TO VERIFY THREAD FIT PRIOR TO SHIPPING: PARTS MUST ASSEMBLE FULLY BY HAND

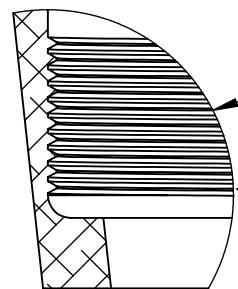
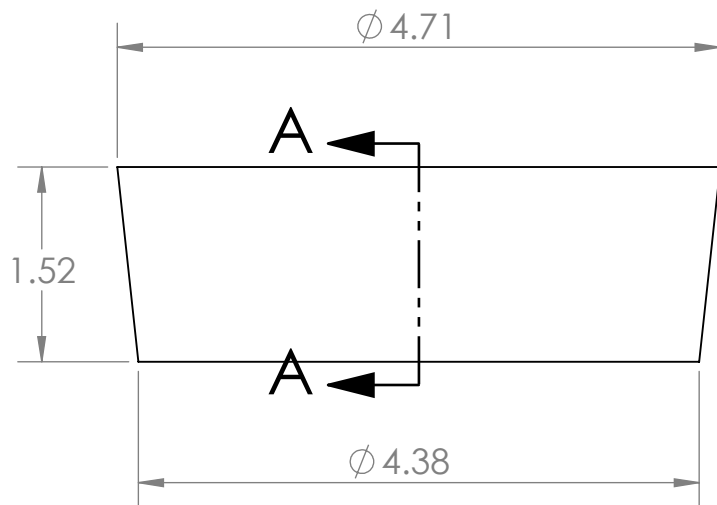
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INTERPRET GEOMETRIC TOLERANCING PER:		Q.A.			TITLE: 42_S3 Boattail Assembly		
MATERIAL		COMMENTS:					
6061-T6 AL							
FINISH							
AS-MACHINED							
DO NOT SCALE DRAWING		SIZE		DWG. NO.		REV	
		A				1.0	
		SCALE: 1:4		WEIGHT:		SHEET 1 OF 1	

2

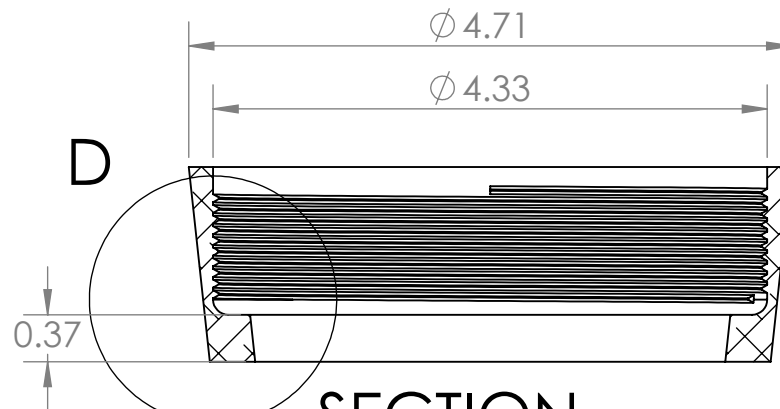
1

B



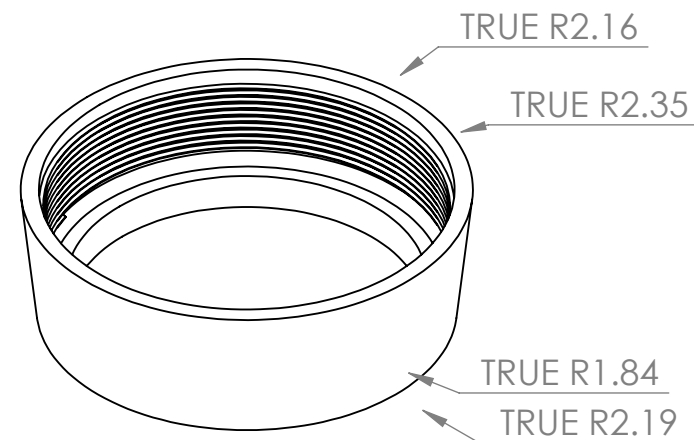
DETAIL D

SCALE 1 : 1



SECTION A-A

SCALE 1 : 1.5

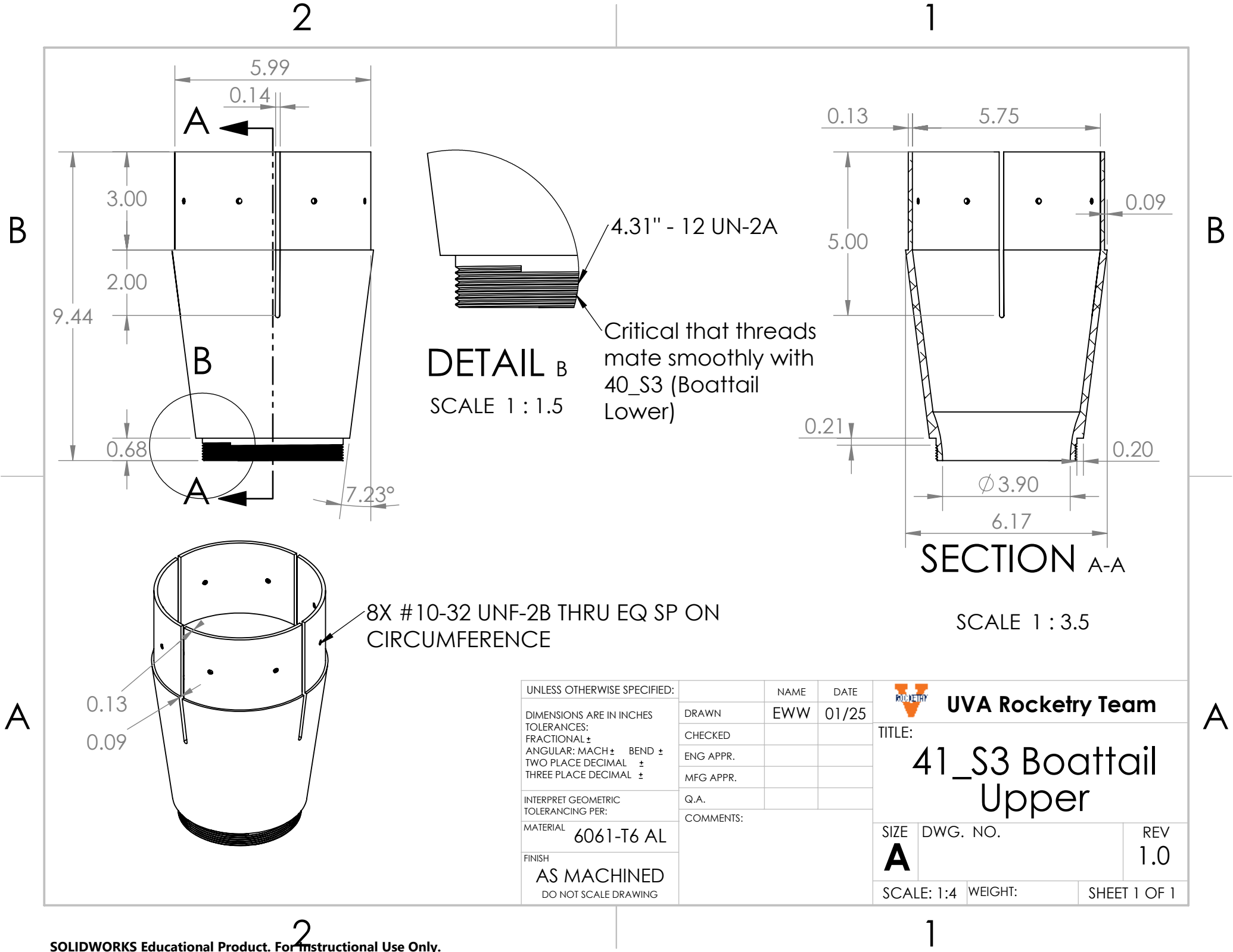


A

UNLESS OTHERWISE SPECIFIED:		NAME	DATE	 UVA Rocketry Team TITLE: 40_S3 Boattail Lower
DIMENSIONS ARE IN INCHES		DRAWN	EWV	
TOLERANCES:		CHECKED		
FRACTIONAL ±		ENG APPR.		
ANGULAR: MACH ± BEND ±		MFG APPR.		
TWO PLACE DECIMAL ±		Q.A.		SIZE DWG. NO. REV A 1.0
THREE PLACE DECIMAL ±		COMMENTS:		
INTERPRET GEOMETRIC TOLERANCING PER:				SCALE: 1:2
MATERIAL				WEIGHT:
6061-T6 AL				SHEET 1 OF 1
FINISH				
AS MACHINED				
DO NOT SCALE DRAWING				

B

A



DETAIL B
SCALE 1 : 1.5

4.31" - 12 UN-2A
Critical that threads
mate smoothly with
40_S3 (Boattail
Lower)

SECTION A-A

SCALE 1 : 3.5

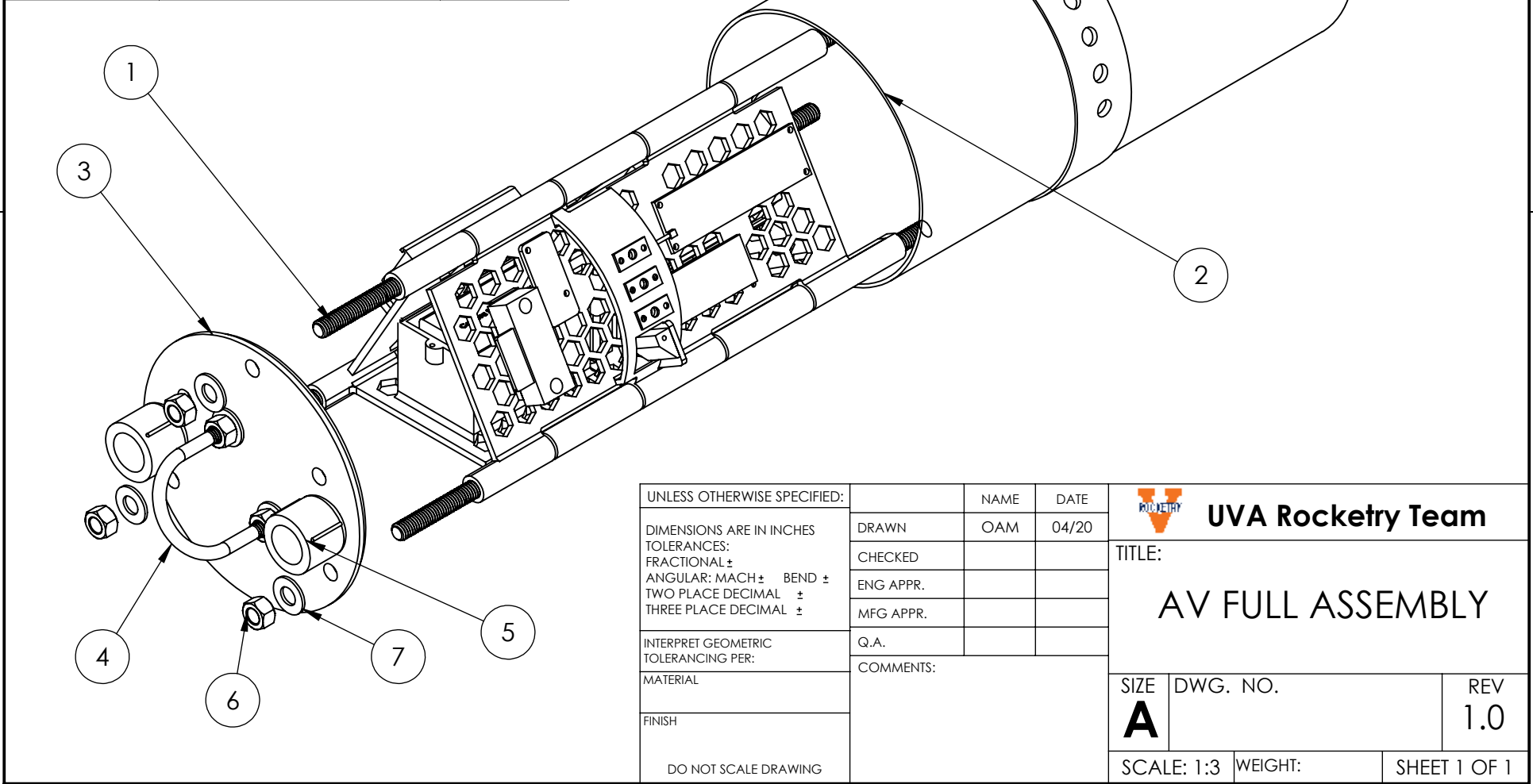
8X #10-32 UNF-2B THRU EQ SP ON
CIRCUMFERENCE

UNLESS OTHERWISE SPECIFIED:		NAME	DATE	 UVA Rocketry Team	
DIMENSIONS ARE IN INCHES		DRAWN	EWV		
TOLERANCES:		CHECKED			
FRACTIONAL ±		ENG APPR.			
ANGULAR: MACH ± BEND ±		MFG APPR.			
TWO PLACE DECIMAL ±		Q.A.		TITLE: 41_S3 Boattail Upper	
THREE PLACE DECIMAL ±		COMMENTS:			
INTERPRET GEOMETRIC TOLERANCING PER:				SIZE	DWG. NO.
MATERIAL				A	
FINISH					REV
AS MACHINED					1.0
DO NOT SCALE DRAWING				SCALE: 1:4	WEIGHT:
				SHEET 1 OF 1	

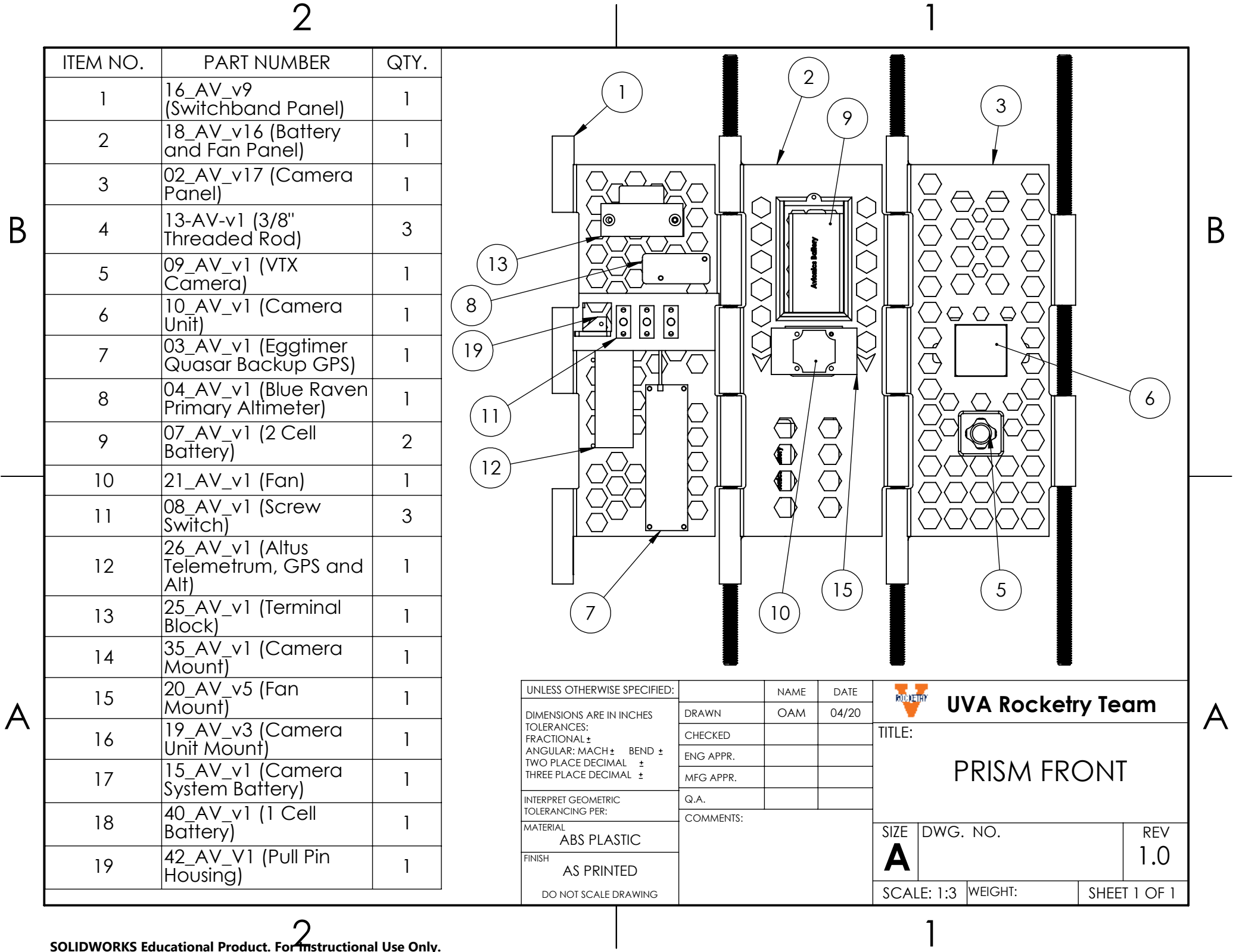
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Drawings for the components of the Recovery Subsystems are found starting on the next page.

ITEM NO.	PART NUMBER	QTY.
1	Prism Assembly	1
2	27_AV_v1 (Coupler Tube)	1
3	Bulkhead	2
4	3/8" U-Bolt	2
5	PVC Charge Well	2
6	3/8" Hex Nut	14
7	3/8" Washer	14



UNLESS OTHERWISE SPECIFIED:		NAME	DATE	 UVA Rocketry Team	
DIMENSIONS ARE IN INCHES		DRAWN	OAM		
TOLERANCES:		CHECKED		TITLE:	
FRACTIONAL ±		ENG APPR.			
ANGULAR: MACH ± BEND ±		MFG APPR.			
TWO PLACE DECIMAL ±		Q.A.		AV FULL ASSEMBLY	
THREE PLACE DECIMAL ±		COMMENTS:			
INTERPRET GEOMETRIC TOLERANCING PER:		SIZE		DWG. NO.	REV
MATERIAL		A			1.0
FINISH		SCALE: 1:3		WEIGHT:	SHEET 1 OF 1
DO NOT SCALE DRAWING					



UNLESS OTHERWISE SPECIFIED:

DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL ±
ANGULAR: MACH ± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±

INTERPRET GEOMETRIC
TOLERANCING PER:

MATERIAL
ABS PLASTIC

FINISH
AS PRINTED

DO NOT SCALE DRAWING

	NAME	DATE
DRAWN	OAM	04/20
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		

COMMENTS:



UVA Rocketry Team

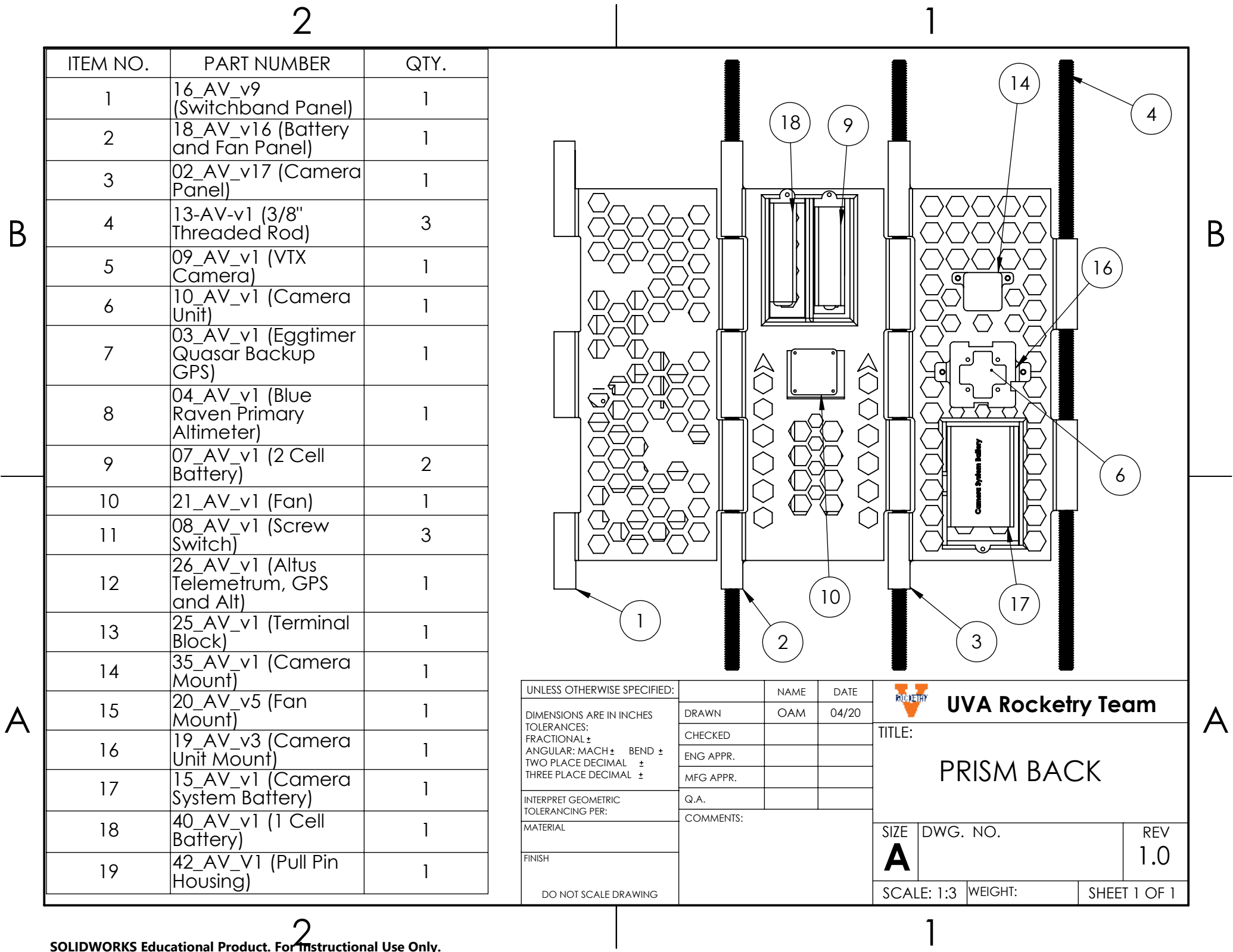
TITLE:

PRISM FRONT

SIZE	DWG. NO.	REV
A		1.0

SCALE: 1:3	WEIGHT:	SHEET 1 OF 1
------------	---------	--------------

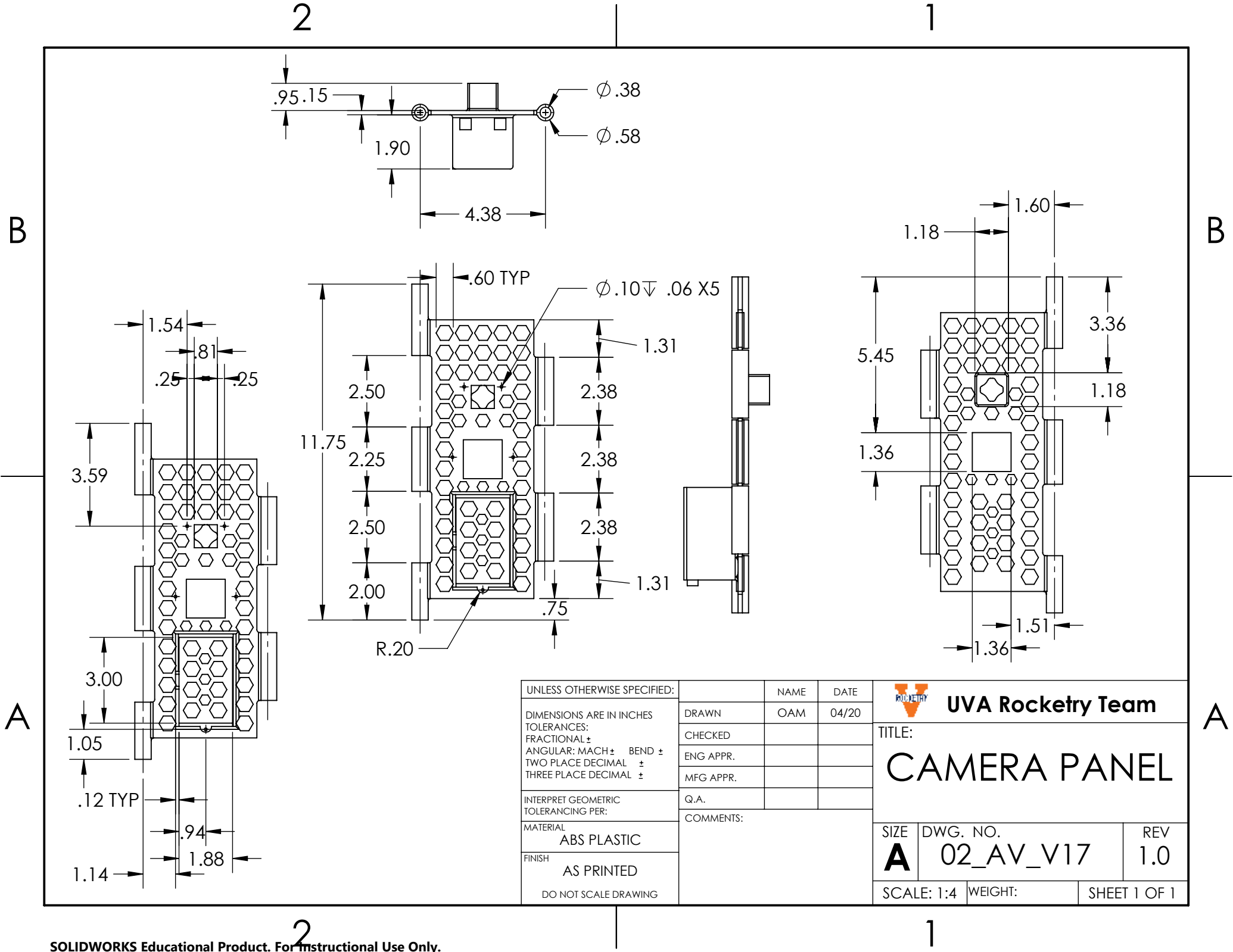
ITEM NO.	PART NUMBER	QTY.
1	16_AV_v9 (Switchband Panel)	1
2	18_AV_v16 (Battery and Fan Panel)	1
3	02_AV_v17 (Camera Panel)	1
4	13-AV-v1 (3/8" Threaded Rod)	3
5	09_AV_v1 (VTX Camera)	1
6	10_AV_v1 (Camera Unit)	1
7	03_AV_v1 (Egg timer Quasar Backup GPS)	1
8	04_AV_v1 (Blue Raven Primary Altimeter)	1
9	07_AV_v1 (2 Cell Battery)	2
10	21_AV_v1 (Fan)	1
11	08_AV_v1 (Screw Switch)	3
12	26_AV_v1 (Altus Telemetrum, GPS and Alt)	1
13	25_AV_v1 (Terminal Block)	1
14	35_AV_v1 (Camera Mount)	1
15	20_AV_v5 (Fan Mount)	1
16	19_AV_v3 (Camera Unit Mount)	1
17	15_AV_v1 (Camera System Battery)	1
18	40_AV_v1 (1 Cell Battery)	1
19	42_AV_V1 (Pull Pin Housing)	1



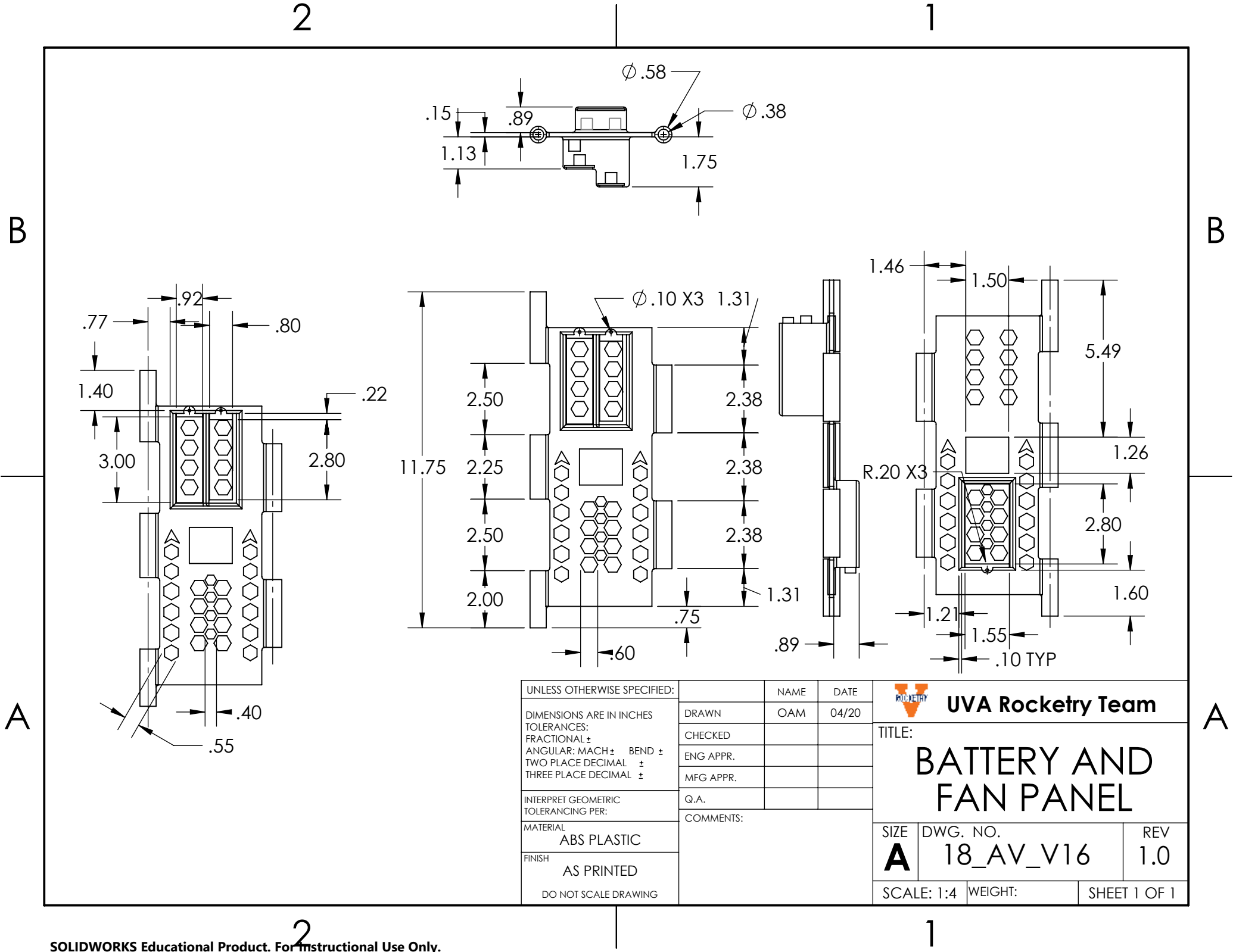
ITEM NO.	PART NUMBER	QTY.
1	16_AV_v9 (Switchband Panel)	1
2	18_AV_v16 (Battery and Fan Panel)	1
3	02_AV_v17 (Camera Panel)	1
4	13-AV-v1 (3/8" Threaded Rod)	3
5	09_AV_v1 (VTX Camera)	1
6	10_AV_v1 (Camera Unit)	1
7	03_AV_v1 (Eggtimer Quasar Backup GPS)	1
8	04_AV_v1 (Blue Raven Primary Altimeter)	1
9	07_AV_v1 (2 Cell Battery)	2
10	21_AV_v1 (Fan)	1
11	08_AV_v1 (Screw Switch)	3
12	26_AV_v1 (Altus Telemetry, GPS and Alt)	1
13	25_AV_v1 (Terminal Block)	1
14	35_AV_v1 (Camera Mount)	1
15	20_AV_v5 (Fan Mount)	1
16	19_AV_v3 (Camera Unit Mount)	1
17	15_AV_v1 (Camera System Battery)	1
18	40_AV_v1 (1 Cell Battery)	1
19	42_AV_V1 (Pull Pin Housing)	1

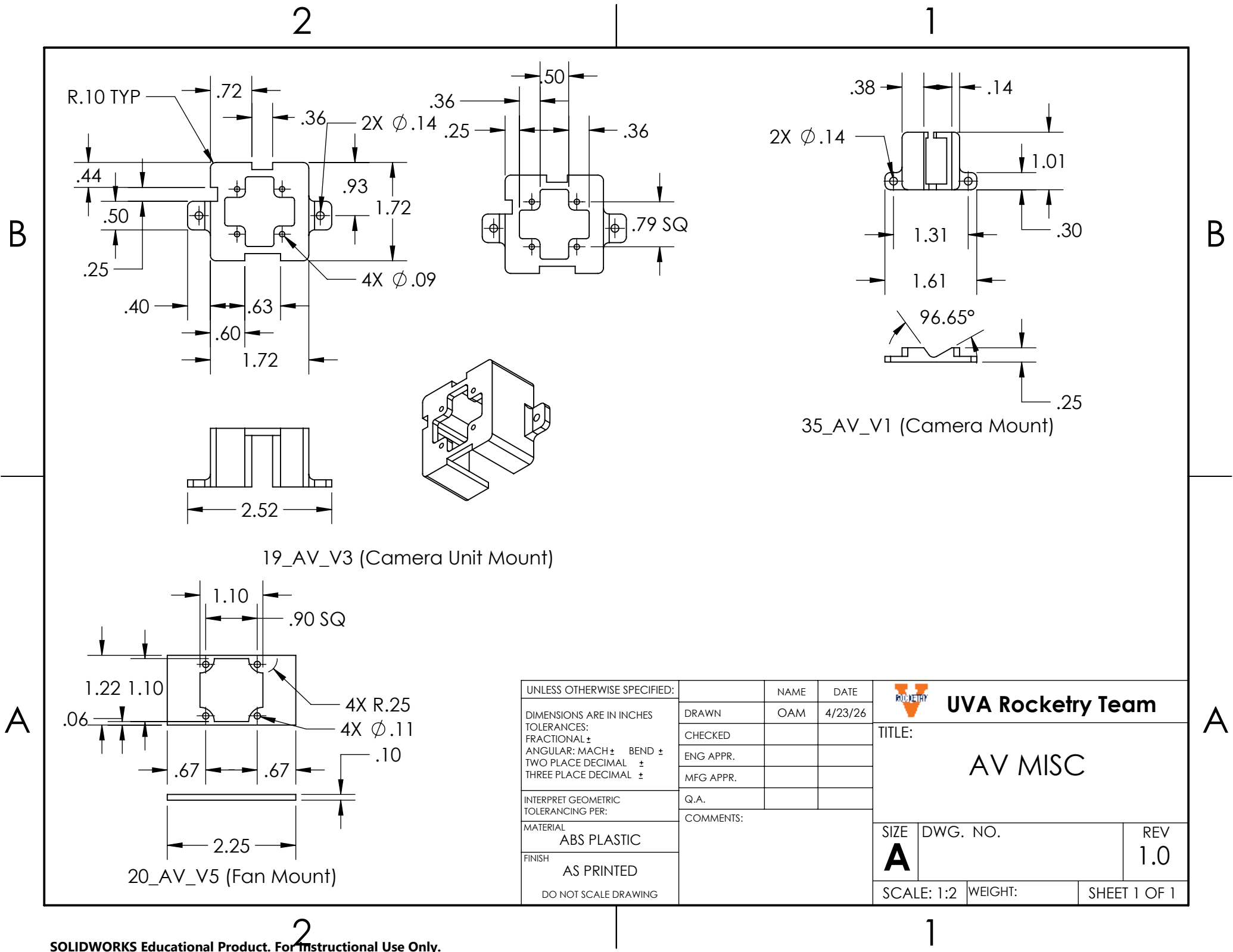
UNLESS OTHERWISE SPECIFIED:		NAME	DATE
DIMENSIONS ARE IN INCHES	DRAWN	OAM	04/20
TOLERANCES:	CHECKED		
FRACTIONAL ±	ENG APPR.		
ANGULAR: MACH ± BEND ±	MFG APPR.		
TWO PLACE DECIMAL ±	Q.A.		
THREE PLACE DECIMAL ±	COMMENTS:		
INTERPRET GEOMETRIC TOLERANCING PER:			
MATERIAL			
FINISH			
DO NOT SCALE DRAWING			

UVA Rocketry Team			
TITLE: PRISM BACK			
SIZE	DWG. NO.		REV
A			1.0
SCALE: 1:3		WEIGHT:	SHEET 1 OF 1

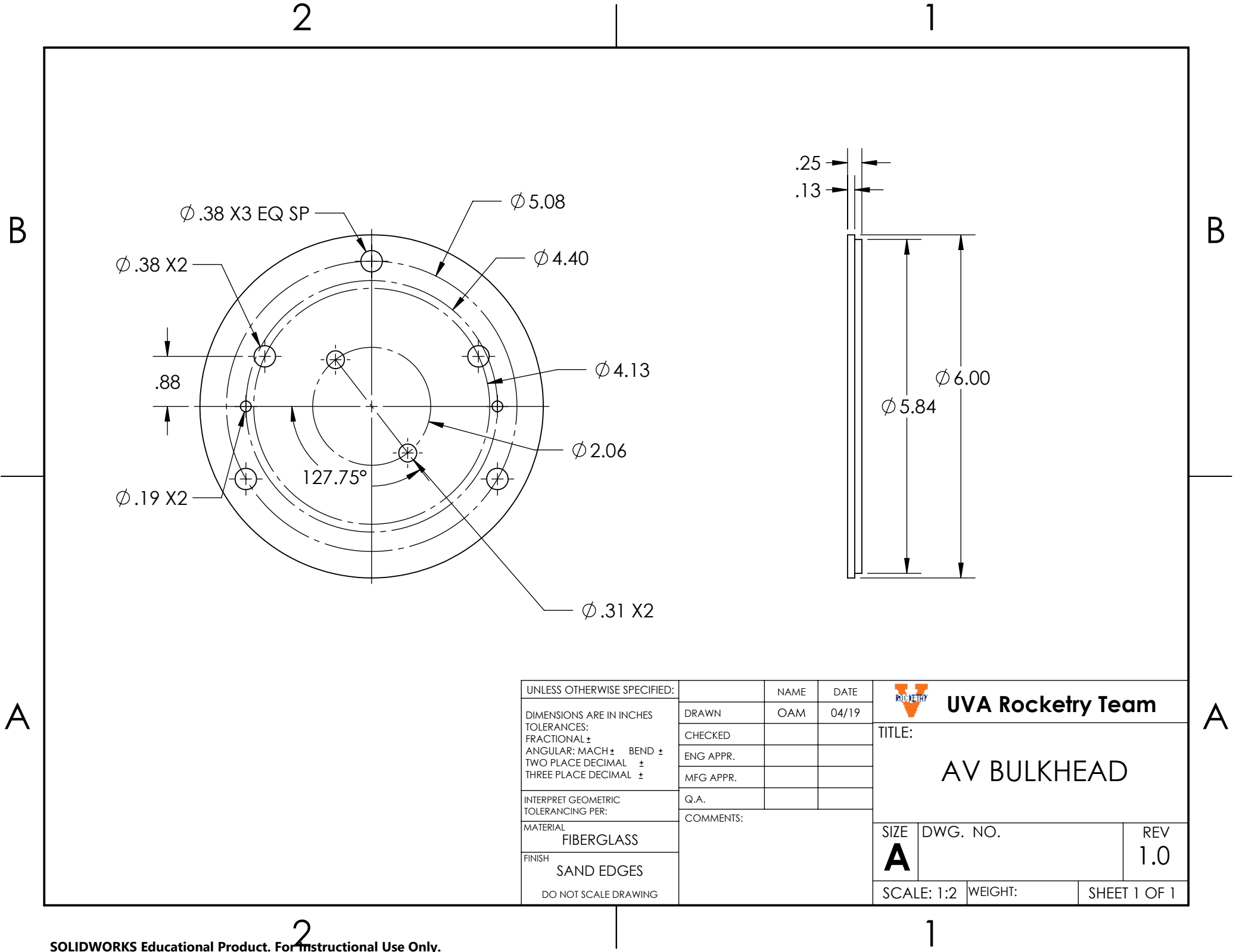






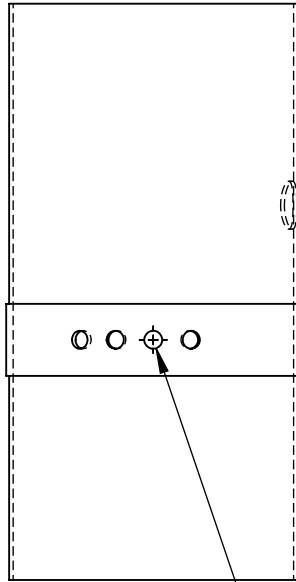
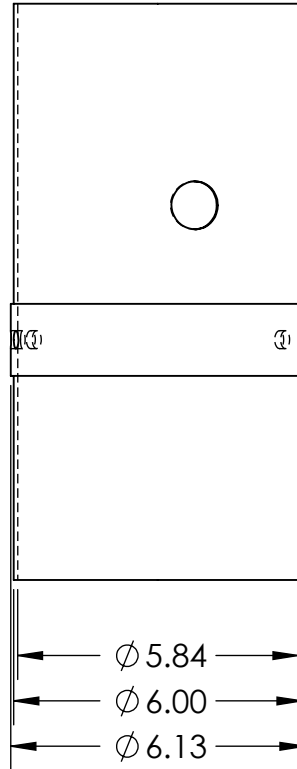
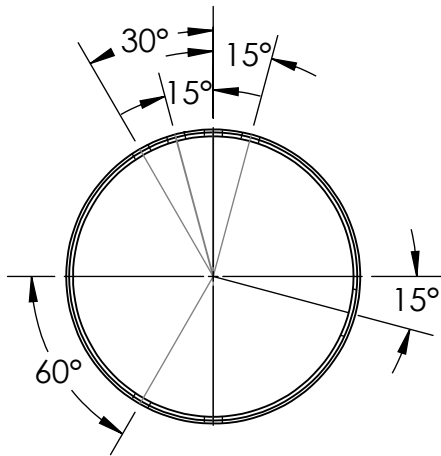


UNLESS OTHERWISE SPECIFIED:		NAME		DATE		 UVA Rocketry Team					
DIMENSIONS ARE IN INCHES		DRAWN		OAM		4/23/26					
TOLERANCES:		CHECKED				TITLE: AV MISC					
FRACTIONAL ±											
ANGULAR: MACH ± BEND ±		ENG APPR.									
TWO PLACE DECIMAL ±											
THREE PLACE DECIMAL ±		MFG APPR.									
INTERPRET GEOMETRIC TOLERANCING PER:		Q.A.									
MATERIAL		COMMENTS:				SIZE		DWG. NO.		REV	
ABS PLASTIC						A				1.0	
FINISH											
AS PRINTED						SCALE: 1:2		WEIGHT:		SHEET 1 OF 1	
DO NOT SCALE DRAWING											



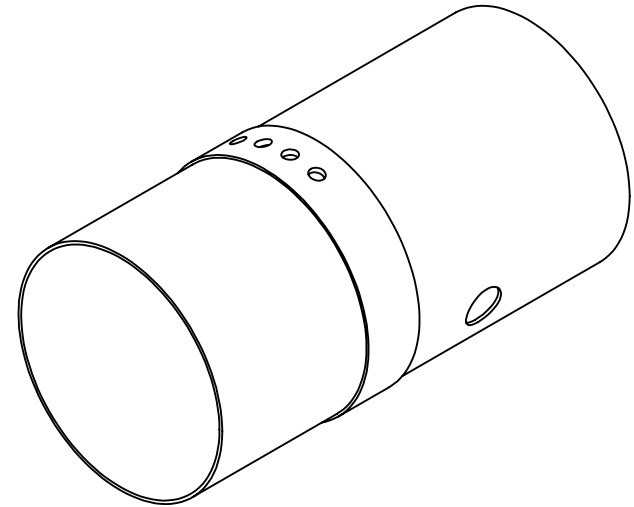
UNLESS OTHERWISE SPECIFIED:		NAME	DATE	 UVA Rocketry Team			
DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ± ANGULAR: MACH ± BEND ± TWO PLACE DECIMAL ± THREE PLACE DECIMAL ±		DRAWN	OAM	04/19	TITLE: AV BULKHEAD		
		CHECKED					
		ENG APPR.					
		MFG APPR.					
INTERPRET GEOMETRIC TOLERANCING PER:		Q.A.					
MATERIAL FIBERGLASS		COMMENTS:			SIZE A	DWG. NO.	REV 1.0
FINISH SAND EDGES							
DO NOT SCALE DRAWING					SCALE: 1:2 WEIGHT: SHEET 1 OF 1		

B

 $\phi .38 \times 6$ 

1.50

4.25

 $\phi 5.84$ $\phi 6.00$ $\phi 6.13$ CAMERA PORT HOLE IS $\phi 1.00$

B

A

UNLESS OTHERWISE SPECIFIED:		NAME		DATE		 UVA Rocketry Team		
DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ± ANGULAR: MACH ± BEND ± TWO PLACE DECIMAL ± THREE PLACE DECIMAL ±		DRAWN	OAM	04/19		TITLE: COUPLER TUBE		
		CHECKED						
		ENG APPR.						
		MFG APPR.						
INTERPRET GEOMETRIC TOLERANCING PER:		Q.A.				SIZE A		
MATERIAL FIBERGLASS		COMMENTS:			DWG. NO.			
FINISH AS MACHINED DO NOT SCALE DRAWING					REV 1.0			
					SCALE: 1:4			
				WEIGHT:		SHEET 1 OF 1		

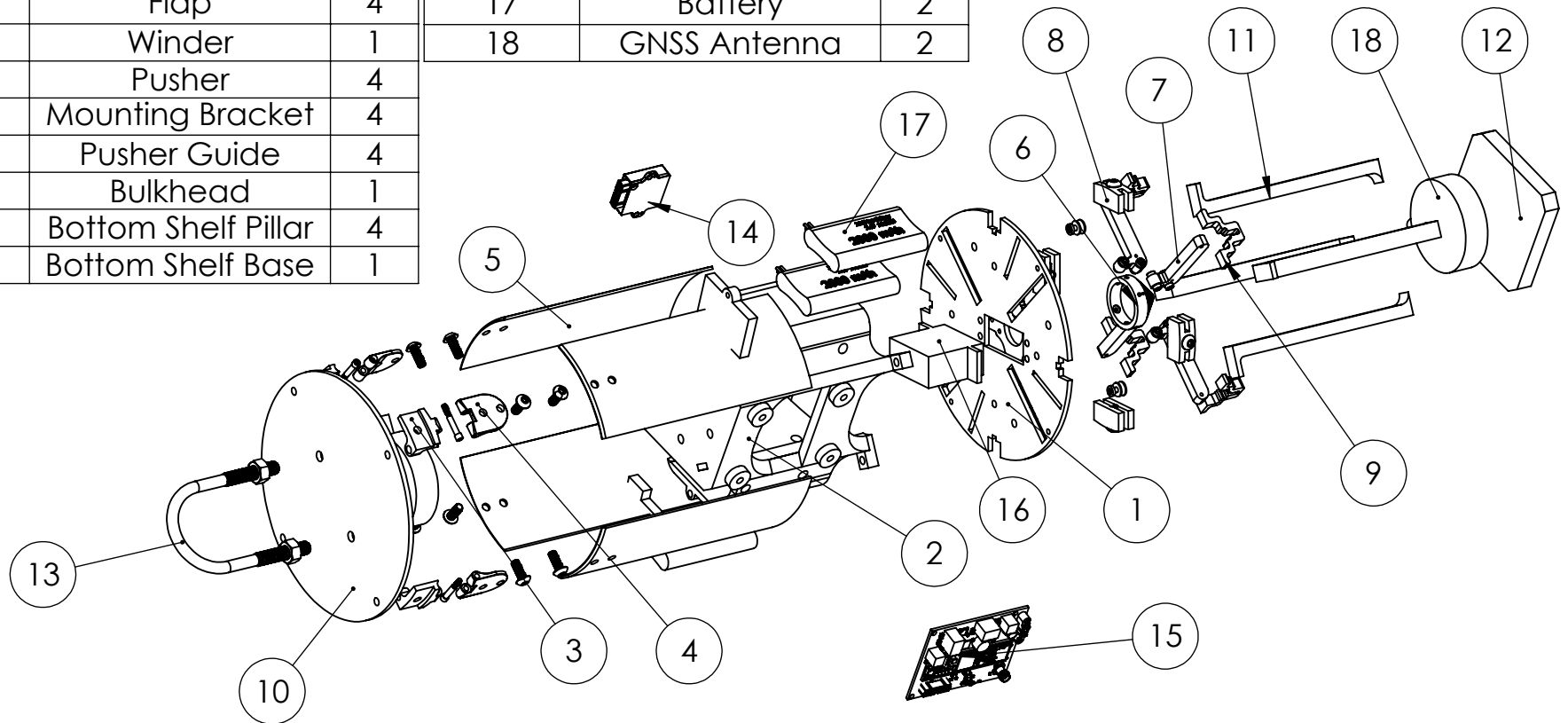
F.3 Airbrakes Drawings

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Drawings for the components of the Airbrakes Subsystems are found starting on the next page.

B

ITEM NO.	PART	QTY.	ITEM NO.	PART	QTY.
1	Baseplate	1	13	U-Bolt	1
2	Shelf	1	14	VectorNav IMU	1
3	Upper Hinge	4	15	PCB	1
4	Lower Hinge	4	16	Servo	1
5	Flap	4	17	Battery	2
6	Winder	1	18	GNSS Antenna	2
7	Pusher	4			
8	Mounting Bracket	4			
9	Pusher Guide	4			
10	Bulkhead	1			
11	Bottom Shelf Pillar	4			
12	Bottom Shelf Base	1			

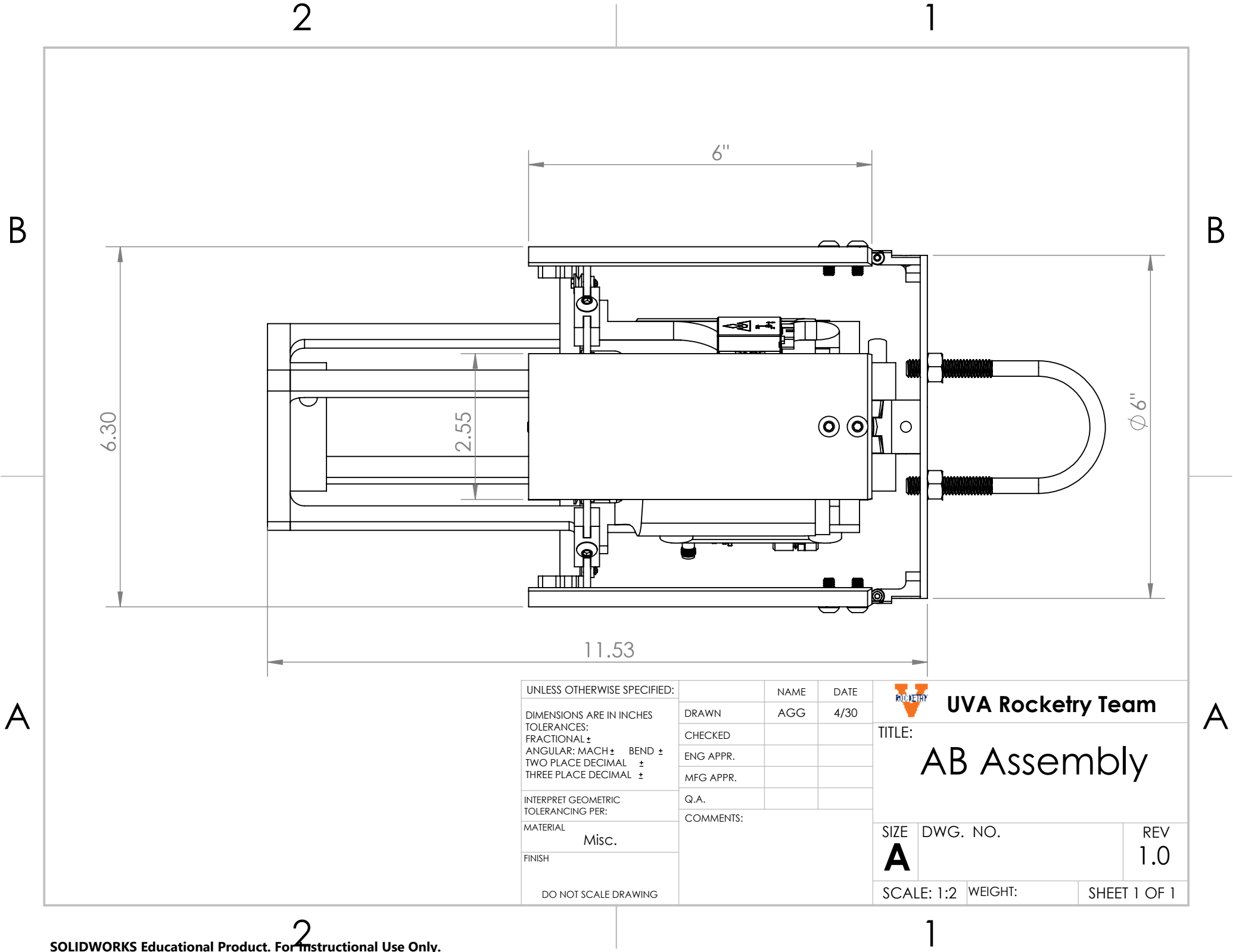


B

A

UNLESS OTHERWISE SPECIFIED:		NAME	DATE	 UVA Rocketry Team
DIMENSIONS ARE IN INCHES		DRAWN	AGG	
TOLERANCES:		CHECKED		
FRACTIONAL ±		ENG APPR.		
ANGULAR: MACH ± BEND ±		MFG APPR.		
TWO PLACE DECIMAL ±		Q.A.		TITLE: AB Assembly
THREE PLACE DECIMAL ±		COMMENTS:		
INTERPRET GEOMETRIC TOLERANCING PER:				SIZE DWG. NO. REV A 1.0
MATERIAL				
FINISH				SCALE: 1:4 WEIGHT: SHEET 1 OF 1
DO NOT SCALE DRAWING				

A

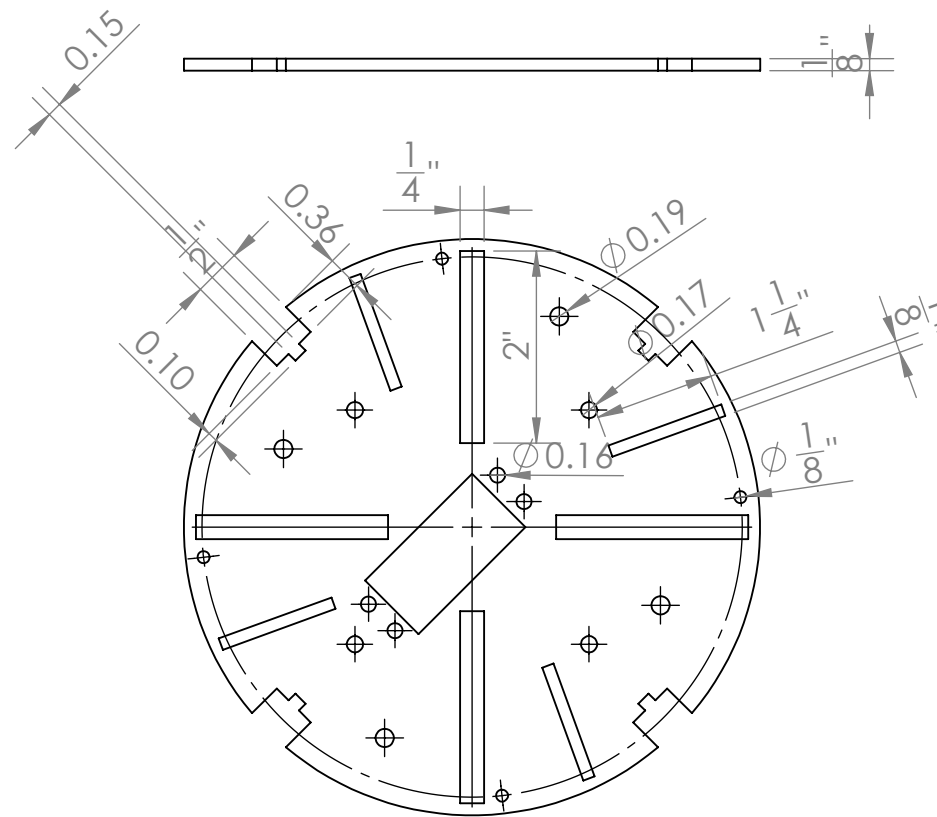


2

1

B

B



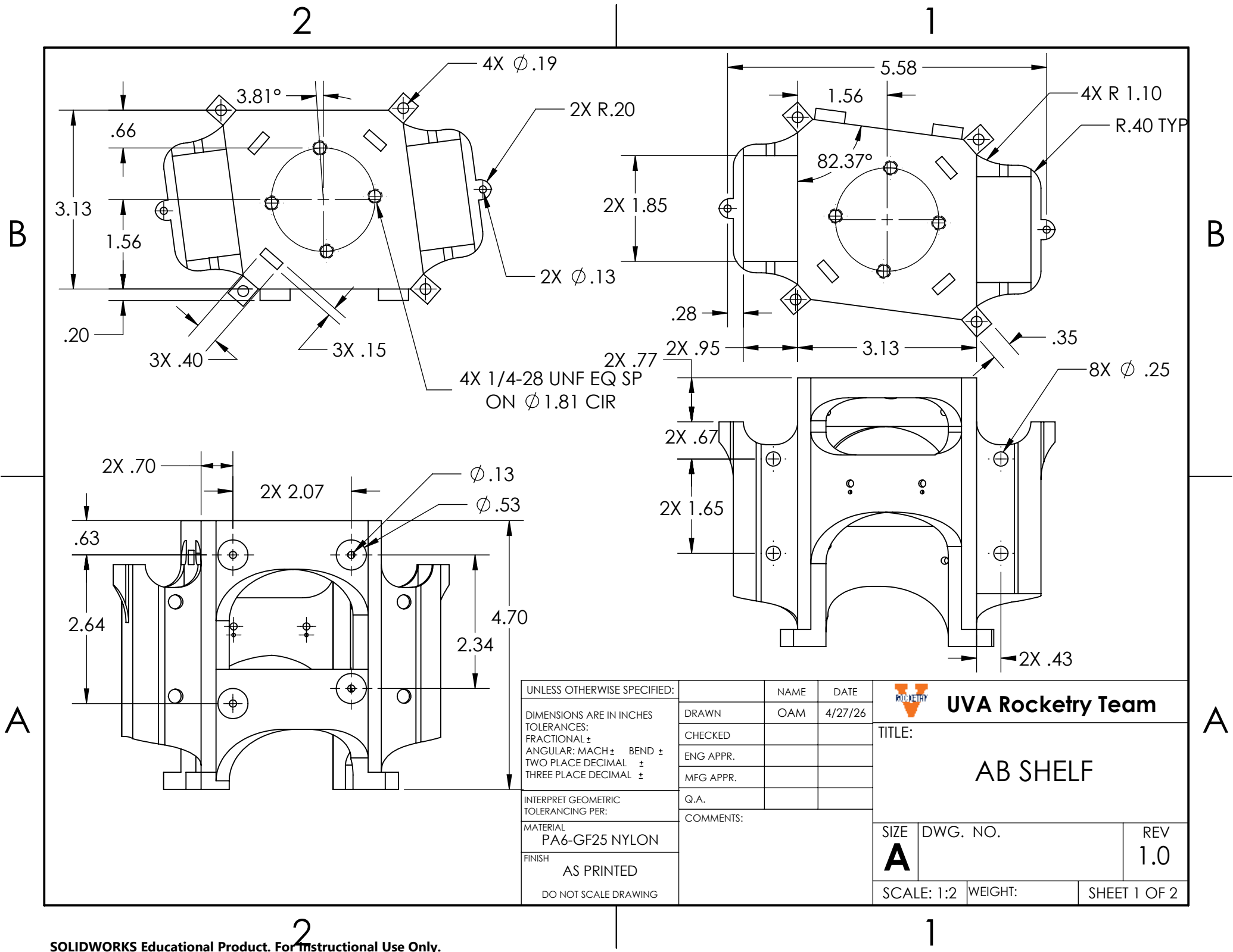
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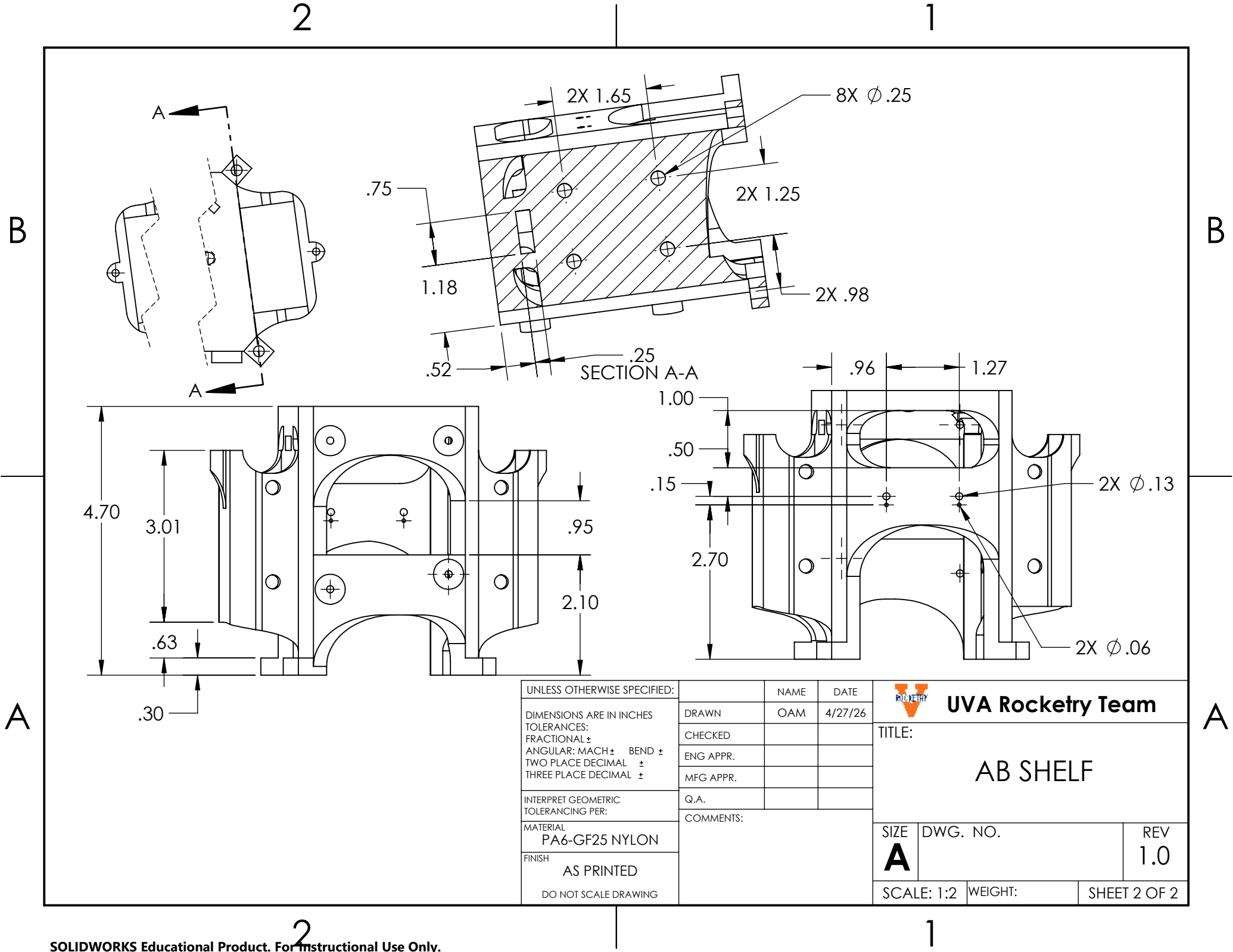
A

UNLESS OTHERWISE SPECIFIED:		NAME	DATE	 UVA Rocketry Team
DIMENSIONS ARE IN INCHES		DRAWN	AGG	
TOLERANCES:		CHECKED		
FRACTIONAL ±		ENG APPR.		
ANGULAR: MACH ± BEND ±		MFG APPR.		
TWO PLACE DECIMAL ±		Q.A.		Base Plate
THREE PLACE DECIMAL ±		COMMENTS:		
INTERPRET GEOMETRIC TOLERANCING PER:				SIZE A DWG. NO. REV 1.0
MATERIAL				SCALE: 1:2 WEIGHT: SHEET 1 OF 1
Carbon Fiber				
FINISH				
Top: Gloss				
Bottom: Peel Ply				
DO NOT SCALE DRAWING				

2

1





UNLESS OTHERWISE SPECIFIED:

DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL $\pm$
ANGULAR: MACH $\pm$ BEND $\pm$
TWO PLACE DECIMAL $\pm$
THREE PLACE DECIMAL $\pm$

INTERPRET GEOMETRIC
TOLERANCING PER:

MATERIAL
PA6-GF25 NYLON

FINISH
AS PRINTED

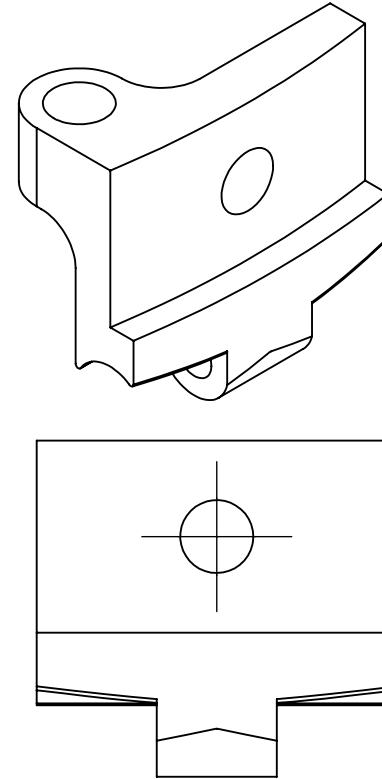
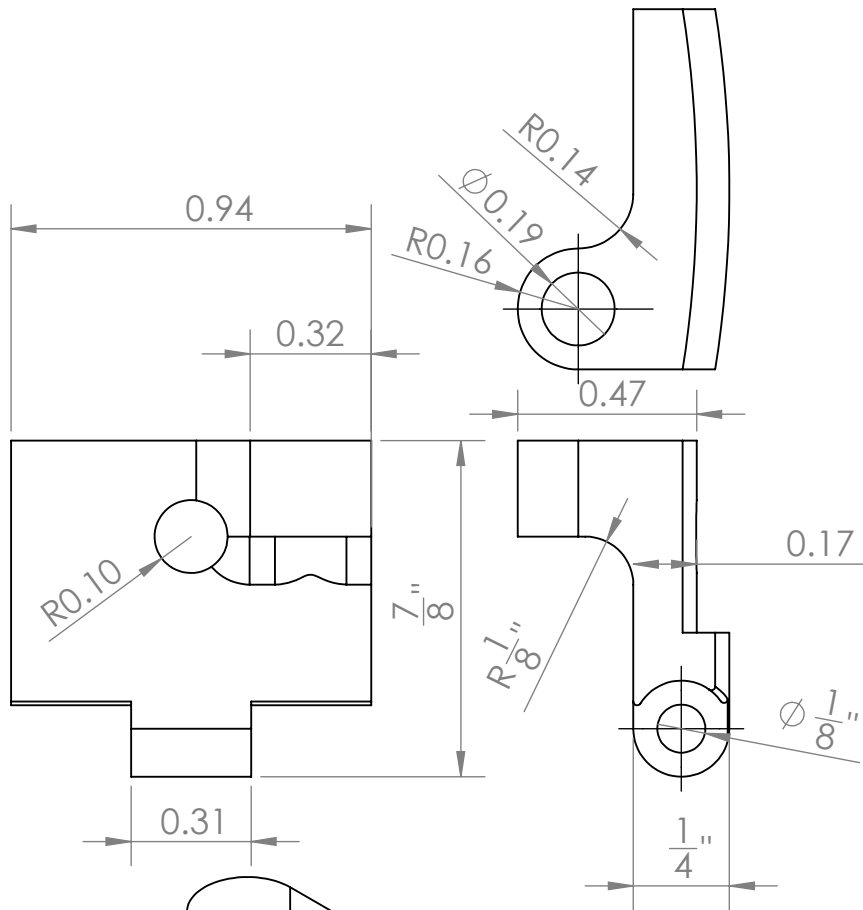
DO NOT SCALE DRAWING

NAME	DATE
DRAWN	OAM 4/27/26
CHECKED	
ENG APPR.	
MFG APPR.	
Q.A.	
COMMENTS:	

UVA Rocketry Team		
TITLE: AB SHELF		
SIZE A	DWG. NO.	REV 1.0
SCALE: 1:2	WEIGHT:	SHEET 2 OF 2

B

B



A

UNLESS OTHERWISE SPECIFIED:

DIMENSIONS ARE IN INCHES
 TOLERANCES:
 FRACTIONAL $\pm$
 ANGULAR: MACH $\pm$ BEND $\pm$
 TWO PLACE DECIMAL $\pm$
 THREE PLACE DECIMAL $\pm$

INTERPRET GEOMETRIC
 TOLERANCING PER:

MATERIAL
 Aluminum 6061

FINISH
 As Machined

DO NOT SCALE DRAWING

DRAWN

NAME

AG

DATE

4/30

CHECKED

ENG APPR.

MFG APPR.

Q.A.

COMMENTS:



UVA Rocketry Team

TITLE:

Upper Hinge

SIZE

A

DWG. NO.

REV

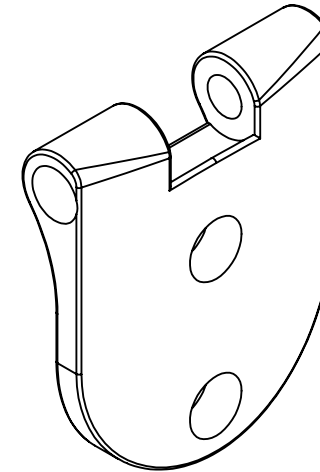
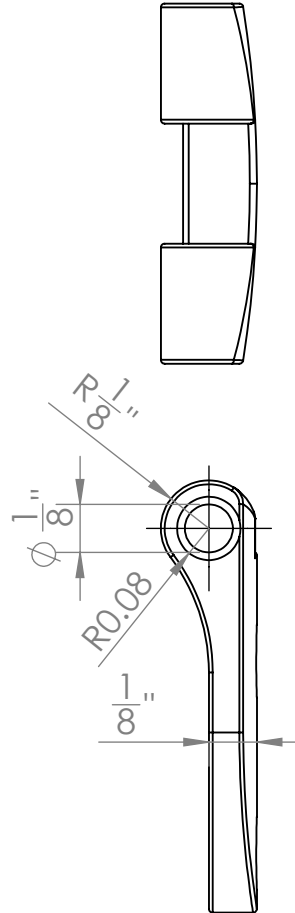
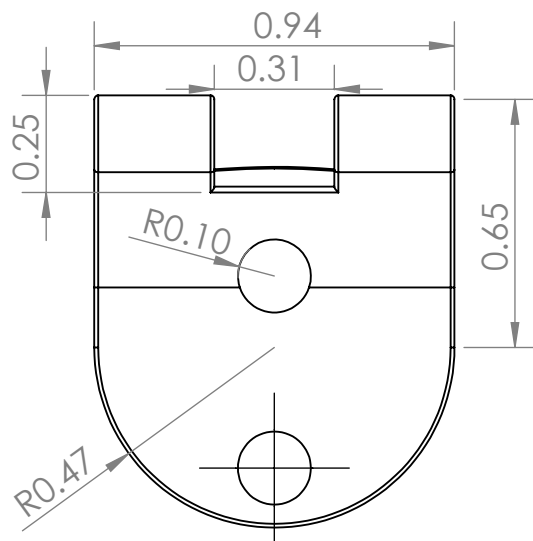
1.0

SCALE: 2:1

WEIGHT:

SHEET 1 OF 1

B

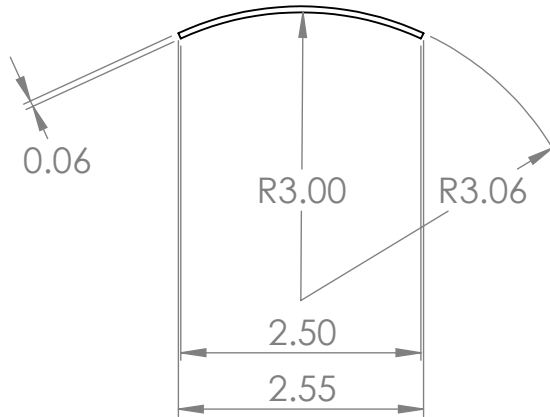
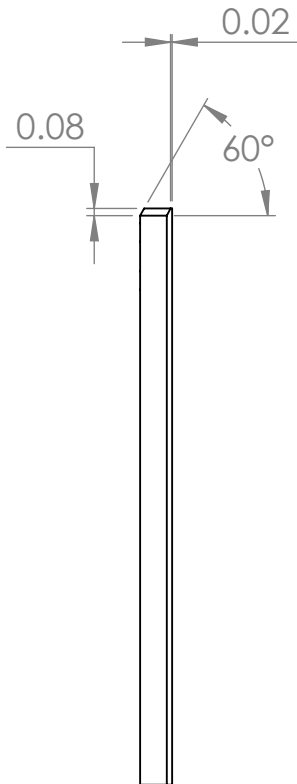
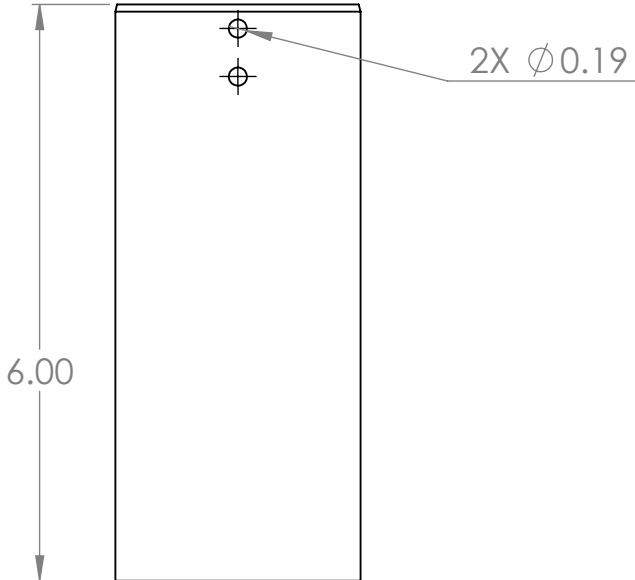
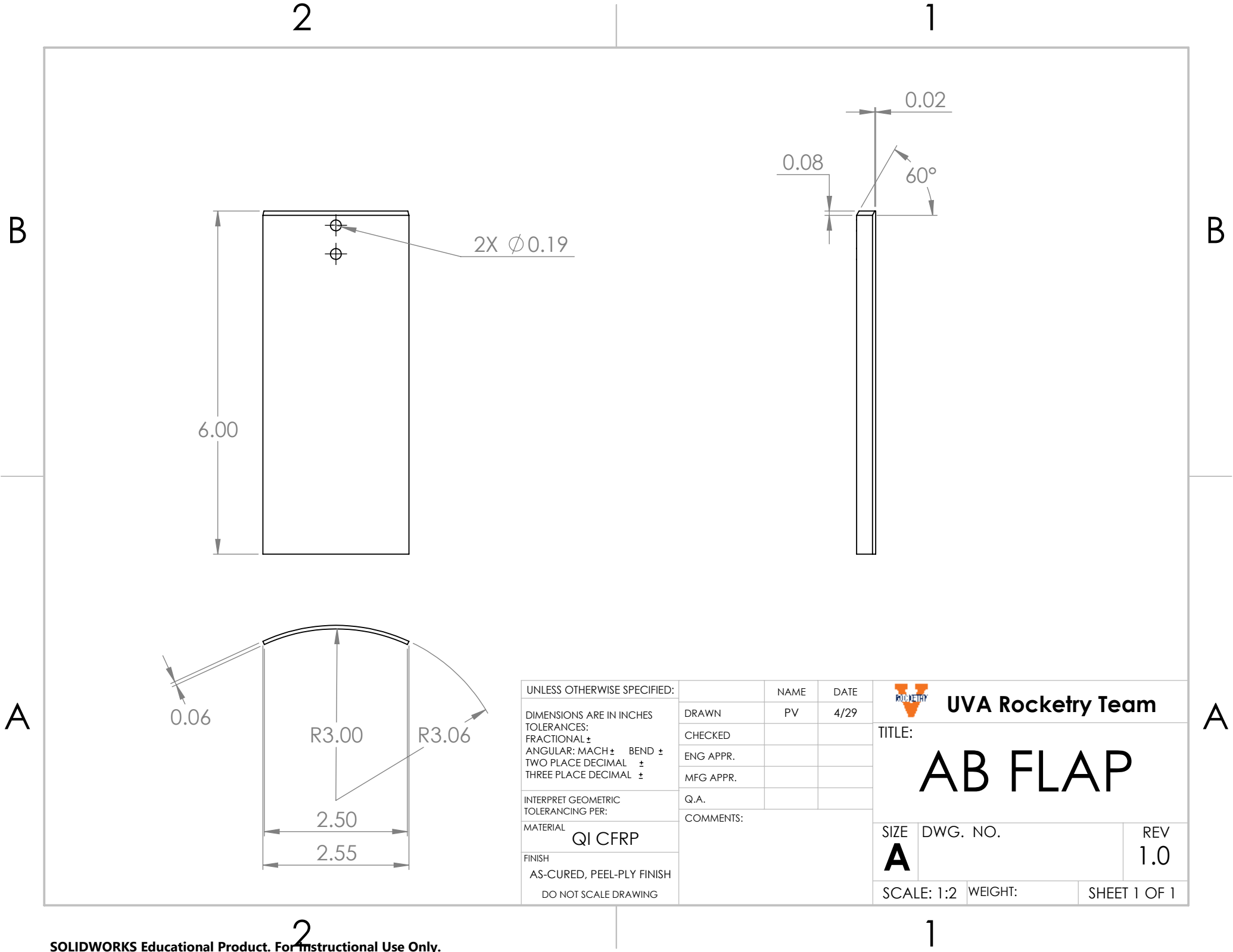


B

A

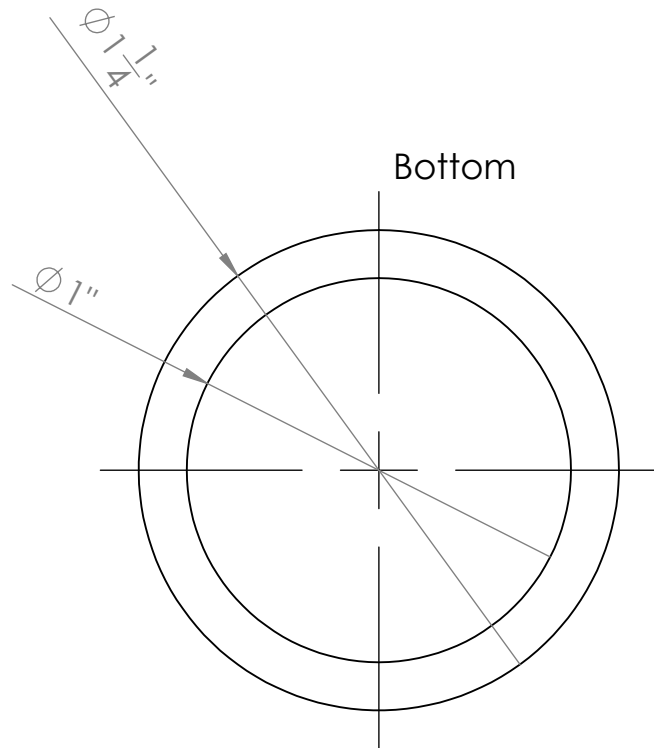
UNLESS OTHERWISE SPECIFIED:		NAME	DATE	 UVA Rocketry Team		
DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ± ANGULAR: MACH ± BEND ± TWO PLACE DECIMAL ± THREE PLACE DECIMAL ±		DRAWN	AGG	4/30	TITLE: Lower Hinge	
		CHECKED				
		ENG APPR.				
		MFG APPR.				
INTERPRET GEOMETRIC TOLERANCING PER:		Q.A.				
MATERIAL		COMMENTS:				
Aluminum 6061						
FINISH						
As Machined						
DO NOT SCALE DRAWING						

A



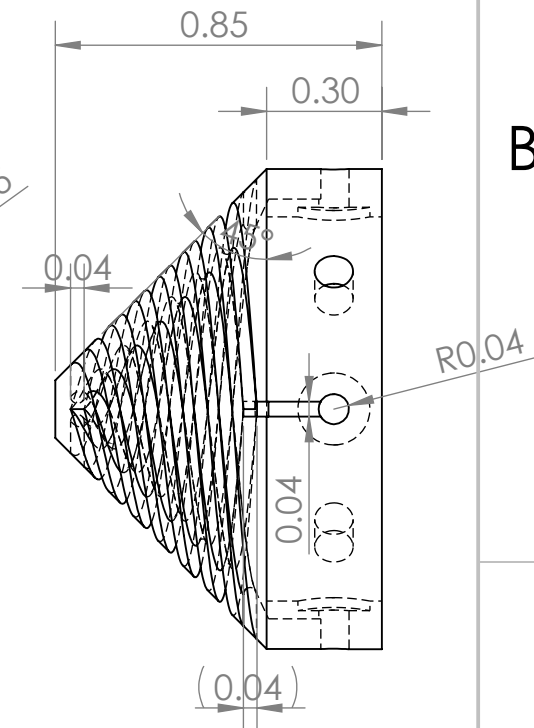
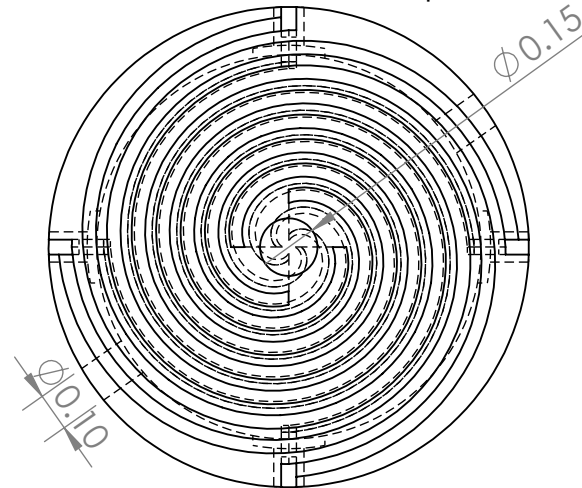
UNLESS OTHERWISE SPECIFIED:		NAME	DATE	 UVA Rocketry Team AB FLAP	
DIMENSIONS ARE IN INCHES		DRAWN	PV		
TOLERANCES:		CHECKED			
FRACTIONAL ±		ENG APPR.			
ANGULAR: MACH ± BEND ±		MFG APPR.			
TWO PLACE DECIMAL ±		Q.A.		TITLE:	
THREE PLACE DECIMAL ±		COMMENTS:		SIZE DWG. NO. REV	
INTERPRET GEOMETRIC TOLERANCING PER:				A	
MATERIAL				1.0	
FINISH				SCALE: 1:2 WEIGHT: SHEET 1 OF 1	
AS-CURED, PEEL-PLY FINISH					
DO NOT SCALE DRAWING					

B



Bottom

Top

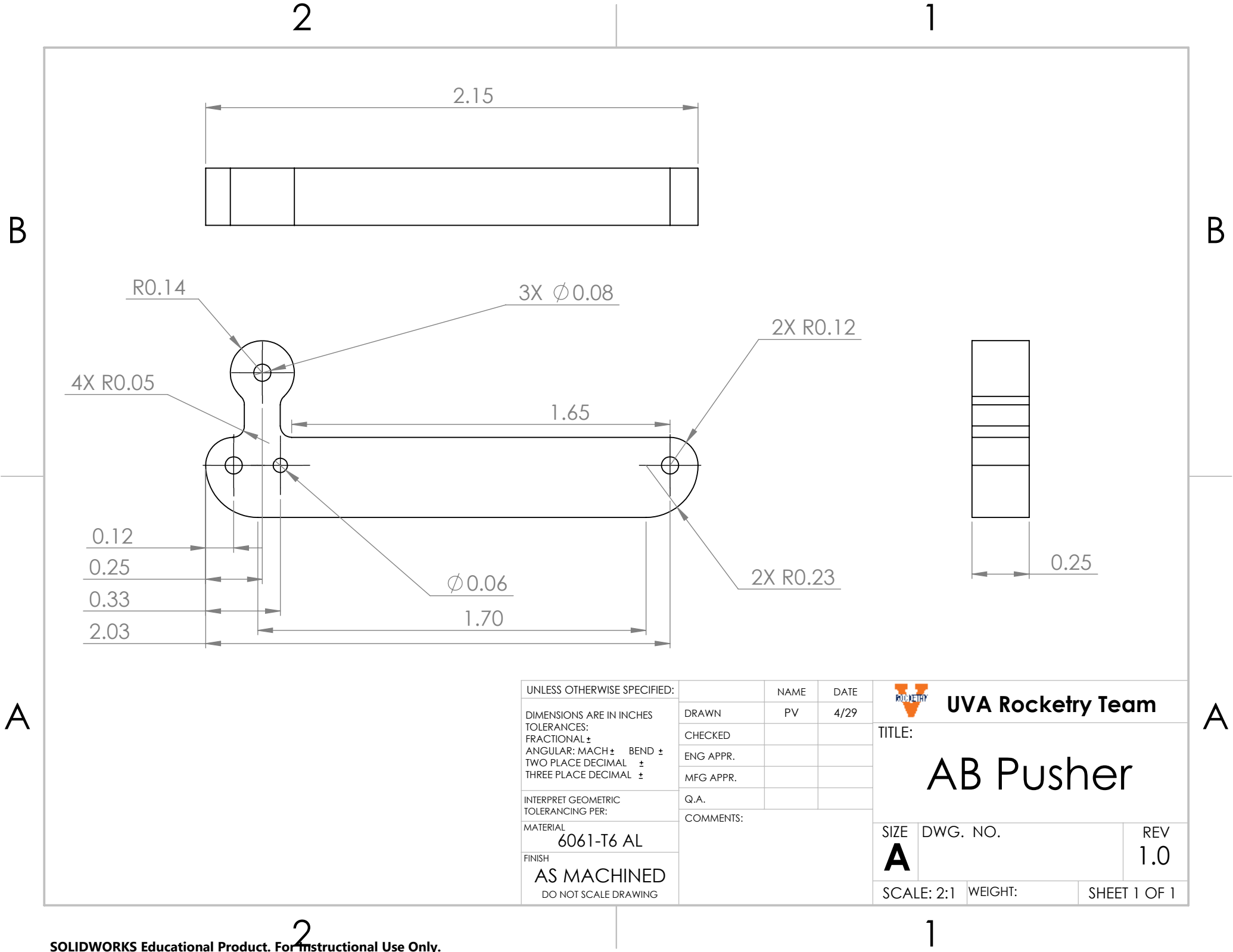


B

A

UNLESS OTHERWISE SPECIFIED:		NAME	DATE	UVA Rocketry Team		
DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ± ANGULAR: MACH ± BEND ± TWO PLACE DECIMAL ± THREE PLACE DECIMAL ±		DRAWN	AGG	4/30	TITLE: Winder	
		CHECKED				
		ENG APPR.				
		MFG APPR.				
INTERPRET GEOMETRIC TOLERANCING PER:		Q.A.			SIZE DWG. NO. REV A 1.0	
MATERIAL		COMMENTS:				
FINISH						
DO NOT SCALE DRAWING						

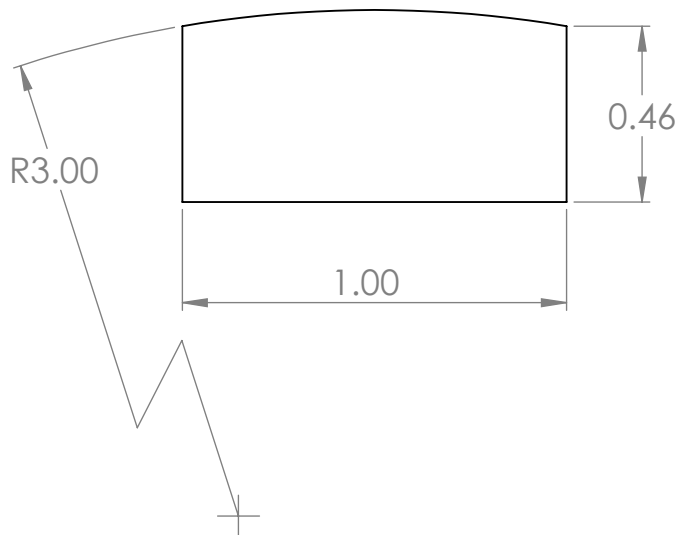
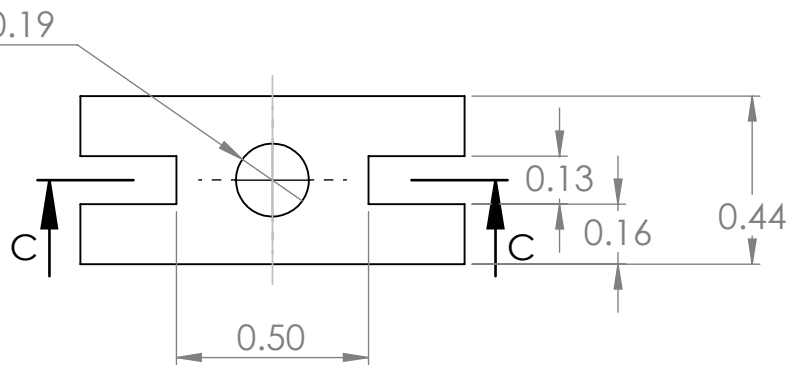
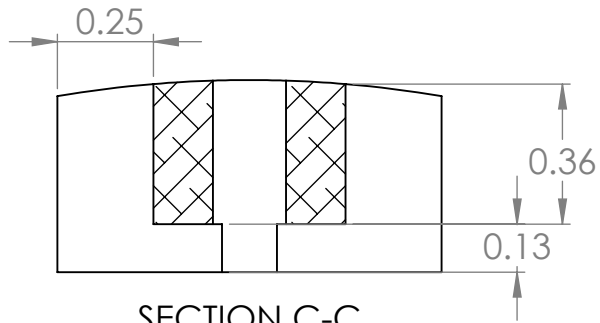
A



UNLESS OTHERWISE SPECIFIED:		NAME	DATE	 UVA Rocketry Team			
DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ± ANGULAR: MACH ± BEND ± TWO PLACE DECIMAL ± THREE PLACE DECIMAL ±		DRAWN	PV	4/29	TITLE: AB Pusher		
		CHECKED					
		ENG APPR.					
		MFG APPR.					
INTERPRET GEOMETRIC TOLERANCING PER:		Q.A.					
MATERIAL		COMMENTS:			SIZE A	DWG. NO.	REV 1.0
6061-T6 AL							
FINISH					SCALE: 2:1	WEIGHT:	SHEET 1 OF 1
AS MACHINED							
DO NOT SCALE DRAWING							

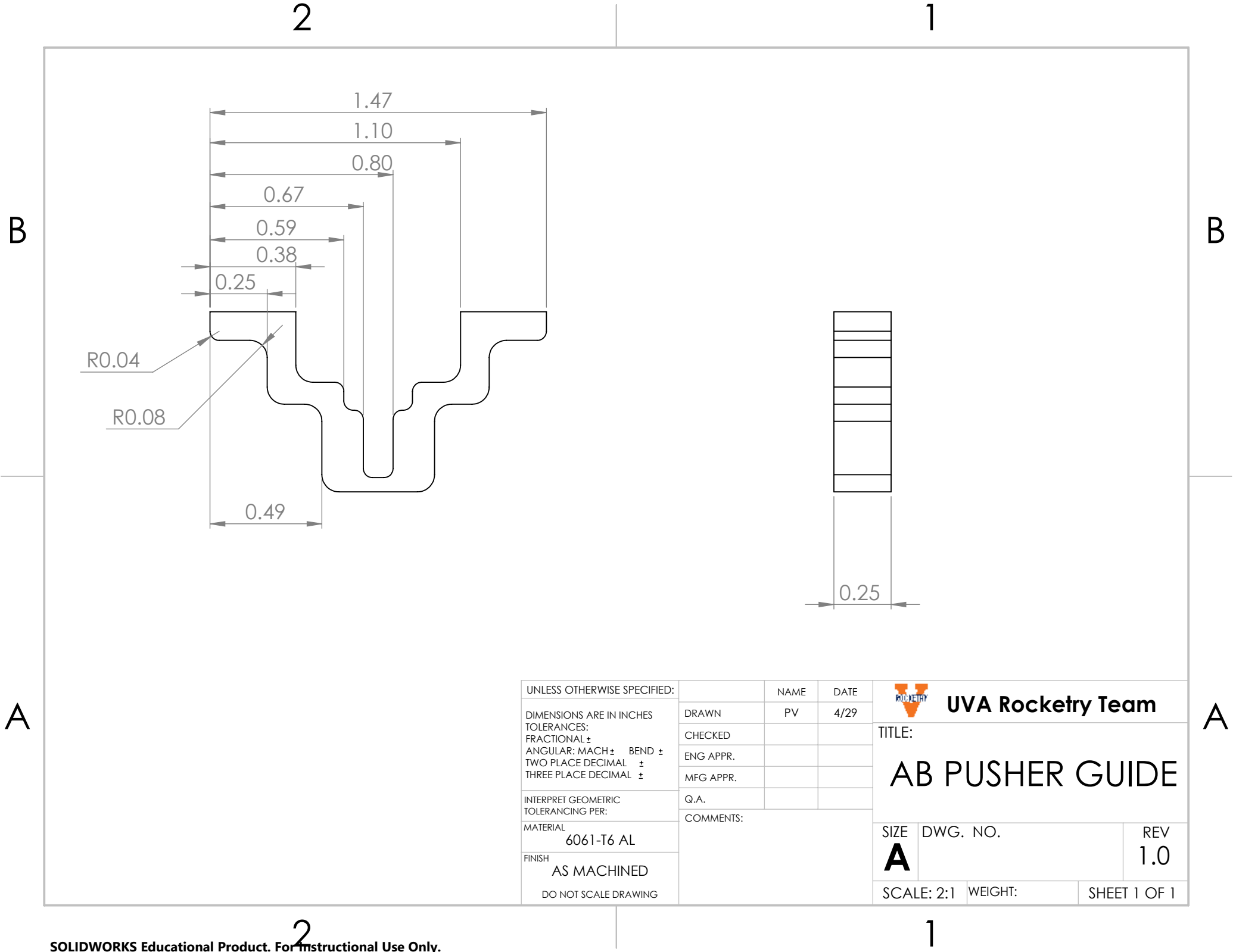
B

B

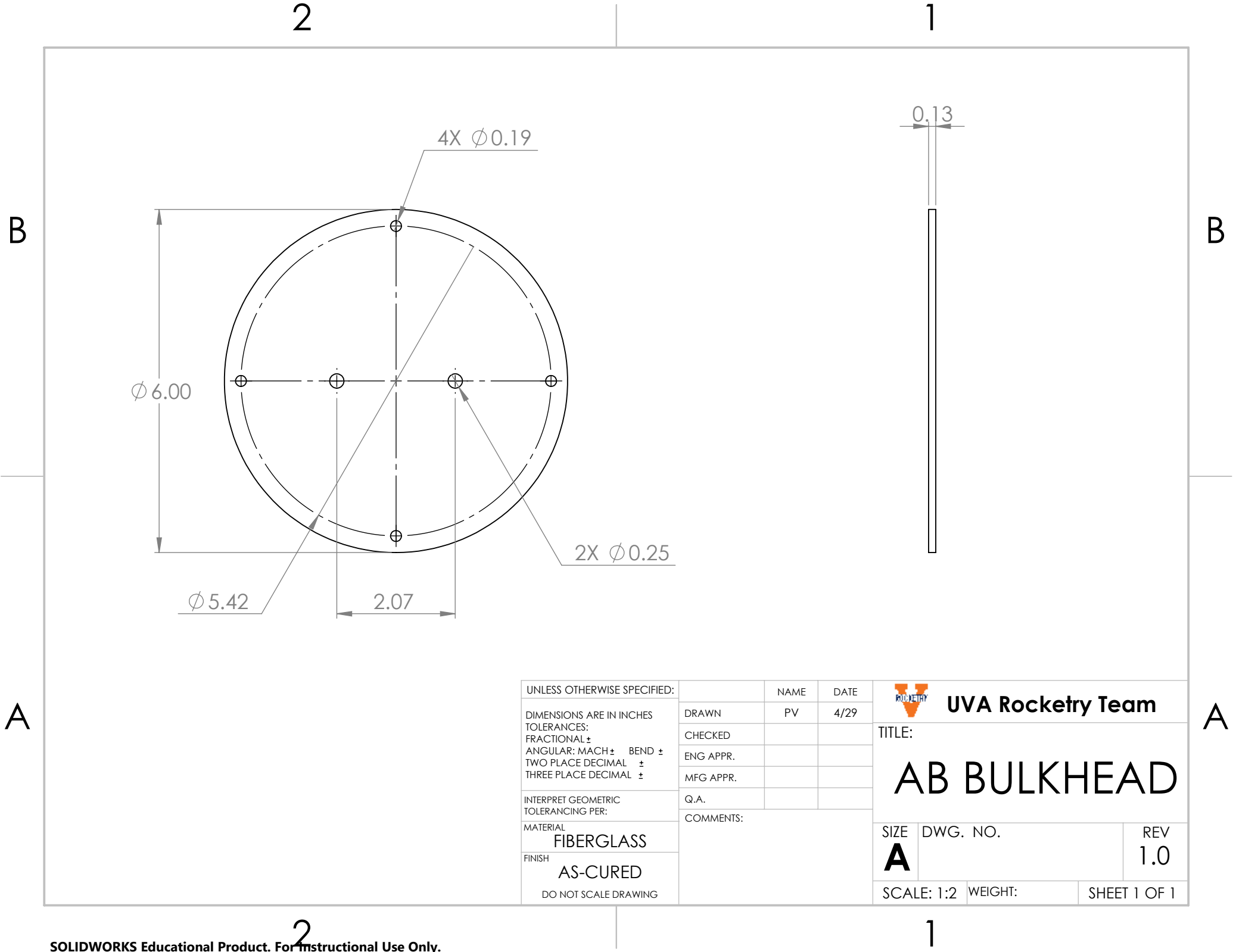


UNLESS OTHERWISE SPECIFIED:		NAME	DATE	 UVA Rocketry Team TITLE: AB MOUNTING BRACKET SIZE DWG. NO. REV A 1.0
DIMENSIONS ARE IN INCHES		DRAWN	PV	
TOLERANCES:		CHECKED		
FRACTIONAL ±		ENG APPR.		
ANGULAR: MACH ± BEND ±		MFG APPR.		
TWO PLACE DECIMAL ±		Q.A.		SCALE: 2:1 WEIGHT: SHEET 1 OF 1
THREE PLACE DECIMAL ±		COMMENTS:		
INTERPRET GEOMETRIC TOLERANCING PER:				
MATERIAL				
6061-T6 AL				
FINISH				
AS MACHINED				
DO NOT SCALE DRAWING				

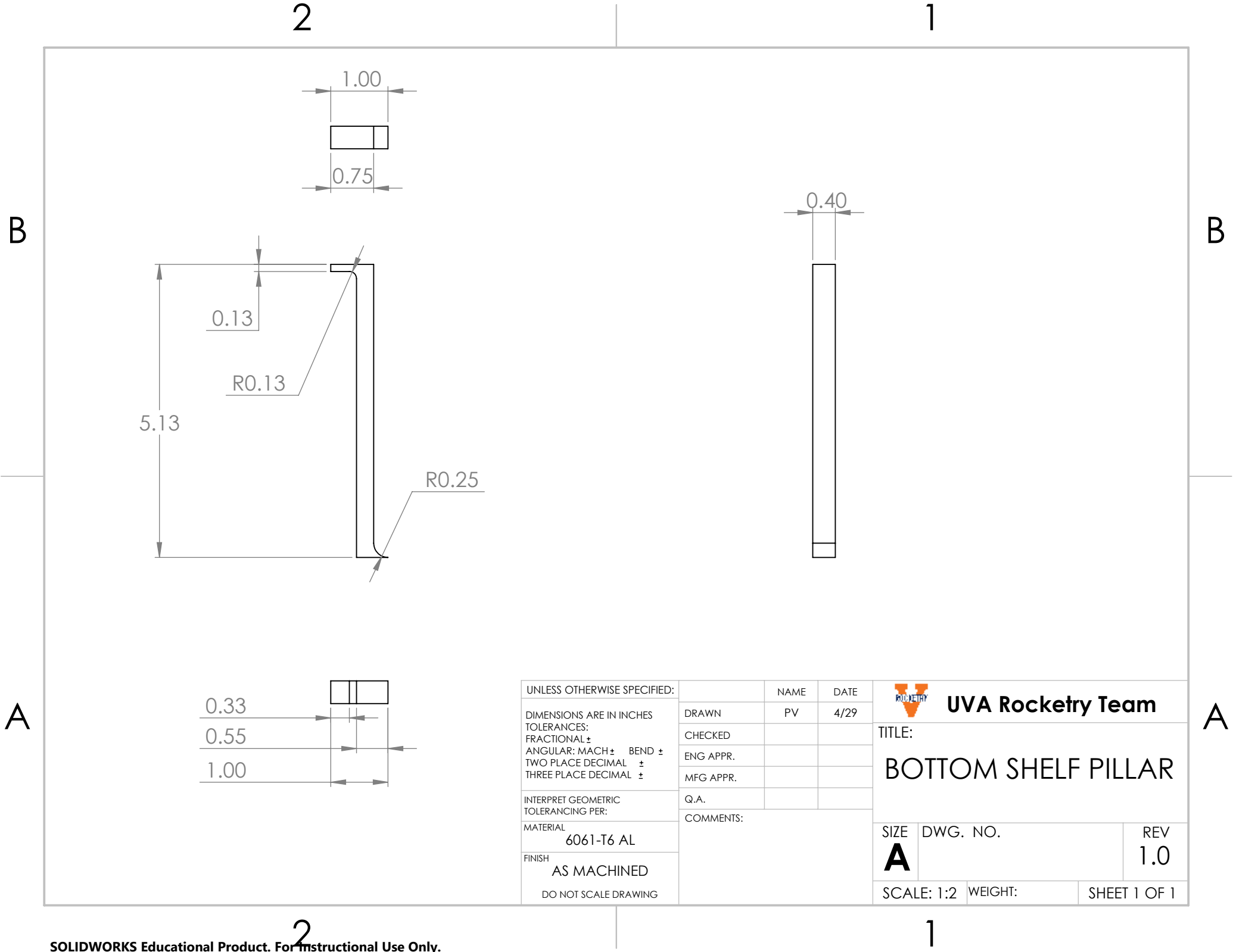
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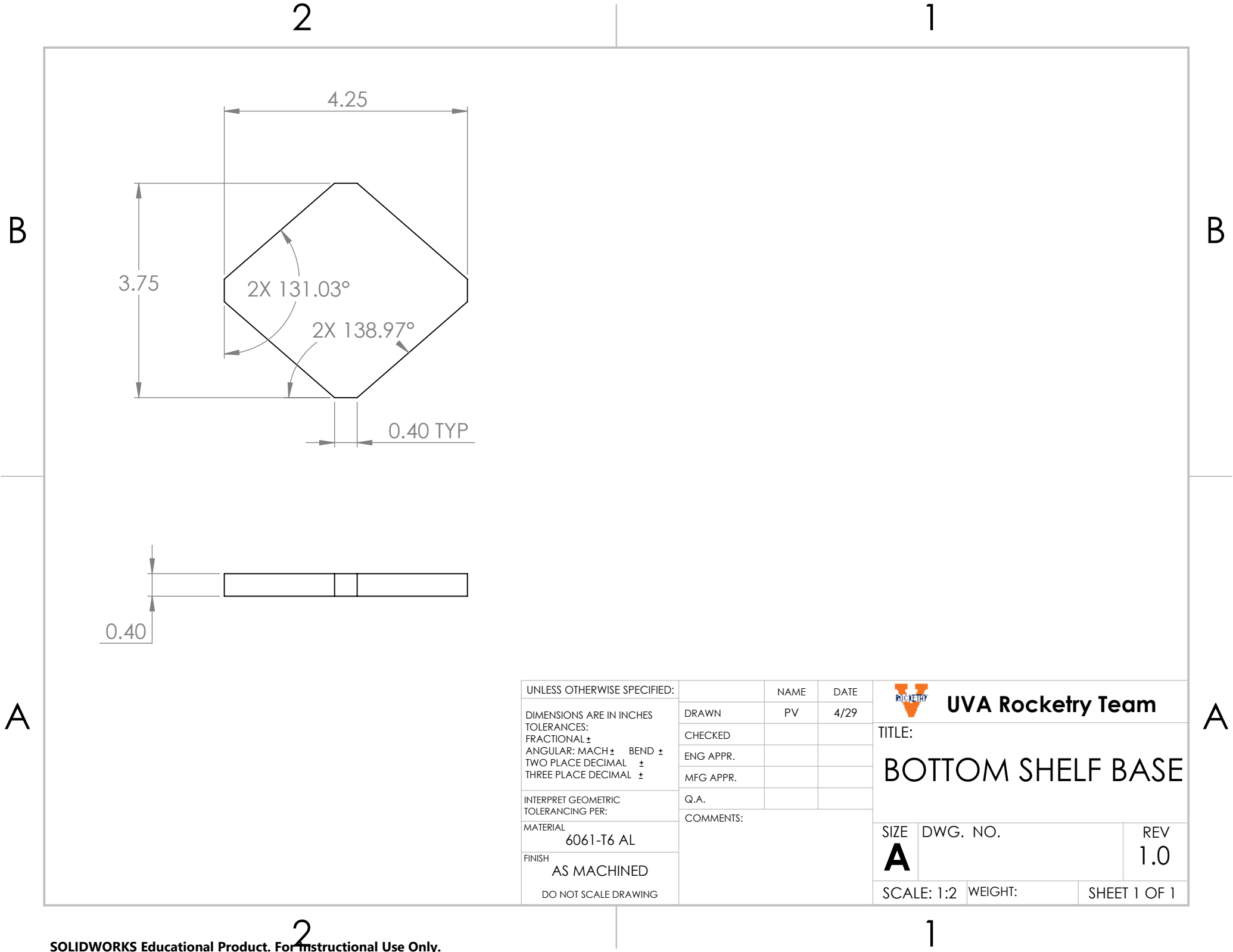


UNLESS OTHERWISE SPECIFIED:		NAME	DATE	 UVA Rocketry Team					
DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ± ANGULAR: MACH ± BEND ± TWO PLACE DECIMAL ± THREE PLACE DECIMAL ±		DRAWN	PV	4/29	TITLE: AB PUSHER GUIDE				
		CHECKED							
		ENG APPR.							
		MFG APPR.							
INTERPRET GEOMETRIC TOLERANCING PER:		Q.A.							
MATERIAL		COMMENTS:			SIZE	DWG. NO.	REV		
6061-T6 AL					A		1.0		
FINISH									
AS MACHINED					SCALE: 2:1			WEIGHT:	SHEET 1 OF 1
DO NOT SCALE DRAWING									



UNLESS OTHERWISE SPECIFIED:		NAME	DATE	 UVA Rocketry Team TITLE: AB BULKHEAD SIZE A DWG. NO. REV 1.0 SCALE: 1:2 WEIGHT: SHEET 1 OF 1	
DIMENSIONS ARE IN INCHES		DRAWN	PV		4/29
TOLERANCES:		CHECKED			
FRACTIONAL ±		ENG APPR.			
ANGULAR: MACH ± BEND ±		MFG APPR.			
TWO PLACE DECIMAL ±		Q.A.			
THREE PLACE DECIMAL ±		COMMENTS:			
INTERPRET GEOMETRIC TOLERANCING PER:					
MATERIAL					
FIBERGLASS					
FINISH					
AS-CURED					
DO NOT SCALE DRAWING					





UNLESS OTHERWISE SPECIFIED:		NAME	DATE	 UVA Rocketry Team	
DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ± ANGULAR: MACH ± BEND ± TWO PLACE DECIMAL ± THREE PLACE DECIMAL ±	DRAWN	PV	4/29	TITLE: BOTTOM SHELF BASE	
	CHECKED				
	ENG APPR.				
	MFG APPR.				
INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.			SIZE DWG. NO. REV A 1.0 SCALE: 1:2 WEIGHT: SHEET 1 OF 1	
MATERIAL	COMMENTS:				
6061-T6 AL					
FINISH					
AS MACHINED					
DO NOT SCALE DRAWING					

F.4 Payload Drawings

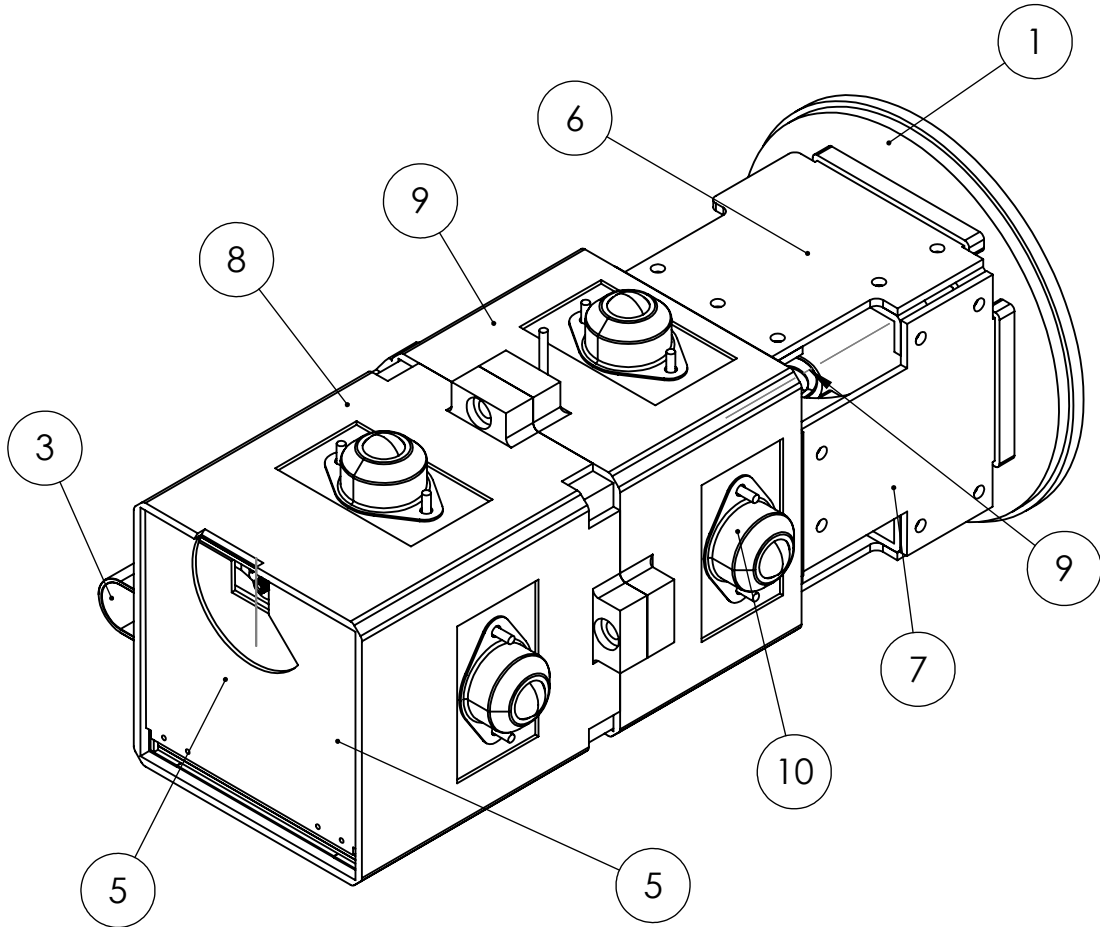
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Drawings for the components of the Payload Subsystems are found starting on the next page.

B

A

ITEM NO.	PART NUMBER	QTY.
1	04_PL (Payload Bulkhead)	1
2	PL Door	1
3	Routing Clamp	2
4	Swivel Link	1
5	Metal CubeSat	1
6	PL Liner Side	2
7	PL Liner Back	1
9	Aft Casing	1
8	Forward Casing	1
10	5-8 Roller Ball Bearing	6



UNLESS OTHERWISE SPECIFIED:

DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL ±
ANGULAR: MACH ± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±

INTERPRET GEOMETRIC
TOLERANCING PER:

MATERIAL

FINISH

DO NOT SCALE DRAWING

	NAME	DATE
DRAWN		
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		
COMMENTS:		



UVA Rocketry Team

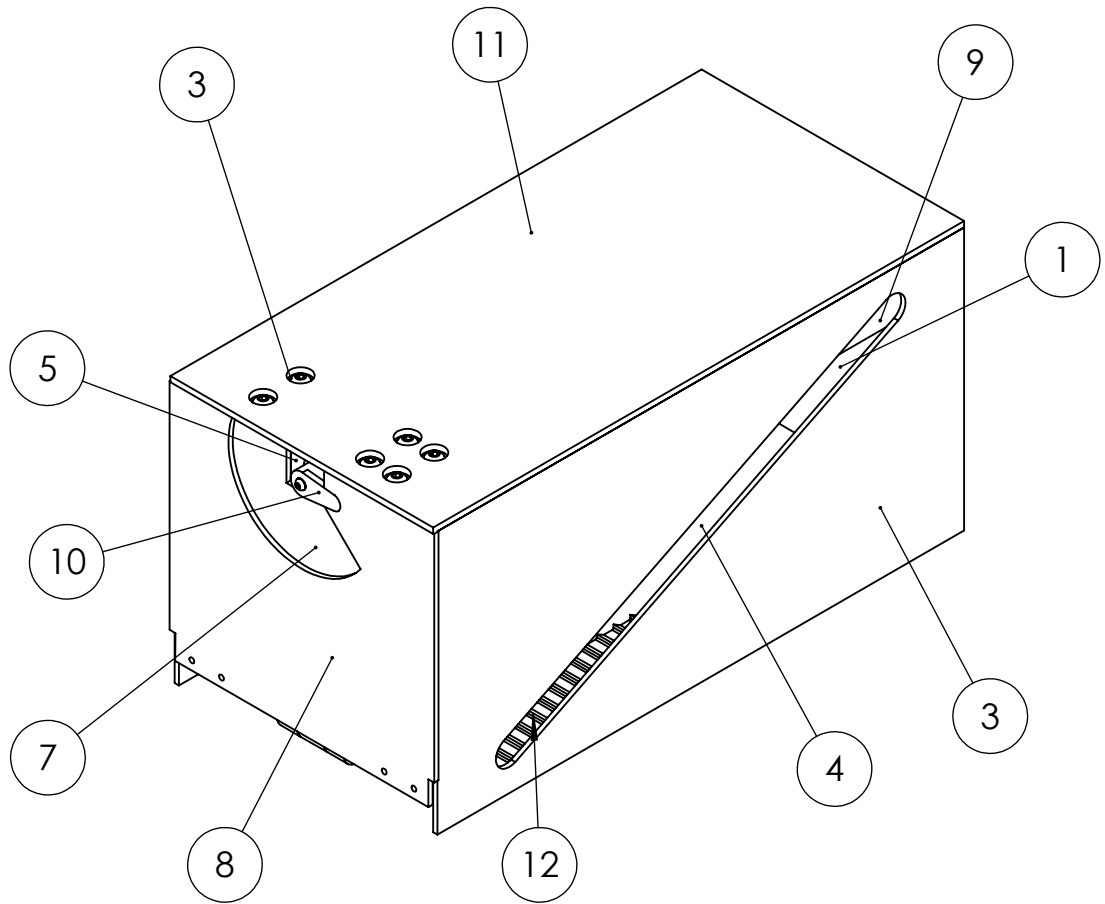
TITLE:

PL Assembly

SIZE	DWG. NO.	REV
A	0305_Payload_Assembly	1.0

SCALE: 1:2.5 WEIGHT: SHEET 1 OF 1

ITEM NO.	PART NUMBER	QTY.
1	0302_Cubesatsteel4	1
2	0302_Cubesatsteel1	1
3	0302_Cubesatsteel2	2
4	0302_Cubesatsteel3	1
5	servometaladapter	1
6	0302_MetalCubeSAT_Shelf	1
7	CubeSat Door Outer	1
8	CubeSat Door Inner	1
9	0302_shelfholder	1
10	Servo	1
11	plexiglasstop	1
12	tracksgripper	2



UNLESS OTHERWISE SPECIFIED:

DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL $\pm$
ANGULAR: MACH $\pm$ BEND $\pm$
TWO PLACE DECIMAL $\pm$
THREE PLACE DECIMAL $\pm$

INTERPRET GEOMETRIC
TOLERANCING PER:

MATERIAL

FINISH

DO NOT SCALE DRAWING

DRAWN

CHECKED

ENG APPR.

MFG APPR.

Q.A.

COMMENTS:

NAME DATE

CAC

4/25



UVA Rocketry Team

TITLE:

PL CUBESAT

SIZE

A

DWG. NO.

0302_MetalCubeSAT

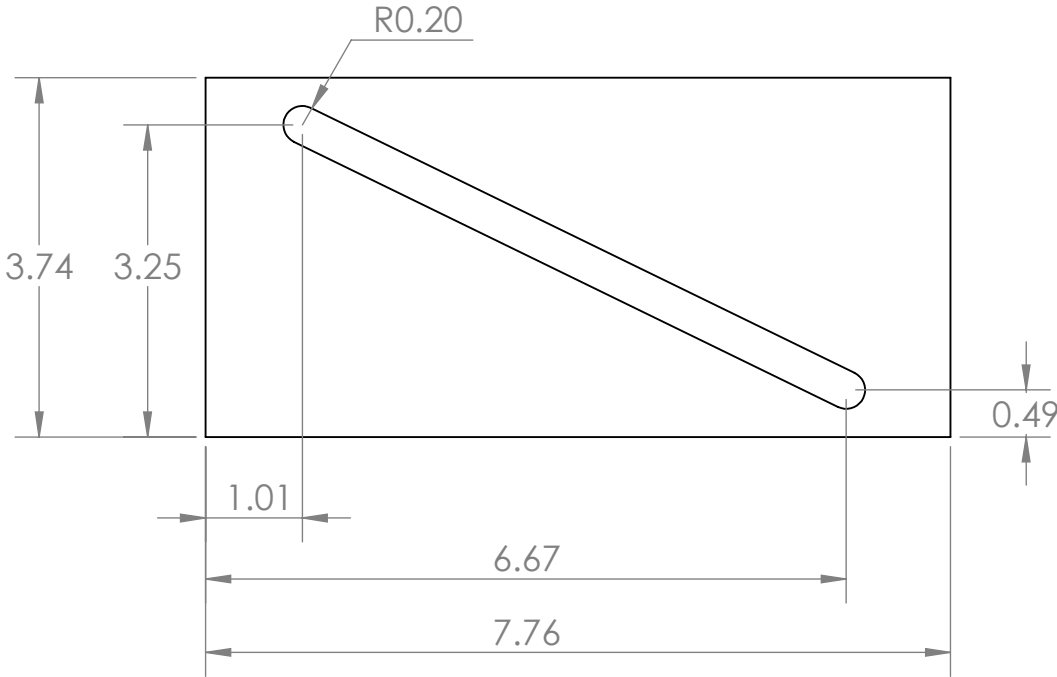
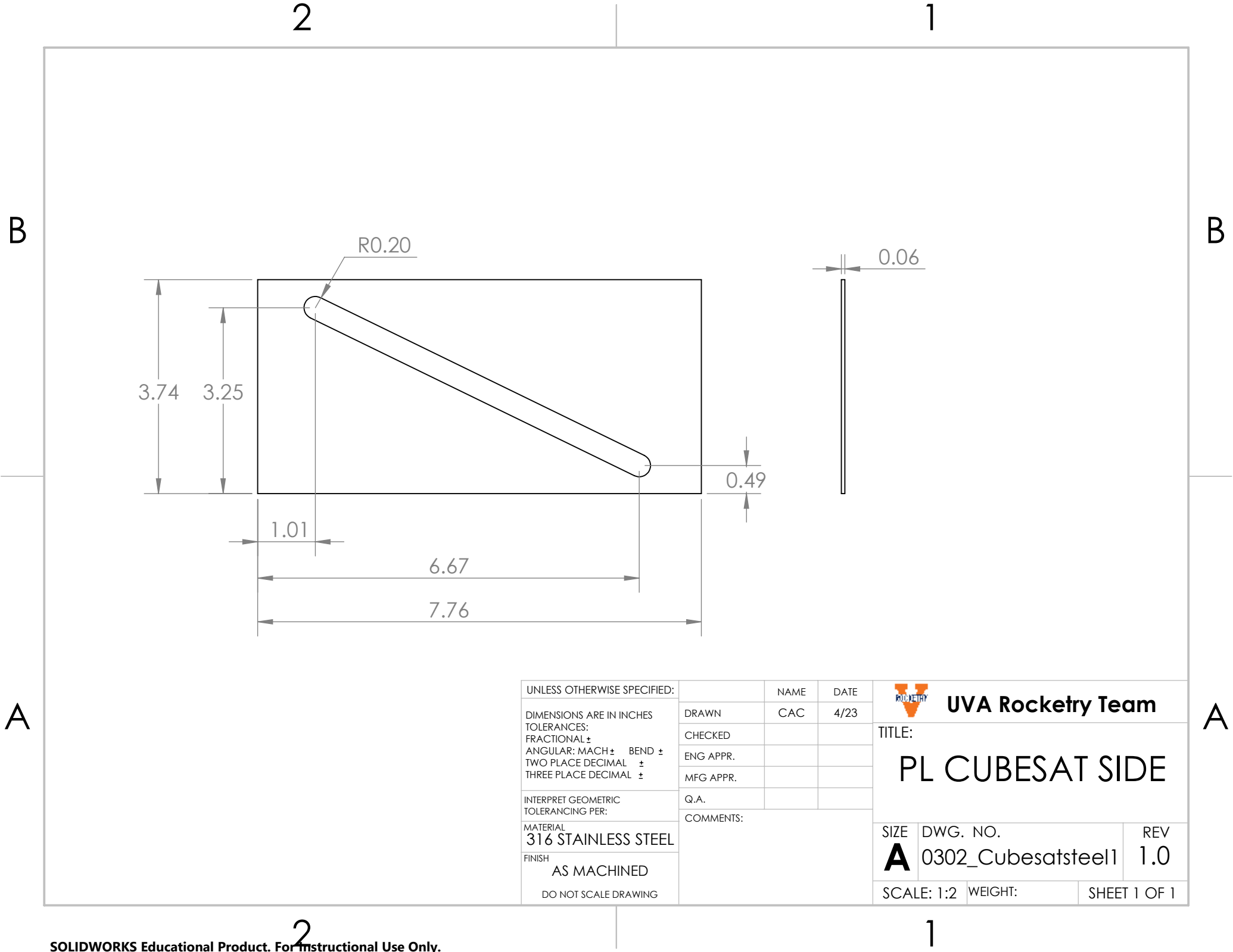
REV

1.0

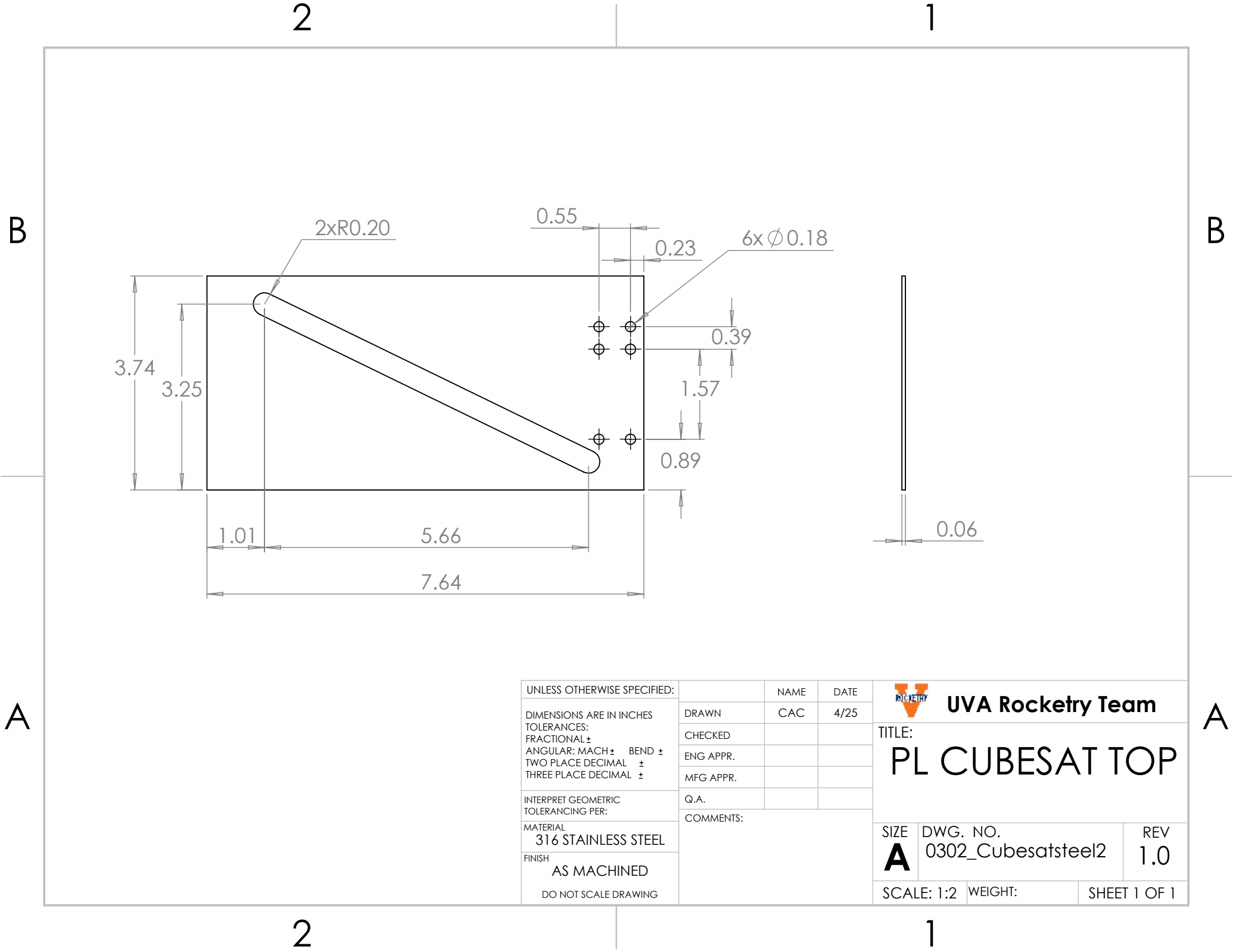
SCALE: 1:5

WEIGHT:

SHEET 1 OF 1



UNLESS OTHERWISE SPECIFIED:		NAME	DATE	 UVA Rocketry Team				
DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ± ANGULAR: MACH ± BEND ± TWO PLACE DECIMAL ± THREE PLACE DECIMAL ±		DRAWN	CAC	4/23	TITLE: PL CUBESAT SIDE			
		CHECKED						
		ENG APPR.						
		MFG APPR.						
		Q.A.						
INTERPRET GEOMETRIC TOLERANCING PER:		COMMENTS:			SIZE		DWG. NO.	REV
MATERIAL					A	0302_Cubesatsteel1	1.0	
316 STAINLESS STEEL								
FINISH								
AS MACHINED		SCALE: 1:2		WEIGHT:		SHEET 1 OF 1		
DO NOT SCALE DRAWING								



UNLESS OTHERWISE SPECIFIED:

DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL $\pm$
ANGULAR: MACH $\pm$ BEND $\pm$
TWO PLACE DECIMAL $\pm$
THREE PLACE DECIMAL $\pm$

INTERPRET GEOMETRIC
TOLERANCING PER:

MATERIAL
316 STAINLESS STEEL

FINISH
AS MACHINED

DO NOT SCALE DRAWING

	NAME	DATE
DRAWN	CAC	4/25
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		
COMMENTS:		



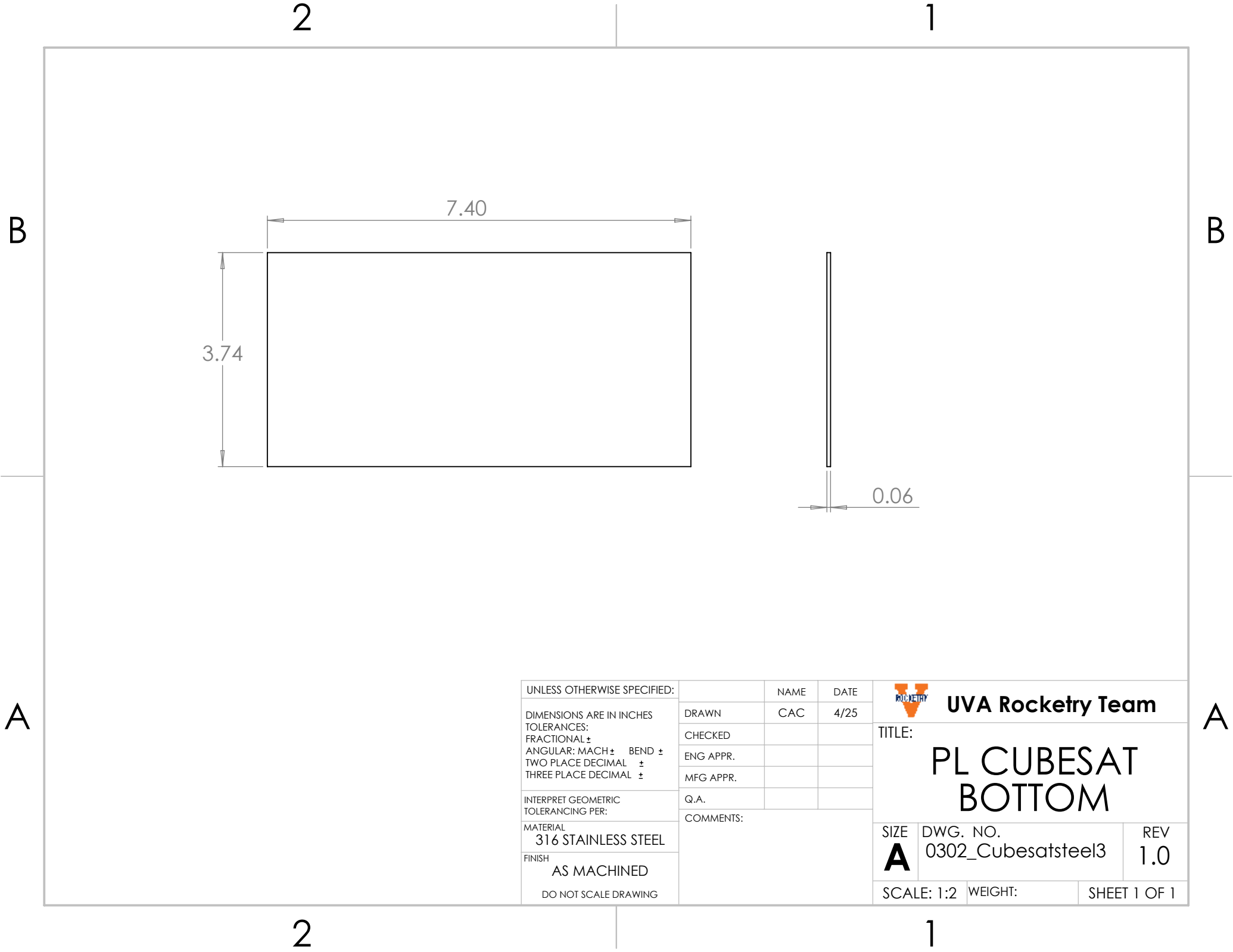
UVA Rocketry Team

TITLE:

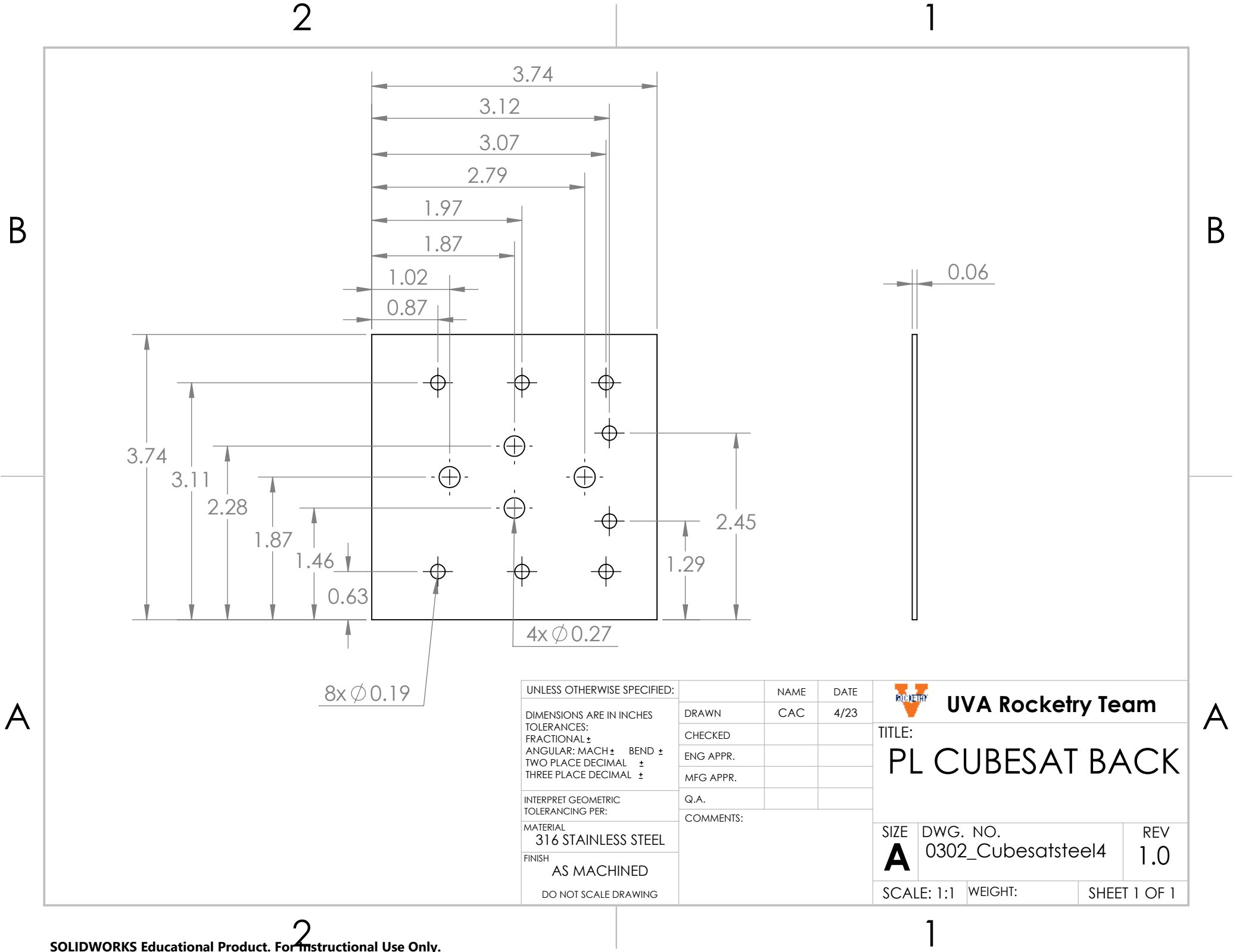
PL CUBESAT TOP

SIZE	DWG. NO.	REV
A	0302_Cubesatsteel2	1.0

SCALE: 1:2	WEIGHT:	SHEET 1 OF 1
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UNLESS OTHERWISE SPECIFIED:		NAME	DATE	 UVA Rocketry Team		
DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ± ANGULAR: MACH ± BEND ± TWO PLACE DECIMAL ± THREE PLACE DECIMAL ±	DRAWN	CAC	4/25	TITLE: PL CUBESAT BOTTOM		
	CHECKED					
	ENG APPR.					
	MFG APPR.					
INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.			SIZE DWG. NO. REV A 0302_Cubesatsteel3 1.0		
MATERIAL 316 STAINLESS STEEL	COMMENTS:					
FINISH AS MACHINED						
DO NOT SCALE DRAWING		SCALE: 1:2		WEIGHT:	SHEET 1 OF 1	



UNLESS OTHERWISE SPECIFIED:

DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL $\pm$
ANGULAR: MACH $\pm$ BEND $\pm$
TWO PLACE DECIMAL $\pm$
THREE PLACE DECIMAL $\pm$

INTERPRET GEOMETRIC
TOLERANCING PER:

MATERIAL
316 STAINLESS STEEL

FINISH
AS MACHINED

DO NOT SCALE DRAWING

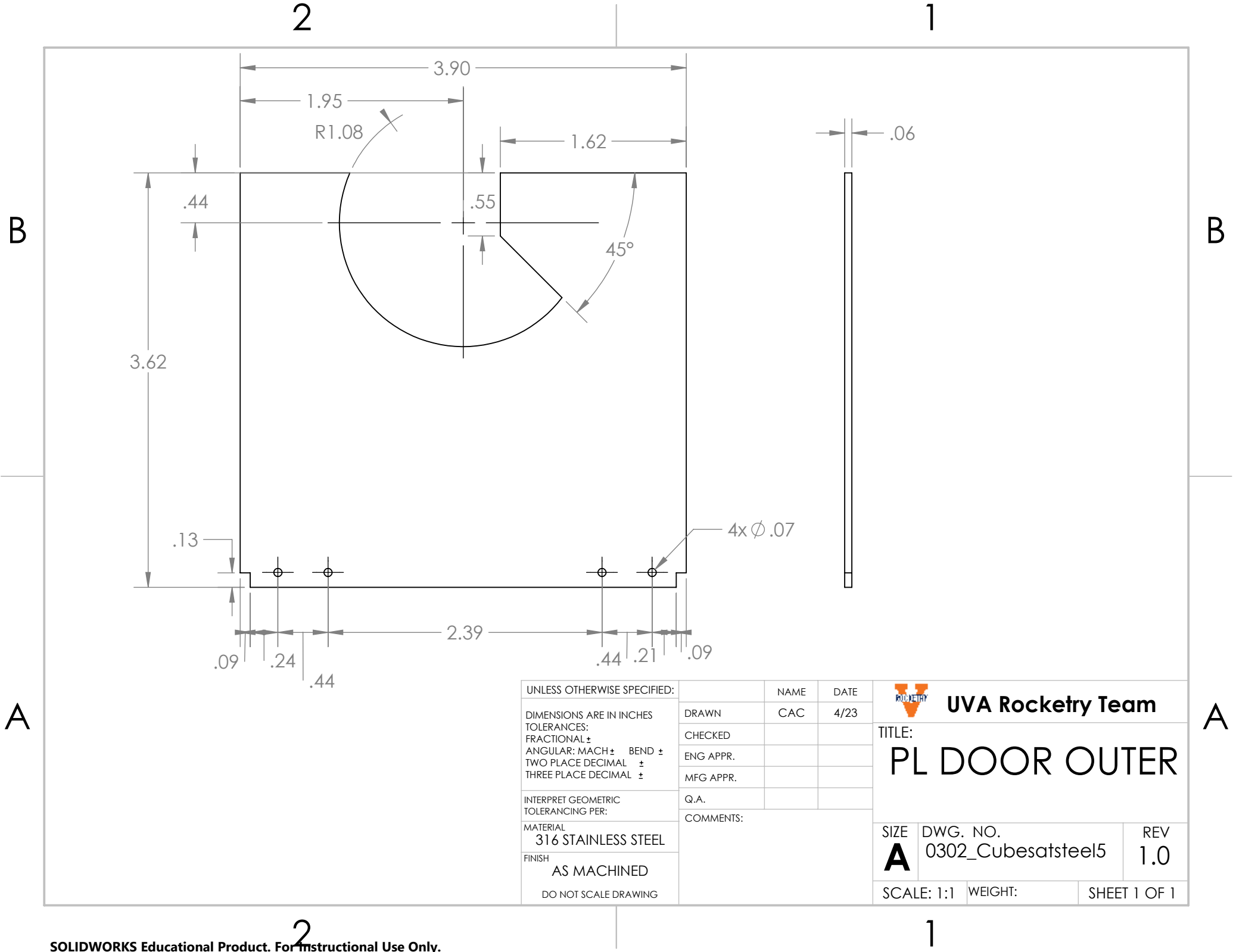
	NAME	DATE
DRAWN	CAC	4/23
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		
COMMENTS:		



UVA Rocketry Team

TITLE:
PL CUBESAT BACK

SIZE A	DWG. NO. 0302_Cubesatsteel4	REV 1.0
SCALE: 1:1	WEIGHT:	SHEET 1 OF 1



UNLESS OTHERWISE SPECIFIED:

DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL ±
ANGULAR: MACH ± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±

INTERPRET GEOMETRIC
TOLERANCING PER:

MATERIAL
316 STAINLESS STEEL

FINISH
AS MACHINED

DO NOT SCALE DRAWING

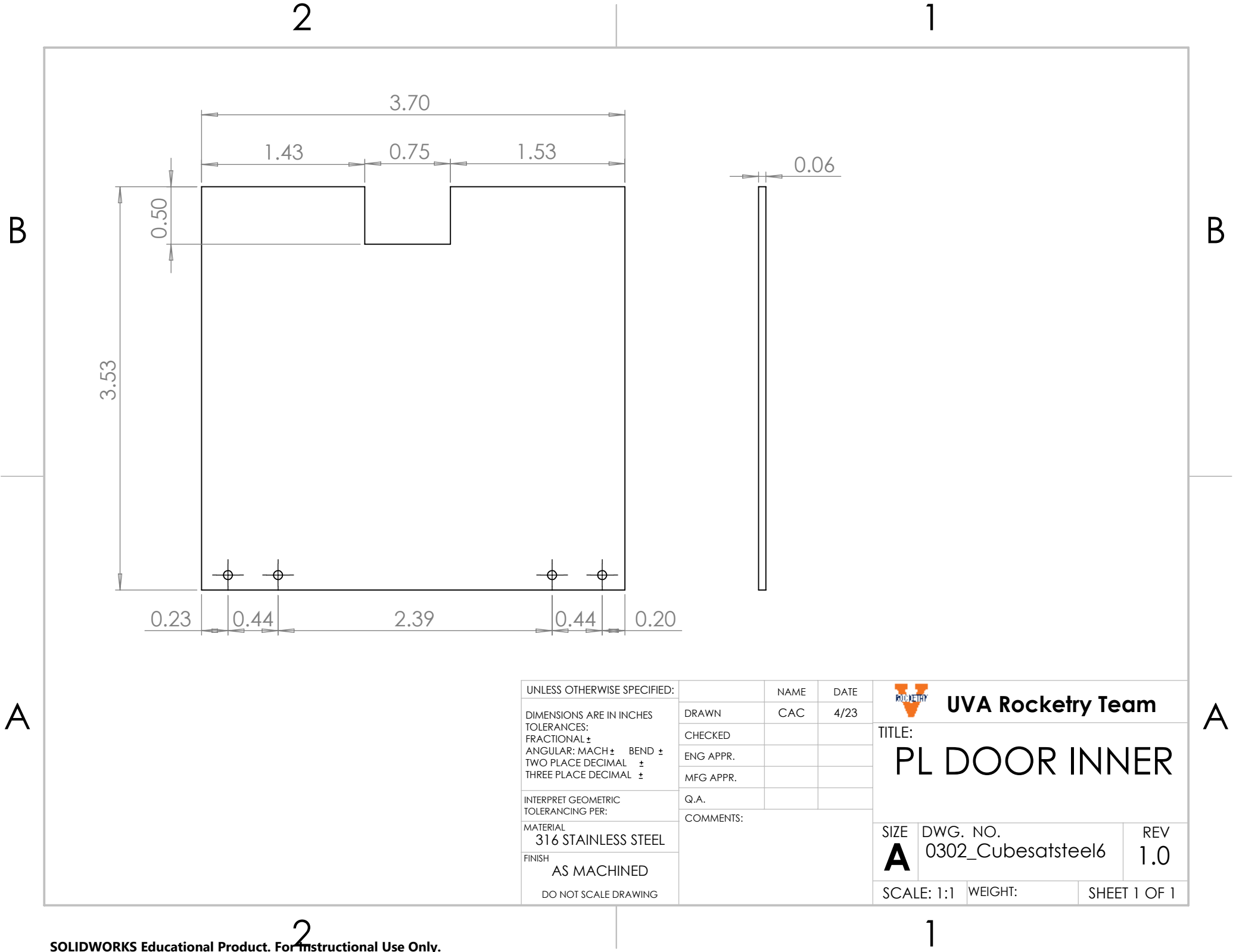
	NAME	DATE
DRAWN	CAC	4/23
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		
COMMENTS:		

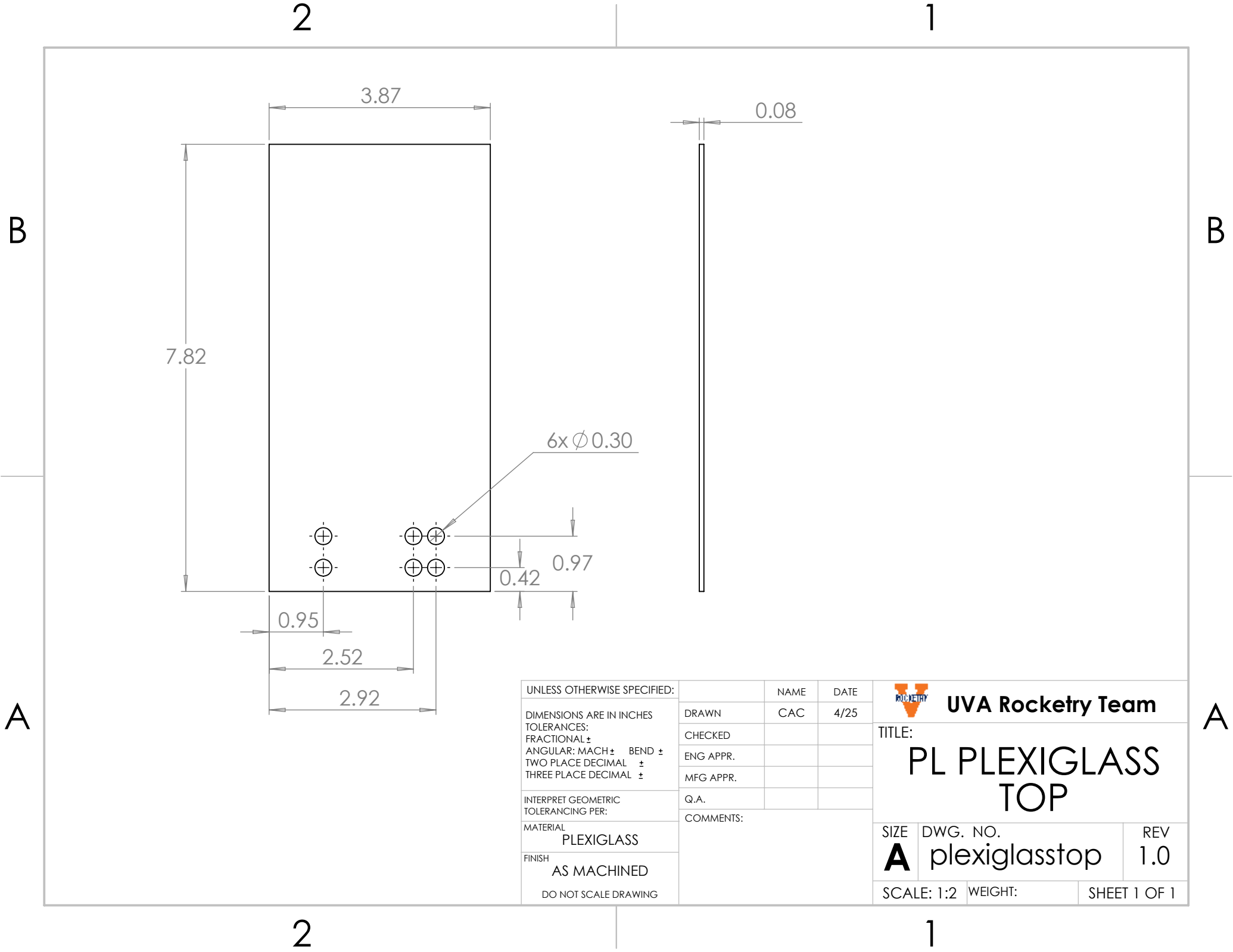


UVA Rocketry Team

TITLE:
PL DOOR OUTER

SIZE A	DWG. NO. 0302_Cubesatsteel5	REV 1.0
SCALE: 1:1	WEIGHT:	SHEET 1 OF 1





UNLESS OTHERWISE SPECIFIED:

DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL ±
ANGULAR: MACH ± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±

INTERPRET GEOMETRIC
TOLERANCING PER:

MATERIAL
PLEXIGLASS

FINISH
AS MACHINED

DO NOT SCALE DRAWING

	NAME	DATE
DRAWN	CAC	4/25
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		
COMMENTS:		



UVA Rocketry Team

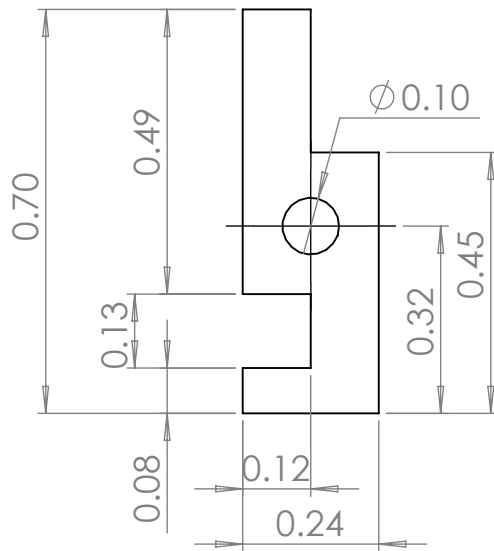
TITLE:

**PL PLEXIGLASS
TOP**

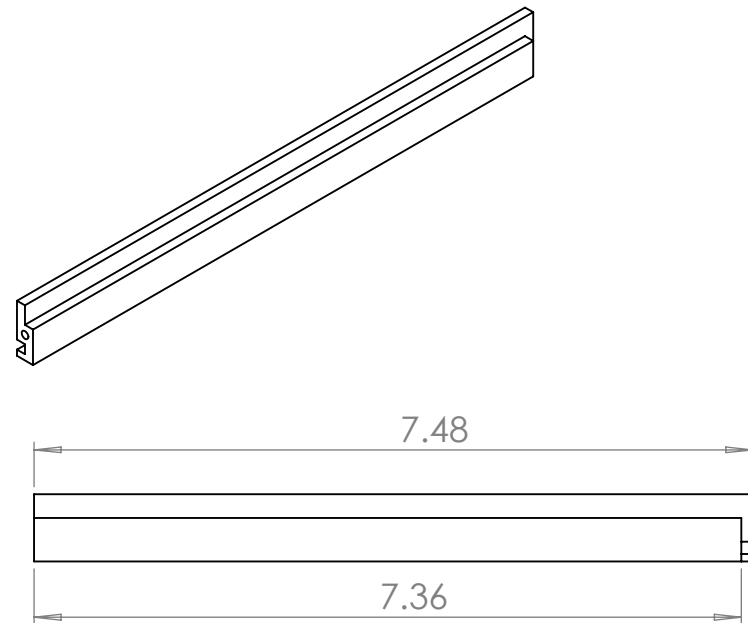
SIZE	DWG. NO.	REV
A	plexiglasstop	1.0
SCALE: 1:2	WEIGHT:	SHEET 1 OF 1

B

A



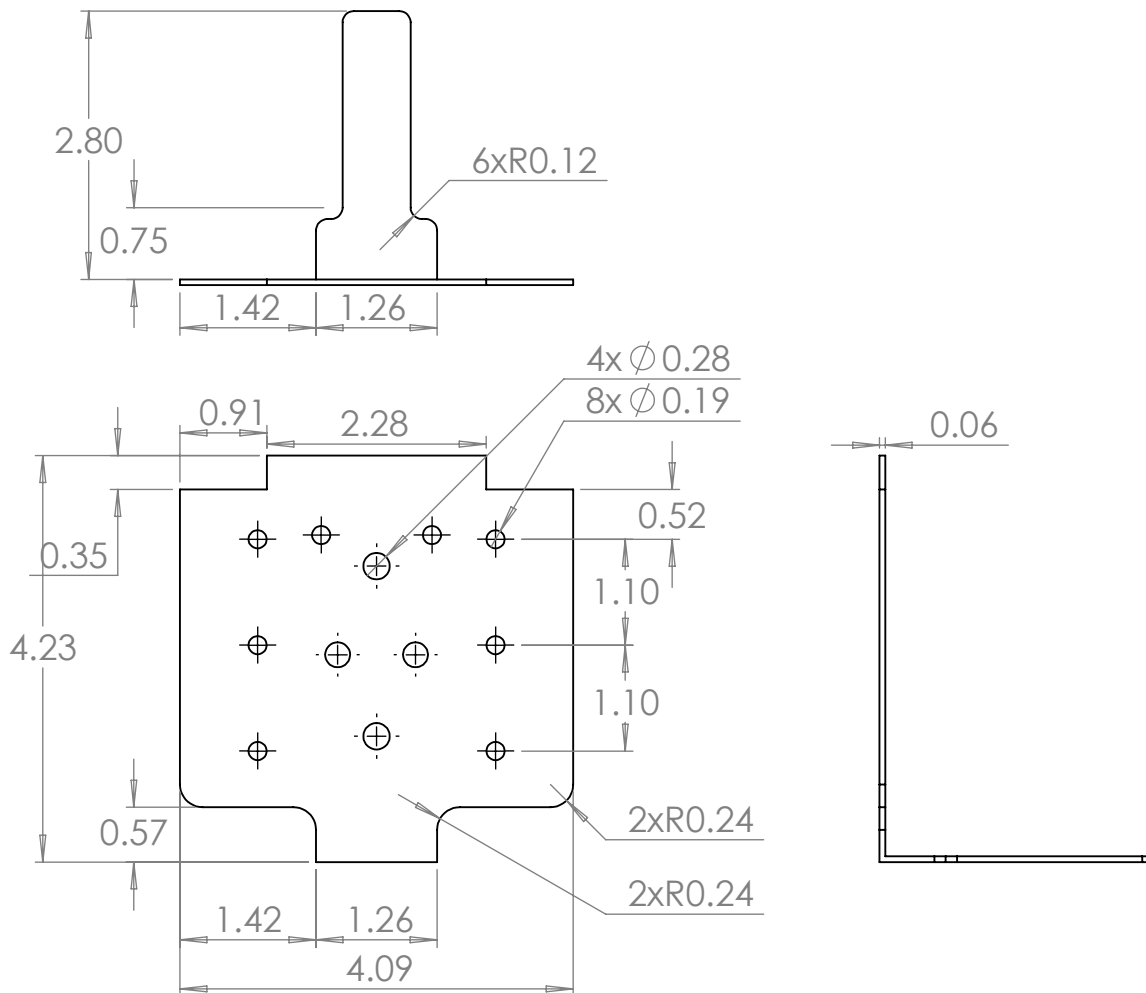
DETAIL A
SCALE 3 : 1



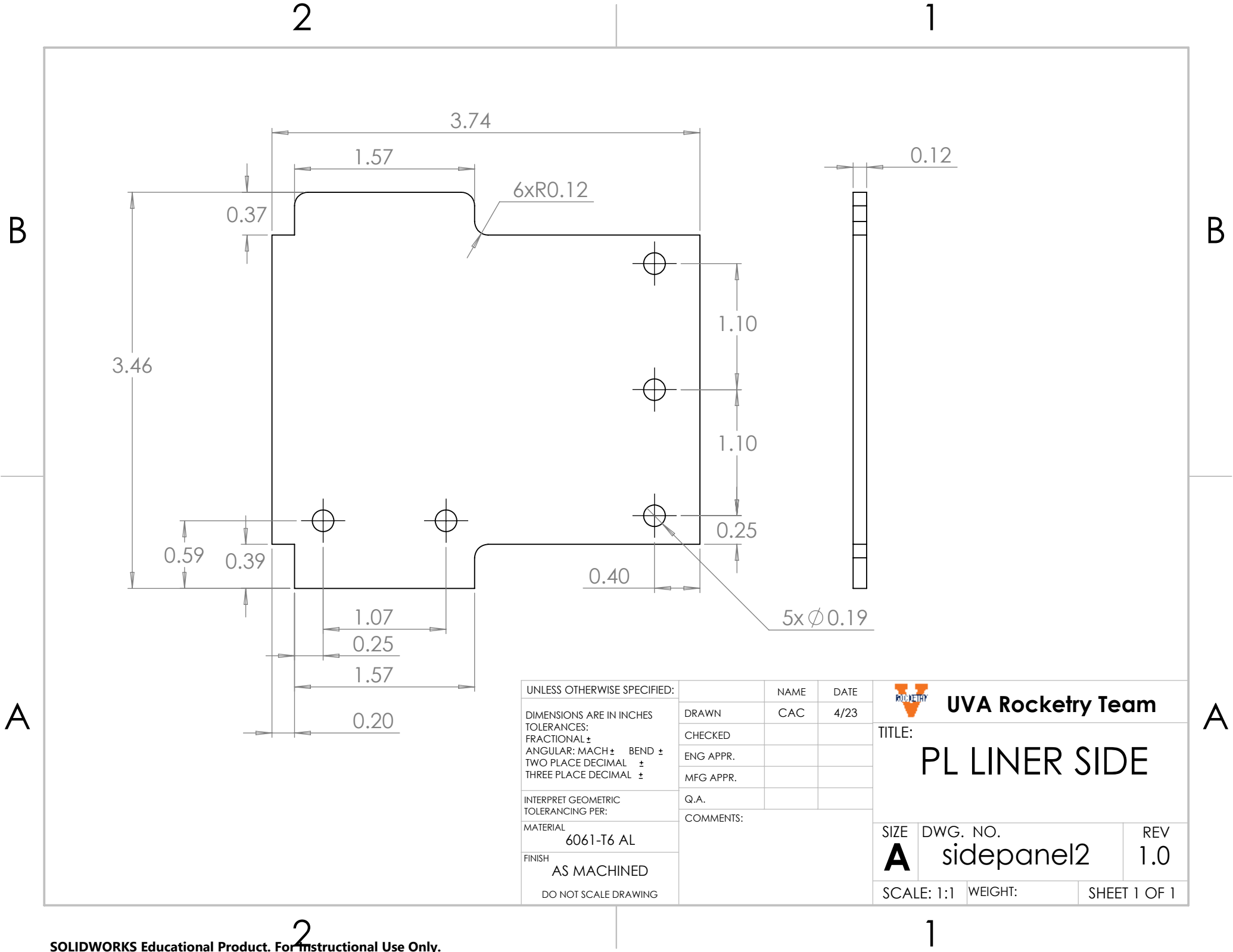
B

A

UNLESS OTHERWISE SPECIFIED:		NAME	DATE	 UVA Rocketry Team	
DIMENSIONS ARE IN INCHES		DRAWN	CAC		
TOLERANCES:		CHECKED			
FRACTIONAL ±		ENG APPR.			
ANGULAR: MACH ± BEND ±		MFG APPR.			
TWO PLACE DECIMAL ±		Q.A.		TITLE: PL SHELF HOLDER	
THREE PLACE DECIMAL ±		COMMENTS:			
INTERPRET GEOMETRIC TOLERANCING PER:				SIZE	DWG. NO.
MATERIAL				A	0302_shelfholder
FINISH					REV
AS PRINTED					1.0
DO NOT SCALE DRAWING				SCALE: 1:2	WEIGHT:
				SHEET 1 OF 1	



UNLESS OTHERWISE SPECIFIED:		NAME	DATE	 UVA Rocketry Team		
DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ± ANGULAR: MACH ± BEND ± TWO PLACE DECIMAL ± THREE PLACE DECIMAL ±	DRAWN	CAC	4/23	TITLE: PL CASING BRACKET		
	CHECKED					
	ENG APPR.					
	MFG APPR.					
INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.			SIZE DWG. NO. REV A steelliner_postmanufacture 1.0		
COMMENTS:						
MATERIAL						
304 STAINLESS STEEL						
FINISH					SCALE: 1:2 WEIGHT: SHEET 1 OF 1	
AS MACHINED						
DO NOT SCALE DRAWING						



UNLESS OTHERWISE SPECIFIED:

DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL $\pm$
ANGULAR: MACH $\pm$ BEND $\pm$
TWO PLACE DECIMAL $\pm$
THREE PLACE DECIMAL $\pm$

INTERPRET GEOMETRIC
TOLERANCING PER:

MATERIAL
6061-T6 AL

FINISH
AS MACHINED

DO NOT SCALE DRAWING

	NAME	DATE
DRAWN	CAC	4/23
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		

COMMENTS:

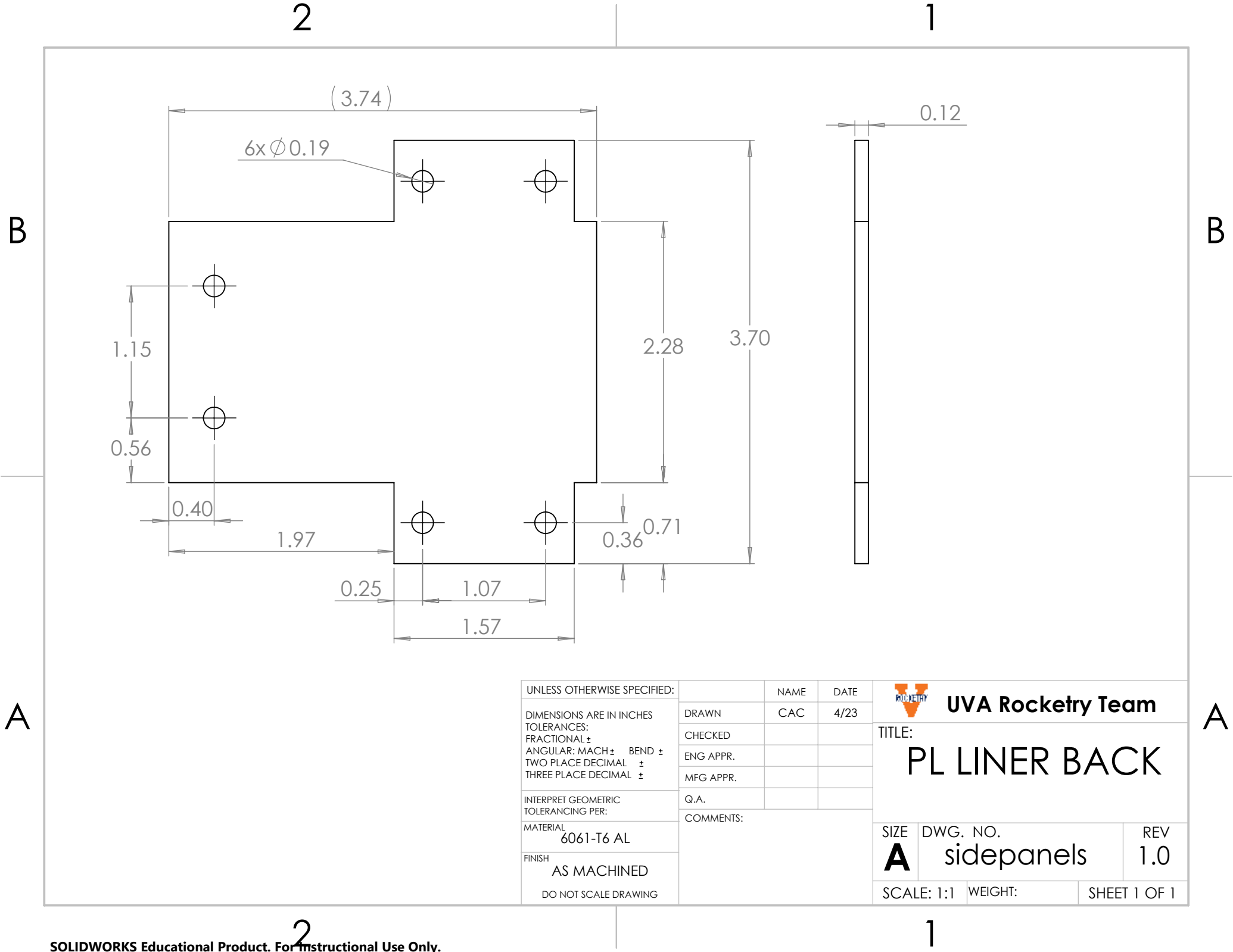


UVA Rocketry Team

TITLE:

PL LINER SIDE

SIZE	DWG. NO.	REV
A	sidepanel2	1.0
SCALE: 1:1	WEIGHT:	SHEET 1 OF 1



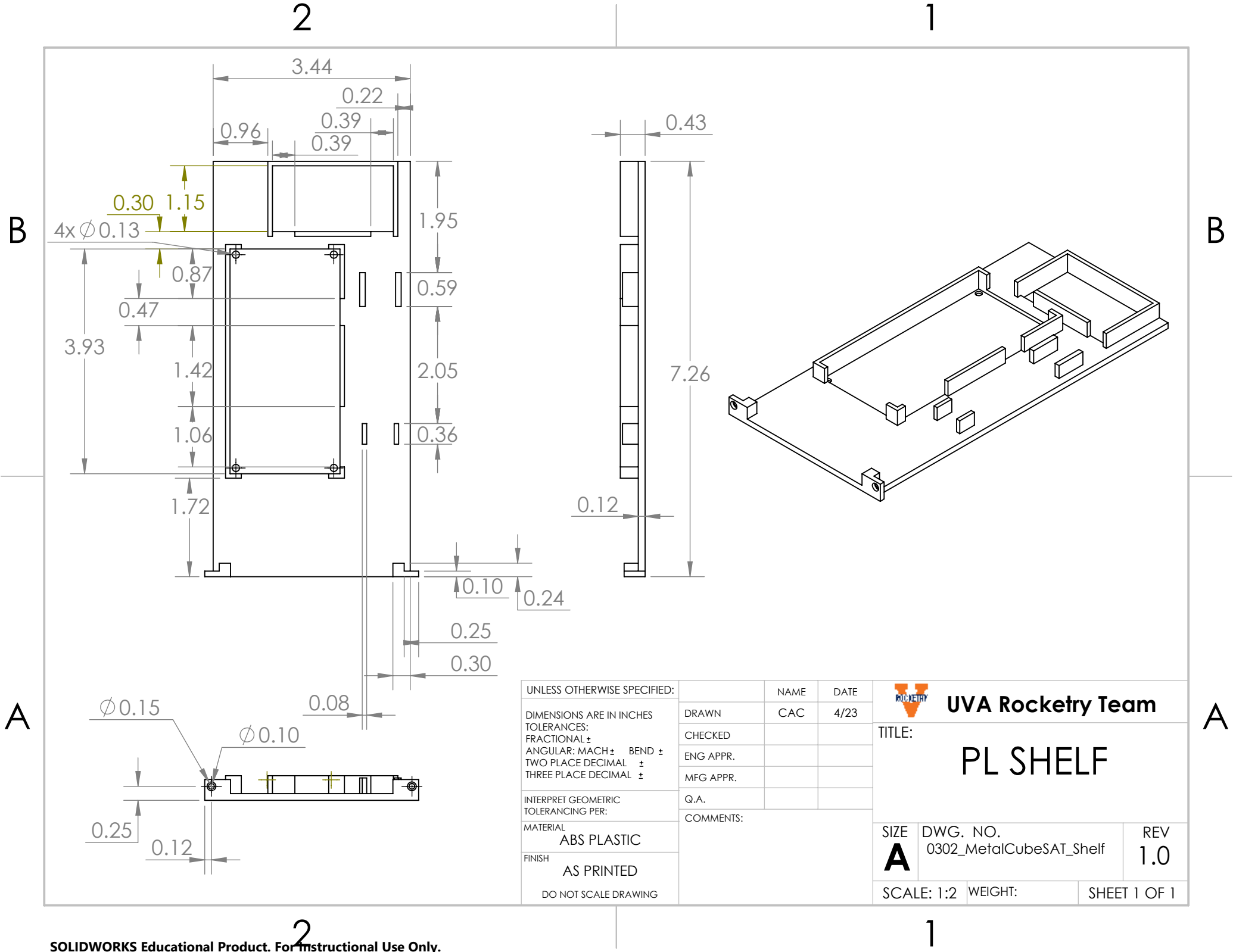
B

B

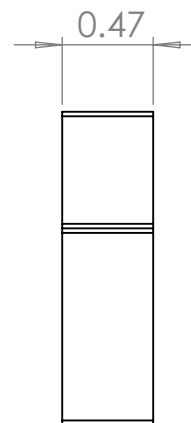
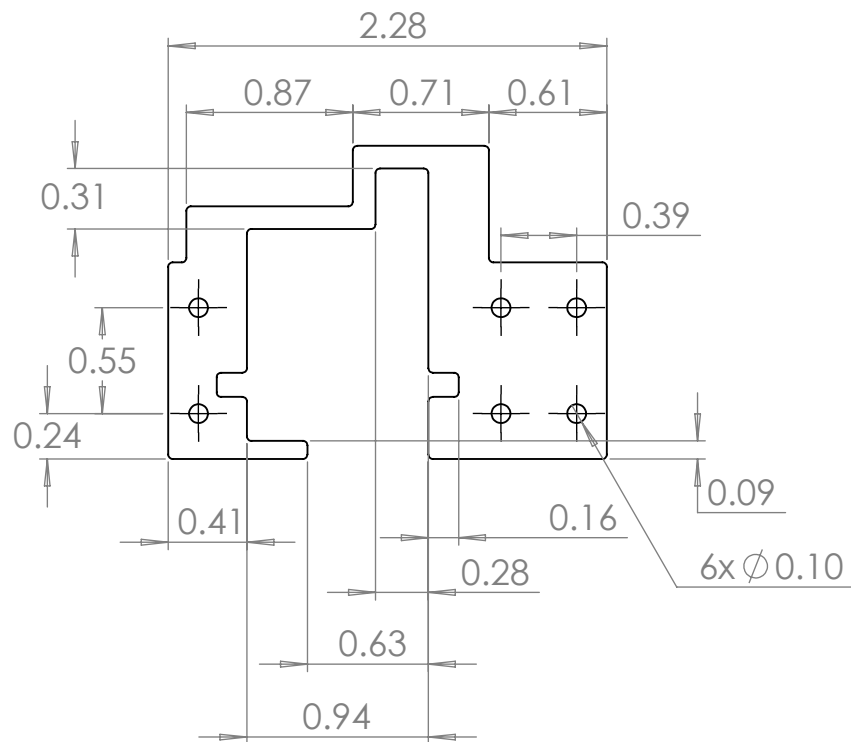
A

A

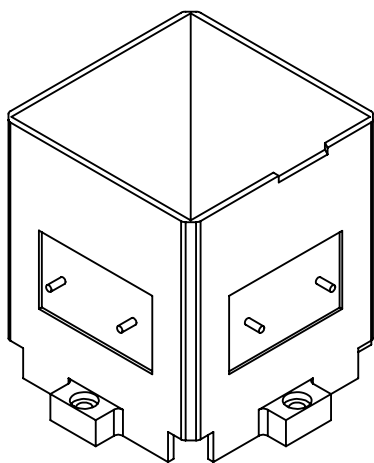
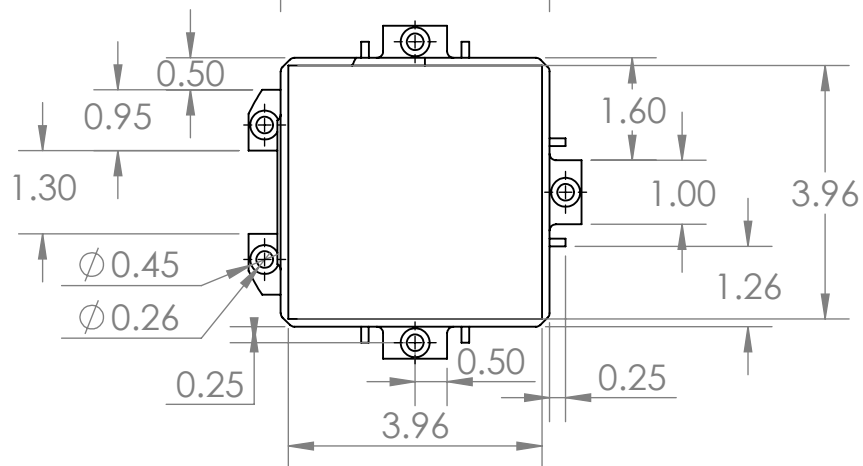
UNLESS OTHERWISE SPECIFIED:		NAME	DATE	 UVA Rocketry Team	
DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ± ANGULAR: MACH ± BEND ± TWO PLACE DECIMAL ± THREE PLACE DECIMAL ± INTERPRET GEOMETRIC TOLERANCING PER: MATERIAL 6061-T6 AL FINISH AS MACHINED DO NOT SCALE DRAWING	DRAWN	CAC	4/23	TITLE: PL LINER BACK	
	CHECKED				
	ENG APPR.				
	MFG APPR.				
	Q.A.				
	COMMENTS:			SIZE DWG. NO. REV	
			A sidepanels 1.0		
			SCALE: 1:1 WEIGHT: SHEET 1 OF 1		



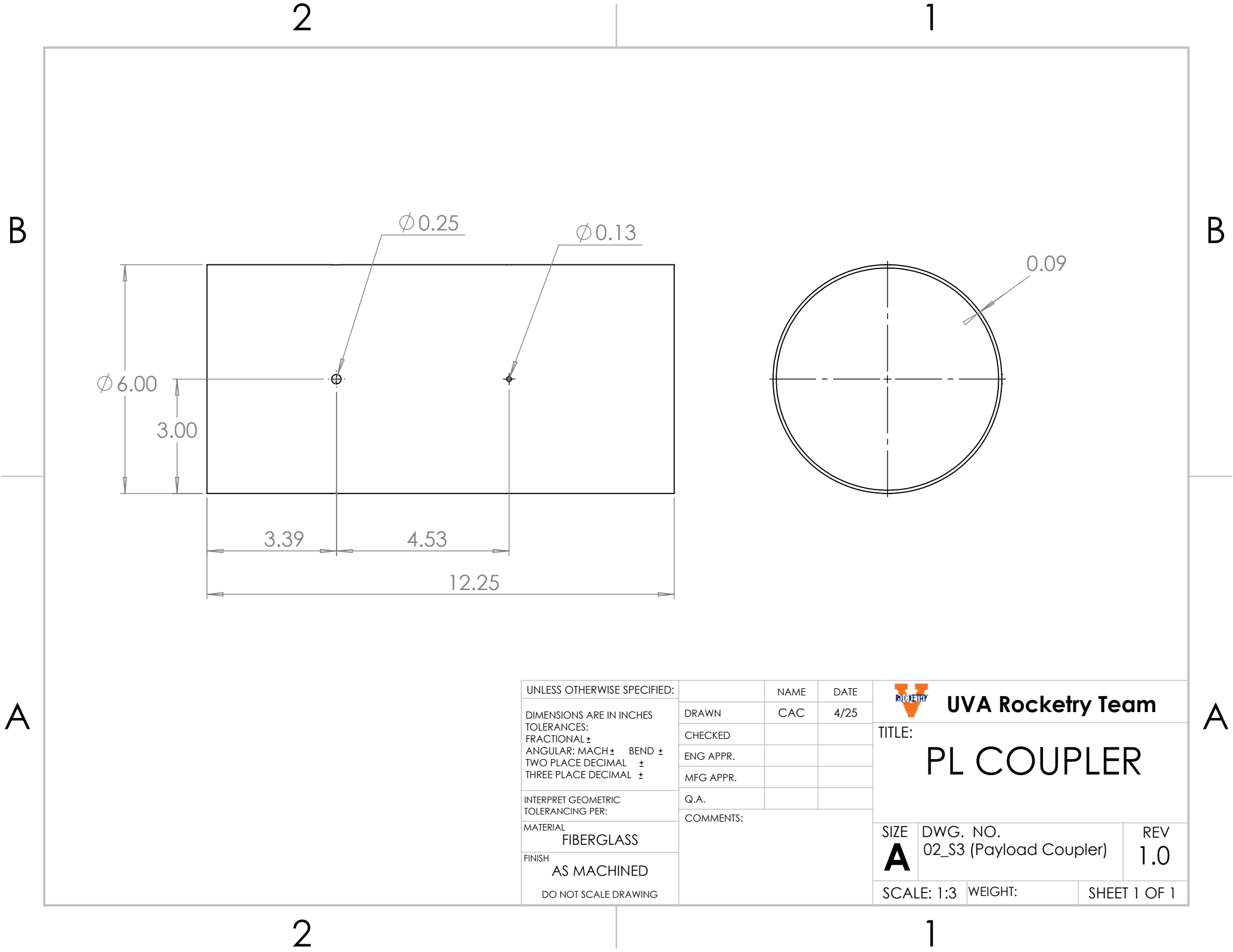
UNLESS OTHERWISE SPECIFIED:		NAME	DATE	 UVA Rocketry Team		
DIMENSIONS ARE IN INCHES		DRAWN	CAC	4/23	TITLE: PL SHELF	
TOLERANCES:		CHECKED				
FRACTIONAL ±		ENG APPR.				
ANGULAR: MACH ± BEND ±		MFG APPR.				
TWO PLACE DECIMAL ±		Q.A.				
THREE PLACE DECIMAL ±		COMMENTS:			SIZE DWG. NO. REV A 0302_MetalCubeSAT_Shelf 1.0	
INTERPRET GEOMETRIC TOLERANCING PER:						
MATERIAL						
ABS PLASTIC					SCALE: 1:2 WEIGHT: SHEET 1 OF 1	
FINISH						
AS PRINTED						
DO NOT SCALE DRAWING						



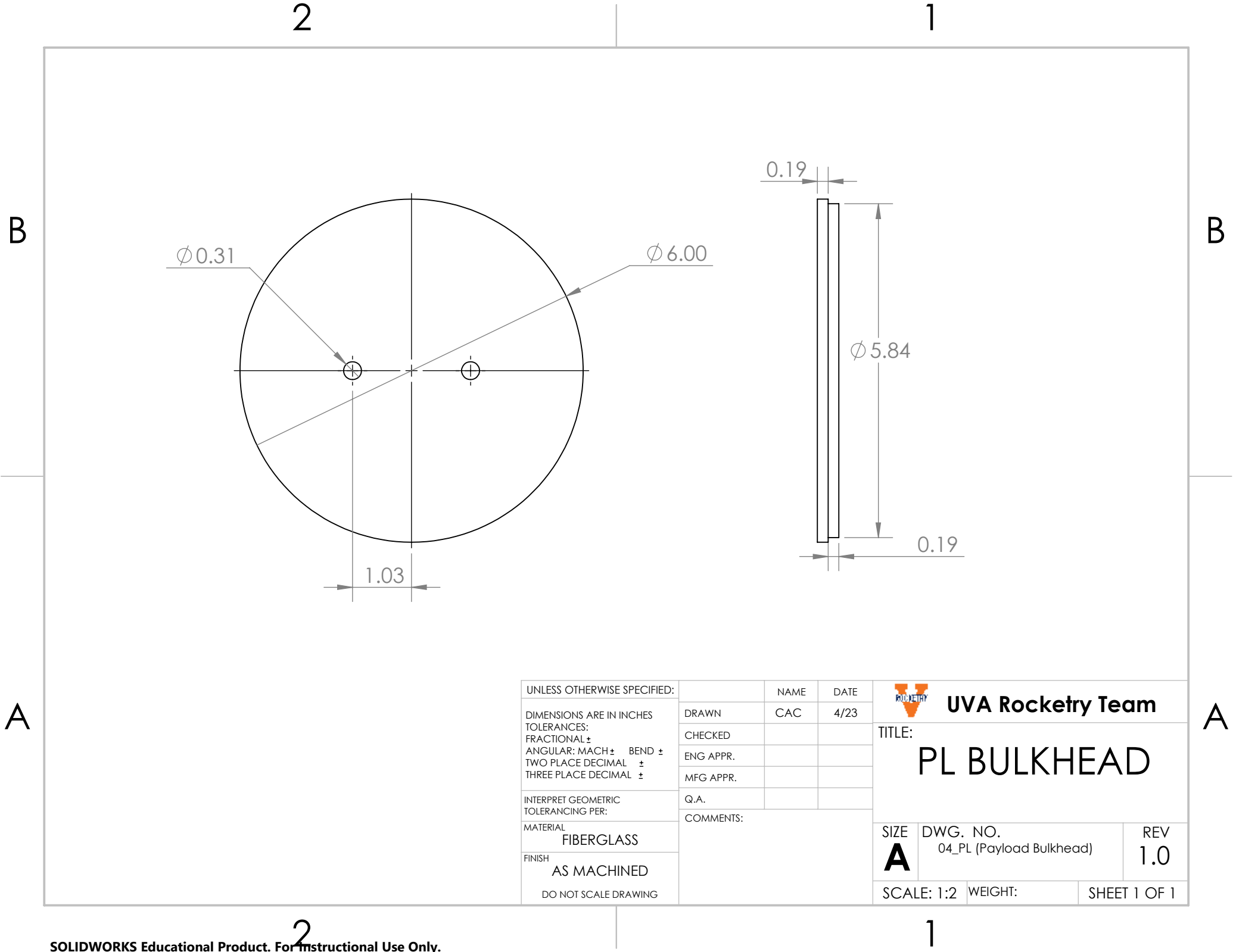
UNLESS OTHERWISE SPECIFIED:		NAME		DATE		 UVA Rocketry Team					
DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ± ANGULAR: MACH ± BEND ± TWO PLACE DECIMAL ± THREE PLACE DECIMAL ±		DRAWN	CAC	4/25		TITLE: PL SERVO HOLDER					
		CHECKED									
		ENG APPR.									
		MFG APPR.									
INTERPRET GEOMETRIC TOLERANCING PER:		Q.A.									
MATERIAL 606-T6 AL		COMMENTS:				SIZE		DWG. NO.		REV	
FINISH AS MACHINED						A		servometaladapter		1.0	
DO NOT SCALE DRAWING								SCALE: 1:1		WEIGHT:	



UNLESS OTHERWISE SPECIFIED:		NAME	DATE	 UVA Rocketry Team	
DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ± ANGULAR: MACH ± BEND ± TWO PLACE DECIMAL ± THREE PLACE DECIMAL ±	DRAWN	CAC	4/23	TITLE: PL AFT CASING	
	CHECKED				
	ENG APPR.				
	MFG APPR.				
INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.				
MATERIAL ABS PLASTIC	COMMENTS:			SIZE A	
FINISH AS PRINTED				DWG. NO. 0305_Casing_Front	
DO NOT SCALE DRAWING				REV 1.0	
			SCALE: 1:3	WEIGHT:	SHEET 1 OF 1



UNLESS OTHERWISE SPECIFIED:		NAME	DATE	 UVA Rocketry Team	
DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ± ANGULAR: MACH ± BEND ± TWO PLACE DECIMAL ± THREE PLACE DECIMAL ±		DRAWN	CAC	4/25	TITLE: PL COUPLER
		CHECKED			
		ENG APPR.			
		MFG APPR.			
INTERPRET GEOMETRIC TOLERANCING PER:		Q.A.			
MATERIAL	FIBERGLASS	COMMENTS:			
FINISH		SIZE	DWG. NO.	REV	
AS MACHINED		A	02_S3 (Payload Coupler)	1.0	
DO NOT SCALE DRAWING		SCALE: 1:3	WEIGHT:	SHEET 1 OF 1	

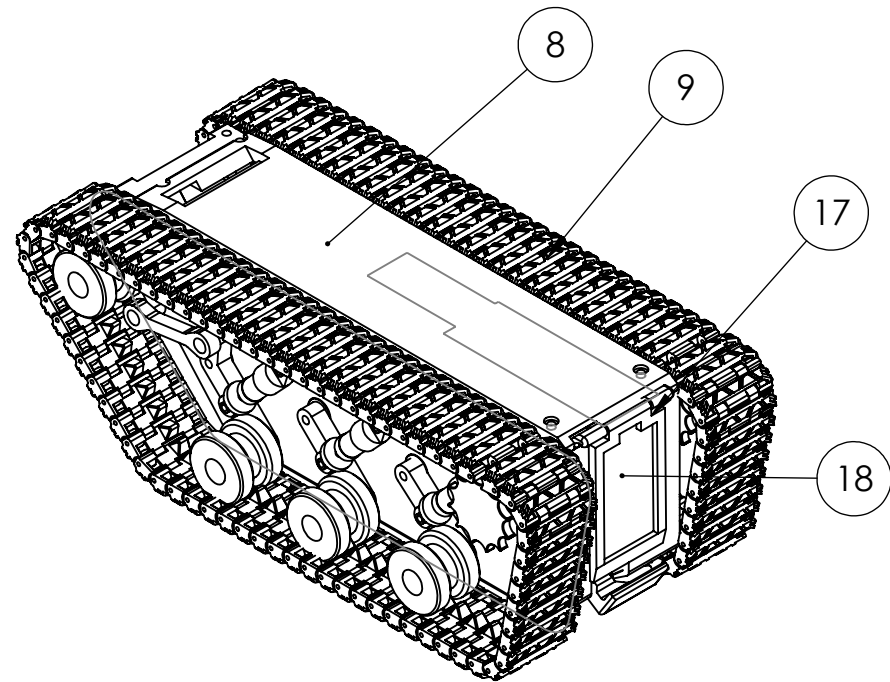


UNLESS OTHERWISE SPECIFIED:		NAME	DATE	 UVA Rocketry Team		
DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ± ANGULAR: MACH ± BEND ± TWO PLACE DECIMAL ± THREE PLACE DECIMAL ±	DRAWN	CAC	4/23	TITLE: PL BULKHEAD		
	CHECKED					
	ENG APPR.					
	MFG APPR.					
INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.			SIZE DWG. NO. REV A 04_PL (Payload Bulkhead) 1.0 SCALE: 1:2 WEIGHT: SHEET 1 OF 1		
MATERIAL FIBERGLASS	COMMENTS:					
FINISH AS MACHINED						
DO NOT SCALE DRAWING						

B

B

ITEM NO.	PART NUMBER	QTY.
1	0202p16_1_shockabsorbertop	6
2	0202p16_2_shockabsorberbottom	6
3	0202p5_roadwheel	8
4	0202p6_bearing	16
5	N20 Right Angle Gear Motor 42to1	2
6	0202p2_sprocket	2
7	0202p9_2s18540battery	1
8	0202p21_chassis top	1
9	0202p1_tread	142
10	Emax ES 9051 servo	1
11	PCB_Payload_Rev2	1
12	videounitholder	1
13	alumwheelarm	4
14	alumttwheelarm	2
15	0202p13_metal.ttadapter	2
16	1x25mmpins	1
17	Back Door Frame	1
18	plexiglassdoor	1
19	chassisbat	1
20	chassispcb	1
21	tracktensioner1	2
22	Tiltarm 9051 Servo	1



UNLESS OTHERWISE SPECIFIED:

DIMENSIONS ARE IN INCHES
 TOLERANCES:
 FRACTIONAL $\pm$
 ANGULAR: MACH $\pm$ BEND $\pm$
 TWO PLACE DECIMAL $\pm$
 THREE PLACE DECIMAL $\pm$

INTERPRET GEOMETRIC
 TOLERANCING PER:

MATERIAL

FINISH

DO NOT SCALE DRAWING

NAME DATE

DRAWN

CHECKED

ENG APPR.

MFG APPR.

Q.A.

COMMENTS:



UVA Rocketry Team

TITLE:

Rover Assembly

SIZE	DWG. NO.	REV
A	0202_V2	1.0

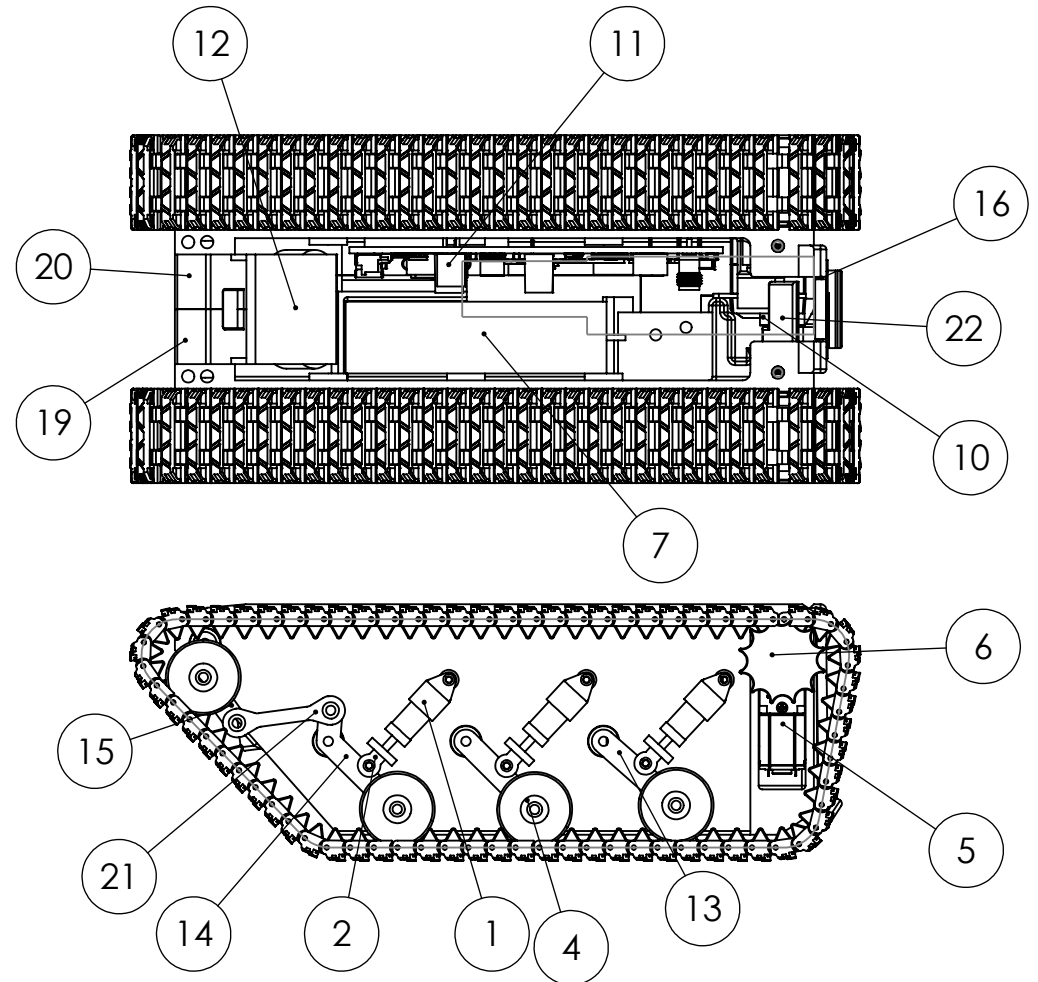
SCALE: 1:5	WEIGHT:	SHEET 1 OF 2
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A

B

B

ITEM NO.	PART NUMBER	QTY.
1	0202p16_1_shockabsorbertop	6
2	0202p16_2_shockabsorberbottom	6
3	0202p5_roadwheel	8
4	0202p6_bearing	16
5	N20 Right Angle Gear Motor 42to1	2
6	0202p2_sprocket	2
7	0202p9_2s18540battery	1
8	0202p21_chassis top	1
9	0202p1_tread	142
10	Emax ES 9051 servo	1
11	PCB_Payload_Rev2	1
12	videounitholder	1
13	alumwheelarm	4
14	alumttwheelarm	2
15	0202p13_metal.ttadapter	2
16	1x25mmpins	1
17	Back Door Frame	1
18	plexiglassdoor	1
19	chassisbat	1
20	chassispcb	1
21	tracktensioner1	2
22	Tiltarm 9051 Servo	1



A

UNLESS OTHERWISE SPECIFIED:

DIMENSIONS ARE IN INCHES
 TOLERANCES:
 FRACTIONAL $\pm$
 ANGULAR: MACH $\pm$ BEND $\pm$
 TWO PLACE DECIMAL $\pm$
 THREE PLACE DECIMAL $\pm$

INTERPRET GEOMETRIC
 TOLERANCING PER:

MATERIAL

FINISH

DO NOT SCALE DRAWING

NAME DATE

DRAWN

CHECKED

ENG APPR.

MFG APPR.

Q.A.

COMMENTS:



UVA Rocketry Team

TITLE:

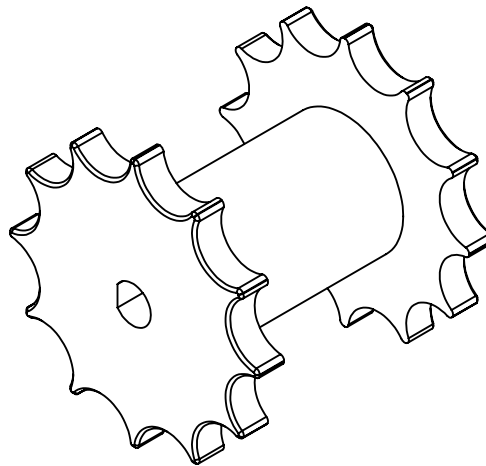
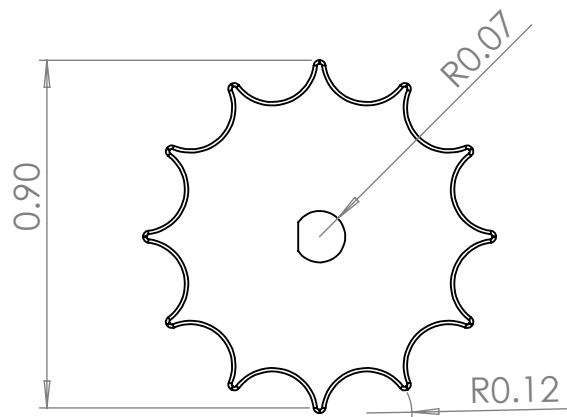
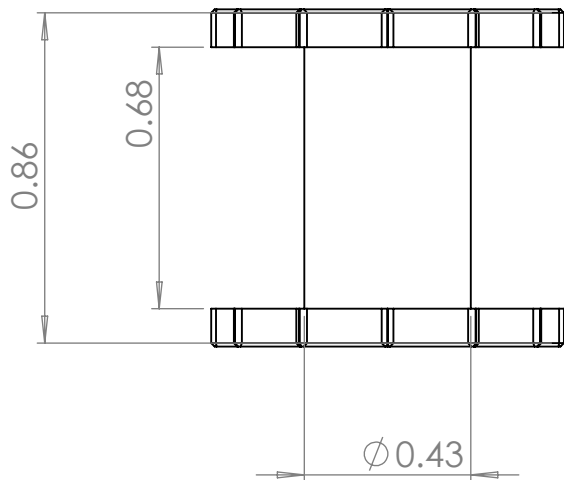
Rover Assembly

SIZE	DWG. NO.	REV
A	0202_V2	1.0

SCALE: 1:5	WEIGHT:	SHEET 2 OF 2
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B

B

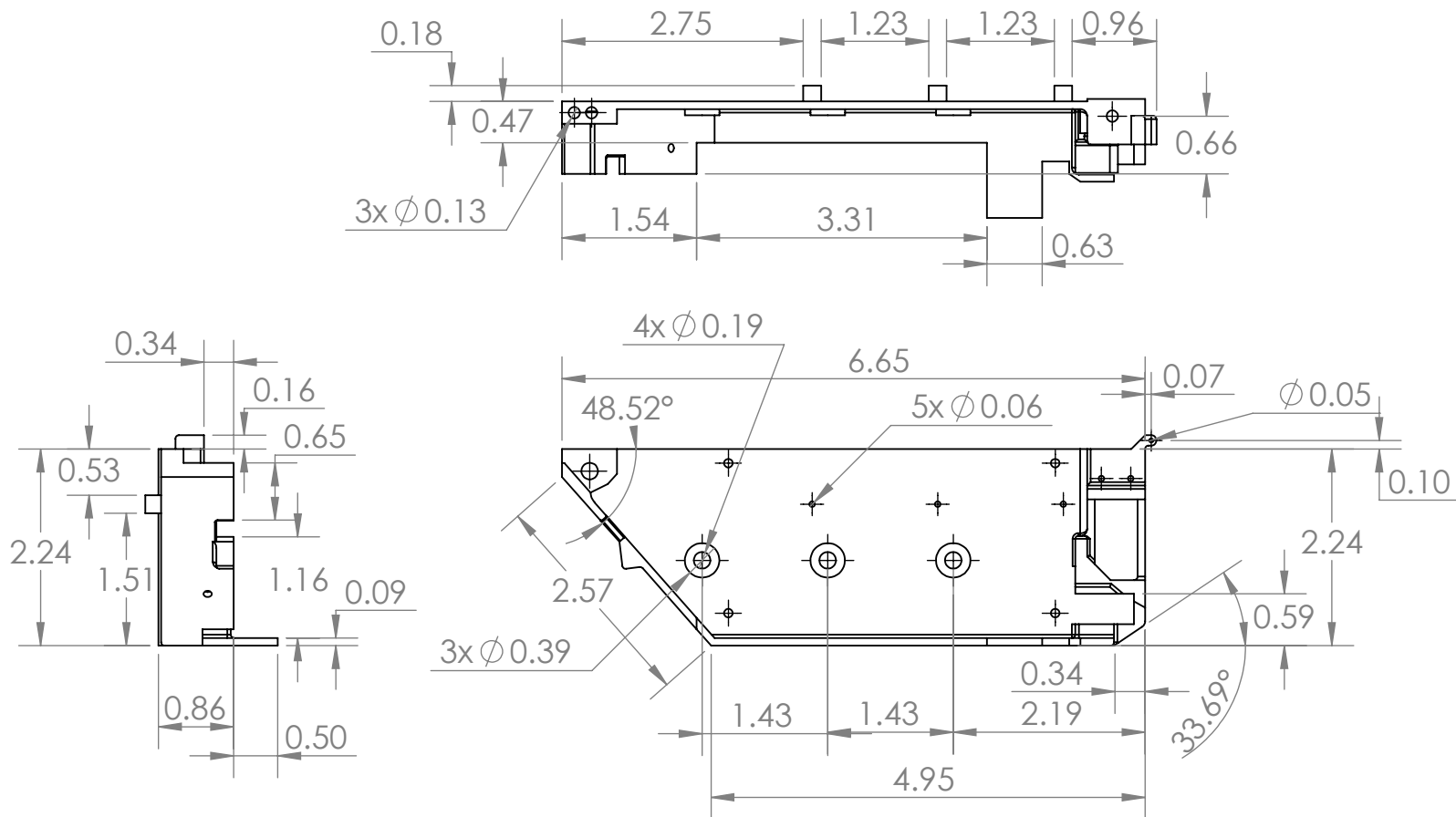


UNLESS OTHERWISE SPECIFIED:		NAME	DATE	 UVA Rocketry Team	
DIMENSIONS ARE IN INCHES		DRAWN	AC		
TOLERANCES:		CHECKED		TITLE: ROVER SPROCKET	
FRACTIONAL $\pm$		ENG APPR.			
ANGULAR: MACH $\pm$ BEND $\pm$		MFG APPR.			
TWO PLACE DECIMAL $\pm$		Q.A.		SIZE DWG. NO. REV A 0202p2_sprocket 1.0	
THREE PLACE DECIMAL $\pm$		COMMENTS:			
INTERPRET GEOMETRIC TOLERANCING PER:					
MATERIAL PA6-GF25 NYLON				SCALE: 2:1 WEIGHT: SHEET 1 OF 1	
FINISH AS PRINTED					
DO NOT SCALE DRAWING					

A

B

B



UNLESS OTHERWISE SPECIFIED:

DIMENSIONS ARE IN INCHES
 TOLERANCES:
 FRACTIONAL $\pm$
 ANGULAR: MACH $\pm$ BEND $\pm$
 TWO PLACE DECIMAL $\pm$
 THREE PLACE DECIMAL $\pm$

INTERPRET GEOMETRIC
 TOLERANCING PER:

MATERIAL
 PA6-GF25 NYLON

FINISH
 AS PRINTED

DO NOT SCALE DRAWING

DRAWN

NAME

CAC

DATE

4/25

CHECKED

ENG APPR.

MFG APPR.

Q.A.

COMMENTS:



UVA Rocketry Team

TITLE:

PL ROVER PCB
 CHASSIS

SIZE

A

DWG. NO.

0202p20_modifiedchassis_PCB_Side

REV

1.0

SCALE: 1:2

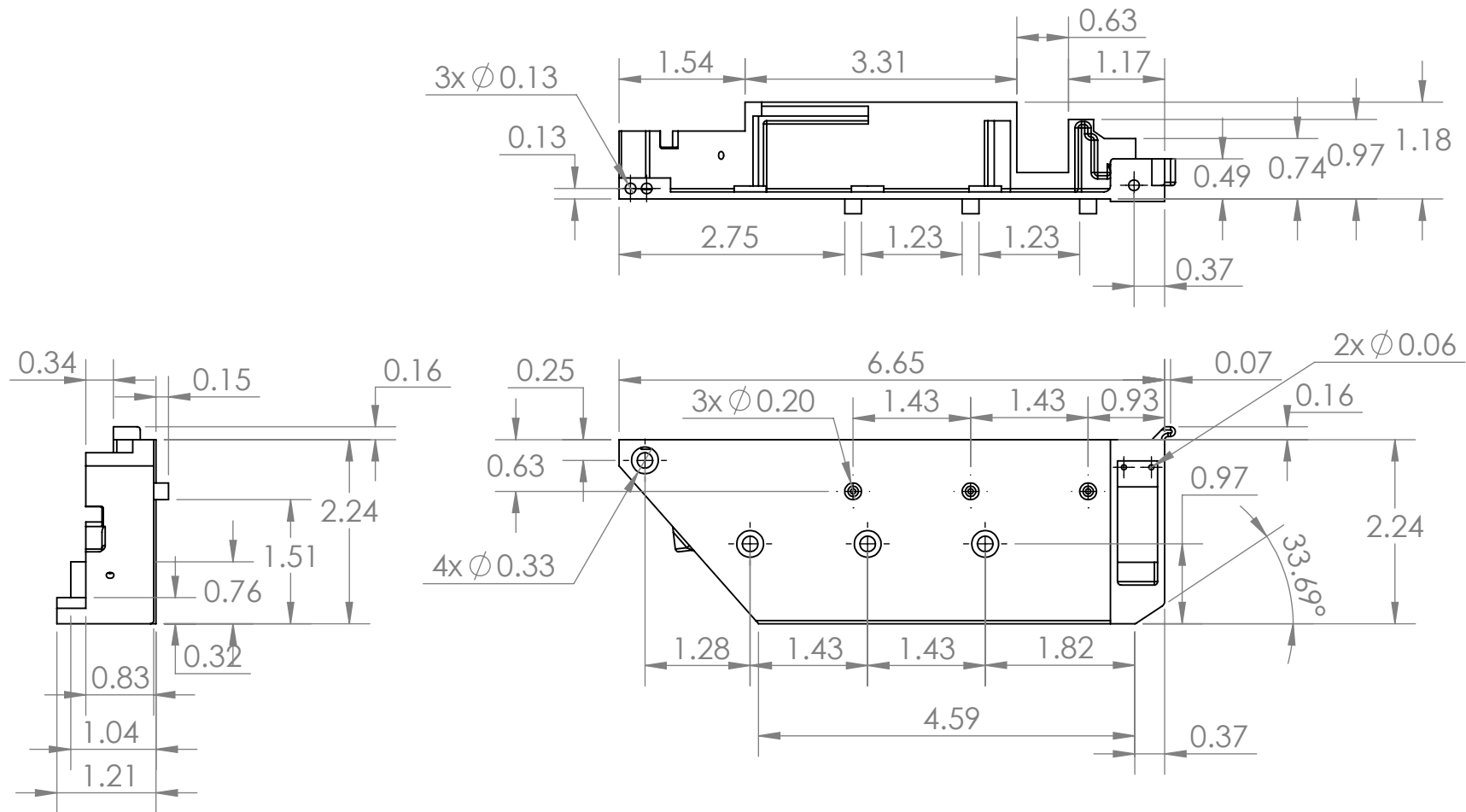
WEIGHT:

SHEET 1 OF 1

A

B

B



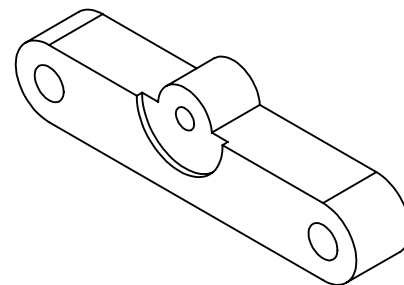
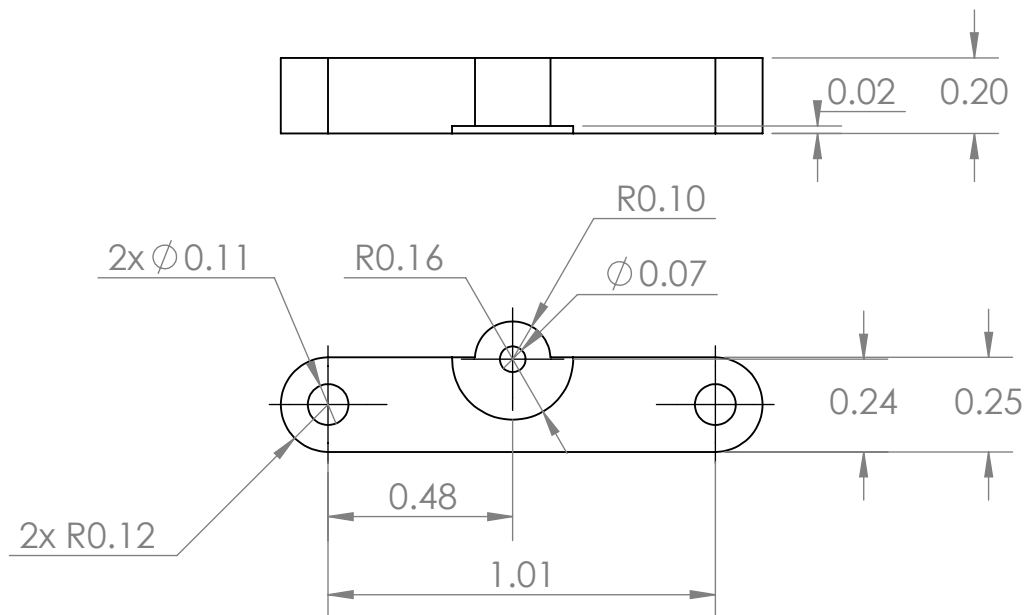
A

A

UNLESS OTHERWISE SPECIFIED:		NAME	DATE	 UVA Rocketry Team	
DIMENSIONS ARE IN INCHES		DRAWN	CAC		
TOLERANCES:		CHECKED			
FRACTIONAL ±		ENG APPR.			
ANGULAR: MACH ± BEND ±		MFG APPR.			
TWO PLACE DECIMAL ±		Q.A.		TITLE: PL ROVER BATTERY CHASSIS	
THREE PLACE DECIMAL ±		COMMENTS:			
INTERPRET GEOMETRIC TOLERANCING PER:		SIZE		DWG. NO.	REV
MATERIAL		A		0202p20_modifiedchassis_Battery_Side	1.0
FINISH		SCALE: 1:2		WEIGHT:	SHEET 1 OF 1
AS PRINTED					
DO NOT SCALE DRAWING					

B

B

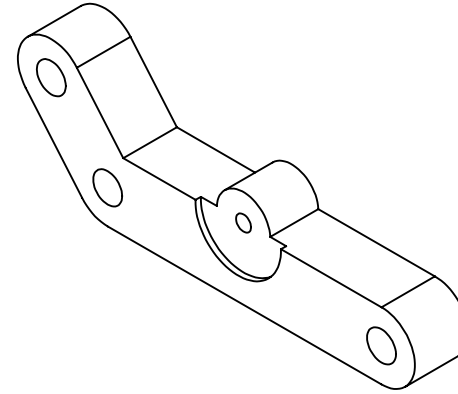
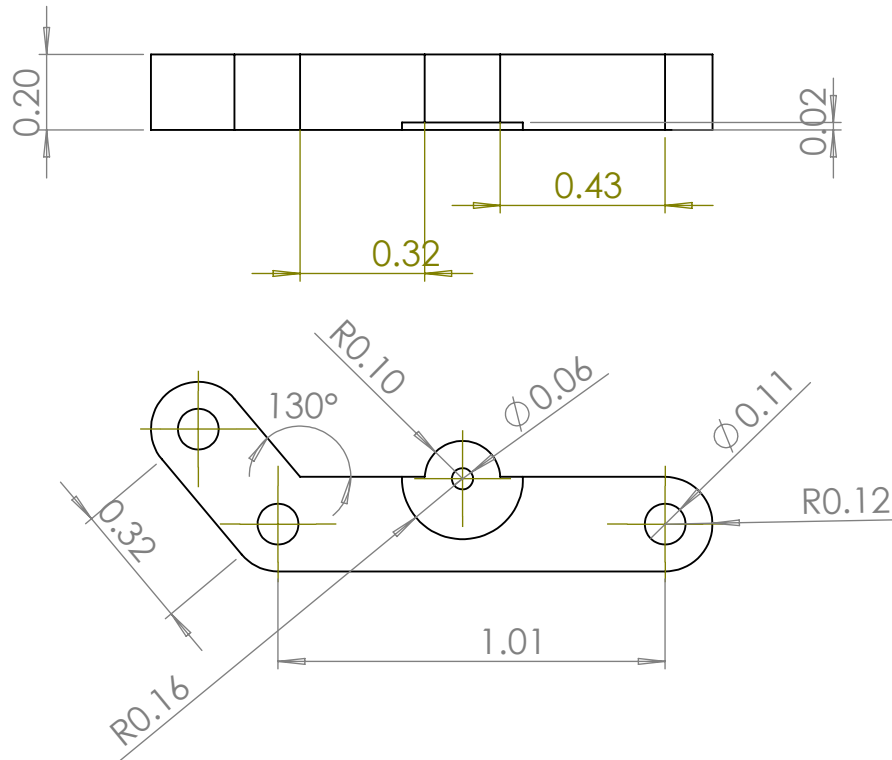


A

A

UNLESS OTHERWISE SPECIFIED:		NAME		DATE		 UVA Rocketry Team	
DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ± ANGULAR: MACH ± BEND ± TWO PLACE DECIMAL ± THREE PLACE DECIMAL ±		DRAWN	CAC	4/25		TITLE: PL WHEEL ARM	
		CHECKED					
		ENG APPR.					
		MFG APPR.					
INTERPRET GEOMETRIC TOLERANCING PER:		Q.A.				SIZE A DWG. NO. 0202p17_wheelarm REV 1.0	
MATERIAL 6061-T6 AL		COMMENTS:					
FINISH AS MACHINED							
DO NOT SCALE DRAWING						SCALE: 2:1 WEIGHT: SHEET 1 OF 1	

B



B

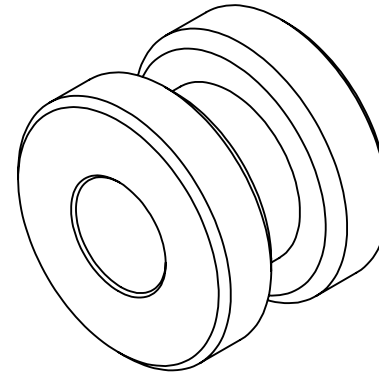
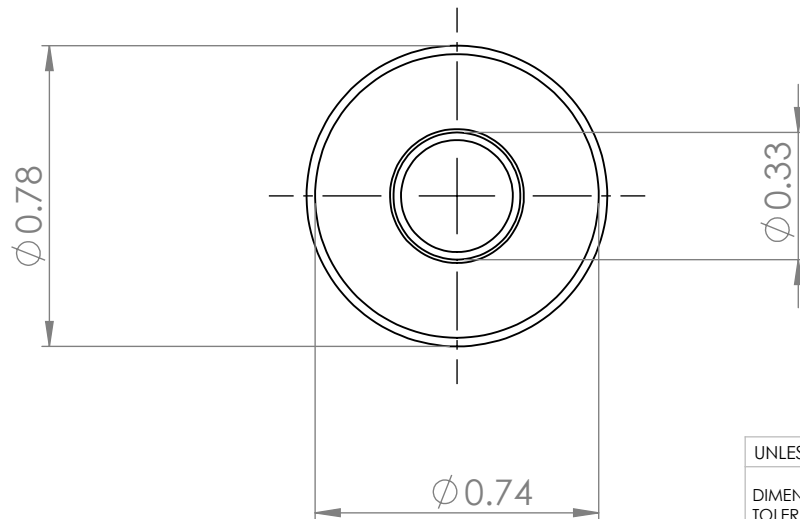
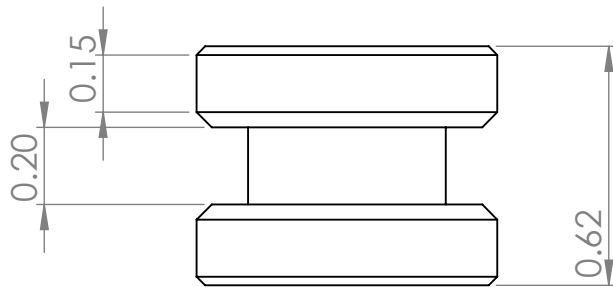
A

UNLESS OTHERWISE SPECIFIED:		NAME	DATE	 UVA Rocketry Team	
DIMENSIONS ARE IN INCHES		DRAWN	AC		
TOLERANCES:		CHECKED			
FRACTIONAL ±		ENG APPR.			
ANGULAR: MACH ± BEND ±		MFG APPR.			
TWO PLACE DECIMAL ±		Q.A.		TITLE: TRACK TENSIONER	
THREE PLACE DECIMAL ±		COMMENTS:			
INTERPRET GEOMETRIC TOLERANCING PER:		SIZE		DWG. NO.	REV
MATERIAL		A		0202p18_ttroadwheel	1.0
FINISH		SCALE: 2:1		WEIGHT:	SHEET 1 OF 1
AS MACHINED					
DO NOT SCALE DRAWING					

A

B

A



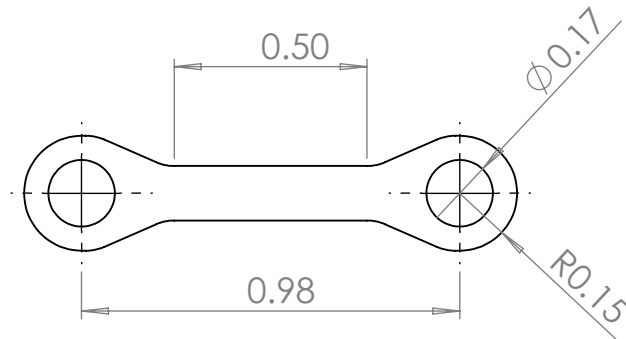
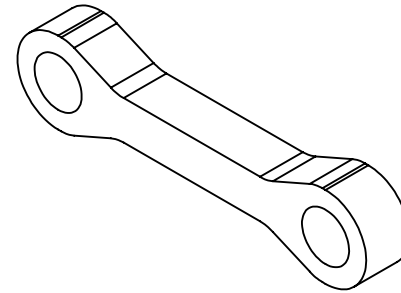
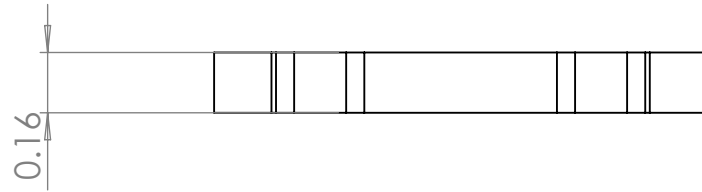
B

A

UNLESS OTHERWISE SPECIFIED:		NAME	DATE	 UVA Rocketry Team	
DIMENSIONS ARE IN INCHES		DRAWN	WH		
TOLERANCES:		CHECKED			
FRACTIONAL ±		ENG APPR.			
ANGULAR: MACH ± BEND ±		MFG APPR.			
TWO PLACE DECIMAL ±		Q.A.		TITLE: ROVER WHEEL	
THREE PLACE DECIMAL ±		COMMENTS:			
INTERPRET GEOMETRIC TOLERANCING PER:		SIZE		DWG. NO.	REV
MATERIAL		A		0202p5_roadwheel	1.0
FINISH		SCALE: 2:1		WEIGHT:	SHEET 1 OF 1
AS PRINTED					
DO NOT SCALE DRAWING					

B

B



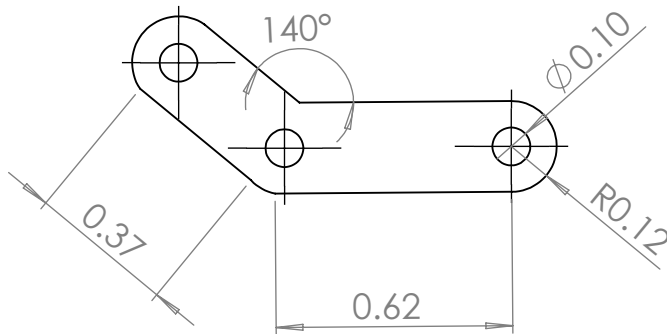
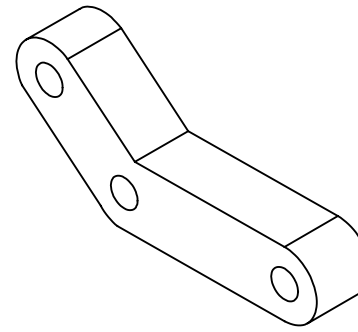
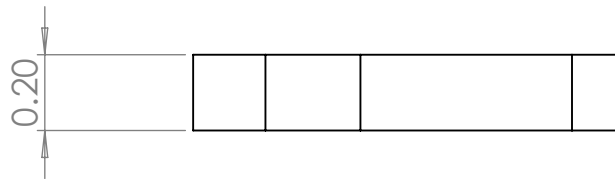
A

A

UNLESS OTHERWISE SPECIFIED:		NAME	DATE	 UVA Rocketry Team		
DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ± ANGULAR: MACH ± BEND ± TWO PLACE DECIMAL ± THREE PLACE DECIMAL ±	DRAWN	AC	4/25/26	TITLE: TRACK TENSIONER		
	CHECKED					
	ENG APPR.					
	MFG APPR.					
INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.			SIZE DWG. NO. REV A tracktensioner1 1.0		
MATERIAL	COMMENTS:					
6061-T6 AL						
FINISH						
AS MACHINED				SCALE: 2:1 WEIGHT: SHEET 1 OF 1		
DO NOT SCALE DRAWING						

B

B



A

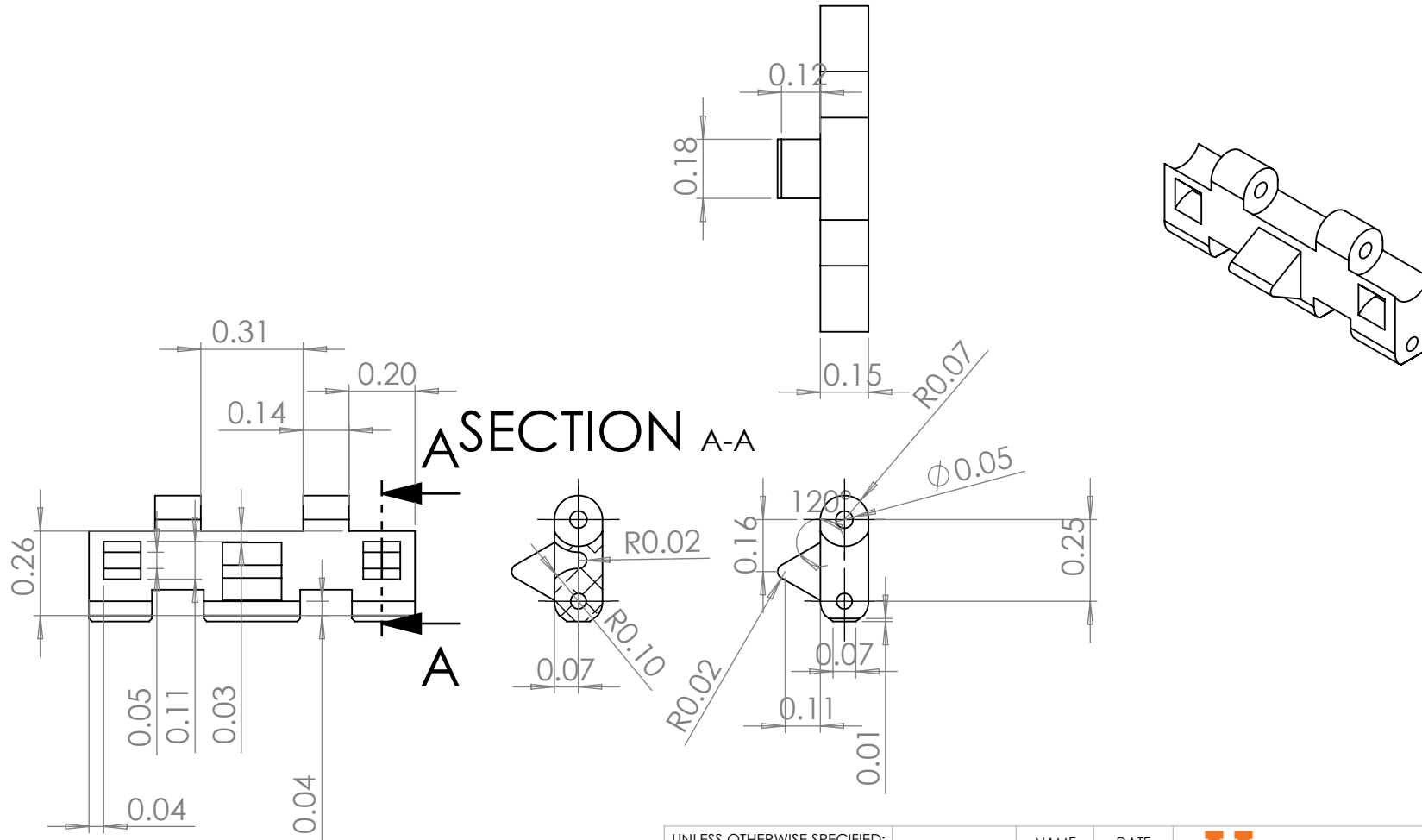
UNLESS OTHERWISE SPECIFIED:		NAME	DATE	 UVA Rocketry Team		
DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ± ANGULAR: MACH ± BEND ± TWO PLACE DECIMAL ± THREE PLACE DECIMAL ±	DRAWN	AC	4/25/26	TITLE: TT ADAPTER		
	CHECKED					
	ENG APPR.					
	MFG APPR.					
INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.			SIZE DWG. NO. REV A 0202p13_metal.ttadapter 1.0		
MATERIAL	COMMENTS:					
6061-T6 AL						
FINISH						
AS MACHINED				SCALE: 2:1 WEIGHT: SHEET 1 OF 1		
DO NOT SCALE DRAWING						

A

B

1

B



SECTION A-A

A

A

UNLESS OTHERWISE SPECIFIED:

DIMENSIONS ARE IN INCHES
 TOLERANCES:
 FRACTIONAL $\pm$
 ANGULAR: MACH $\pm$ BEND $\pm$
 TWO PLACE DECIMAL $\pm$
 THREE PLACE DECIMAL $\pm$

INTERPRET GEOMETRIC
 TOLERANCING PER:

MATERIAL
 ABS PLASTIC

FINISH
 AS PRINTED

DO NOT SCALE DRAWING

DRAWN

NAME

AC

DATE

4/25/26

CHECKED

ENG APPR.

MFG APPR.

Q.A.

COMMENTS:



UVA Rocketry Team

TITLE:

TREAD

SIZE

A

DWG. NO.

0202p1_tread

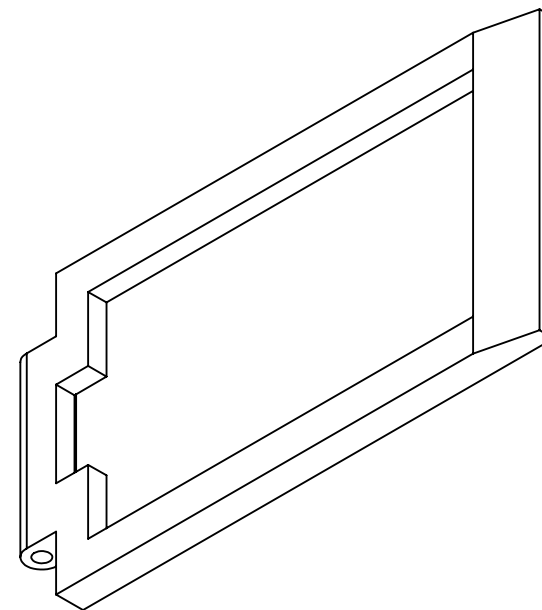
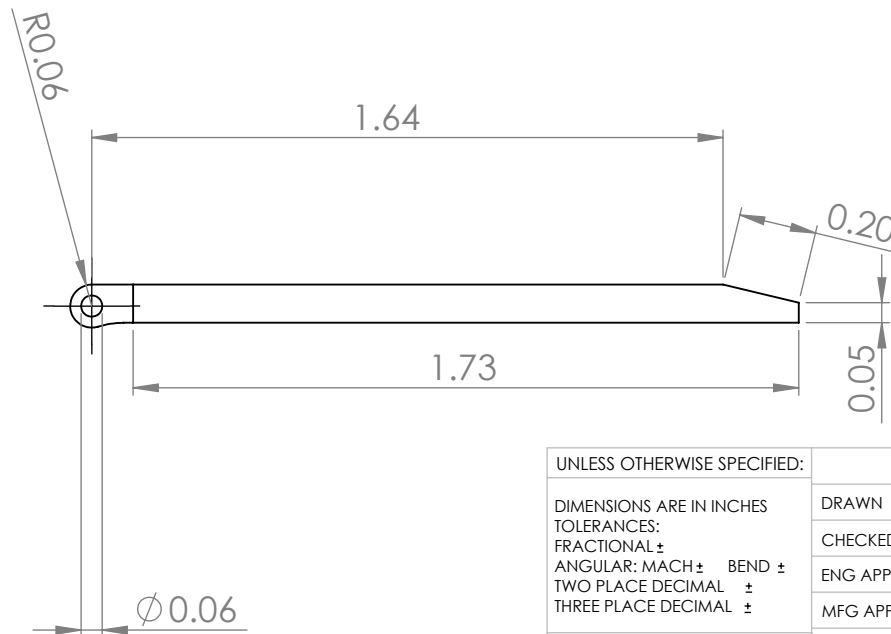
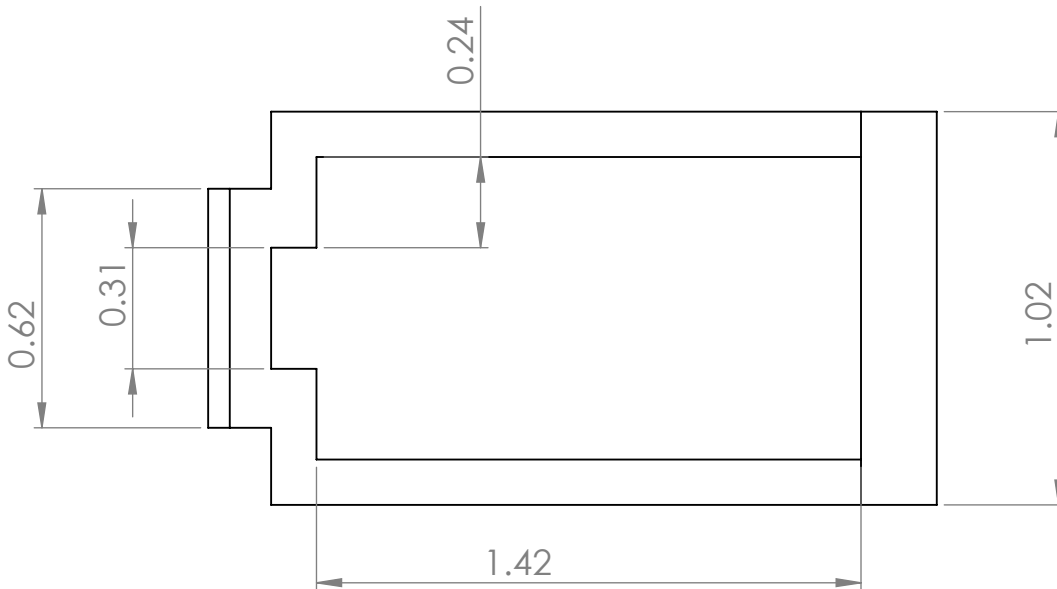
REV

1.0

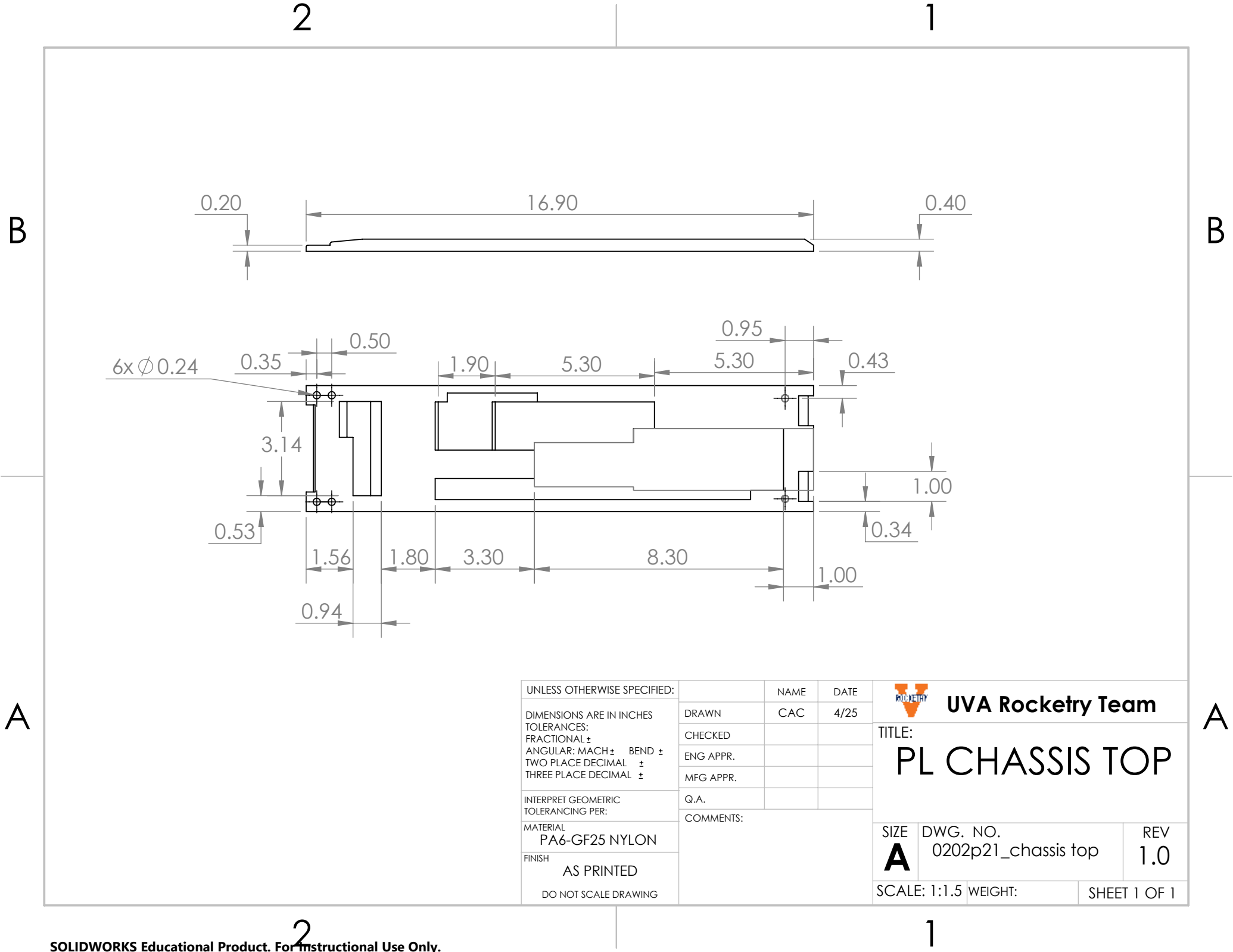
SCALE: 2:1

WEIGHT:

SHEET 1 OF 1



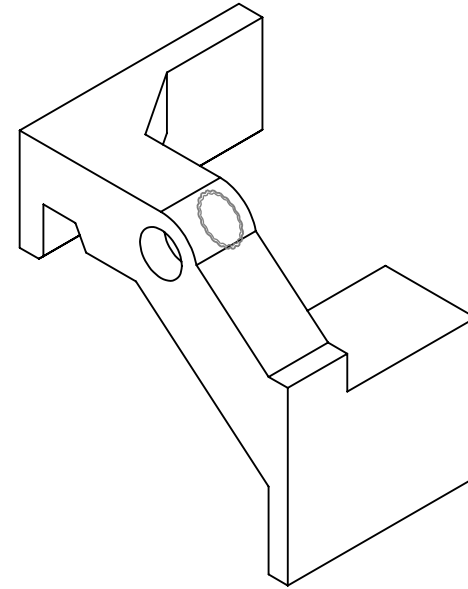
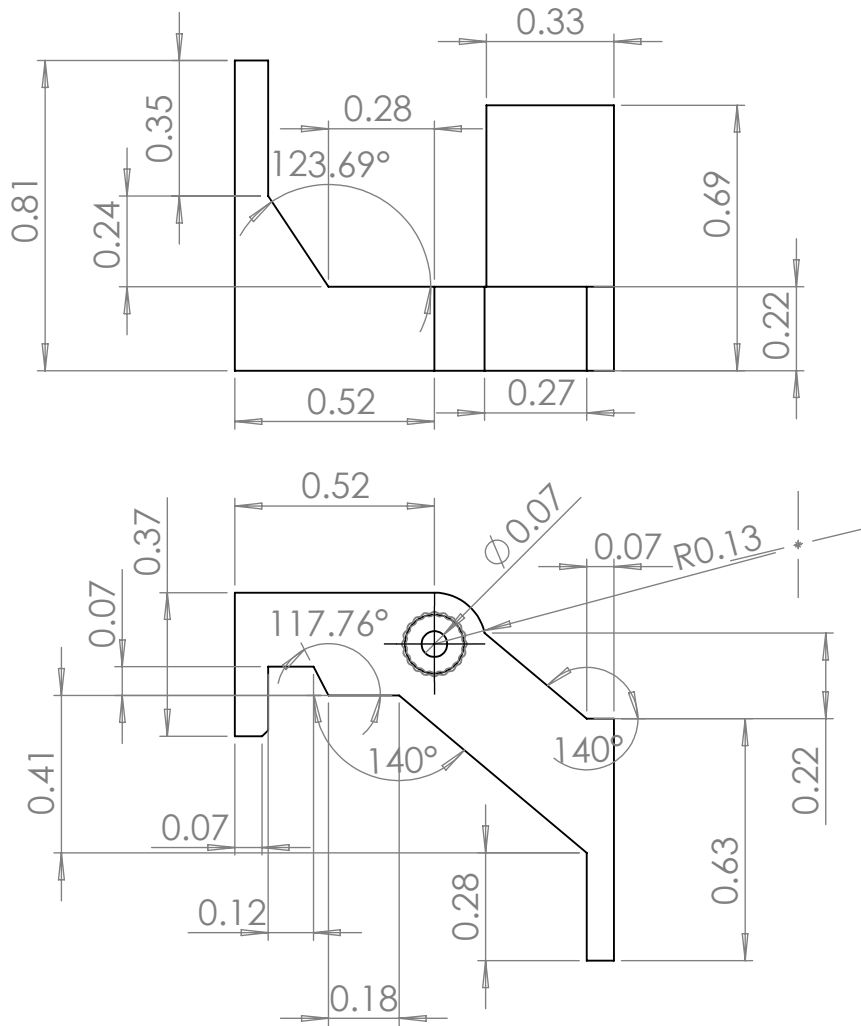
UNLESS OTHERWISE SPECIFIED:		NAME	DATE	 UVA Rocketry Team		
DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ± ANGULAR: MACH ± BEND ± TWO PLACE DECIMAL ± THREE PLACE DECIMAL ±		DRAWN	WH	04/25/26	TITLE: BACK DOOR FRAME	
		CHECKED				
		ENG APPR.				
		MFG APPR.				
INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.					
MATERIAL PA6-GF25 NYLON	COMMENTS:			SIZE A	DWG. NO. Part5	REV 1.0
FINISH AS PRINTED				SCALE: 2:1	WEIGHT:	SHEET 1 OF 1
DO NOT SCALE DRAWING						



UNLESS OTHERWISE SPECIFIED:		NAME	DATE	 UVA Rocketry Team	
DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ± ANGULAR: MACH ± BEND ± TWO PLACE DECIMAL ± THREE PLACE DECIMAL ±		DRAWN	CAC	4/25	TITLE: PL CHASSIS TOP
		CHECKED			
		ENG APPR.			
		MFG APPR.			
		Q.A.			
INTERPRET GEOMETRIC TOLERANCING PER:	COMMENTS:				
MATERIAL PA6-GF25 NYLON					
FINISH AS PRINTED					
DO NOT SCALE DRAWING					
		SIZE A	DWG. NO. 0202p21_chassis top		REV 1.0
		SCALE: 1:1.5		WEIGHT:	SHEET 1 OF 1

B

A



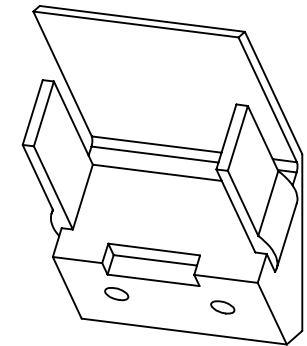
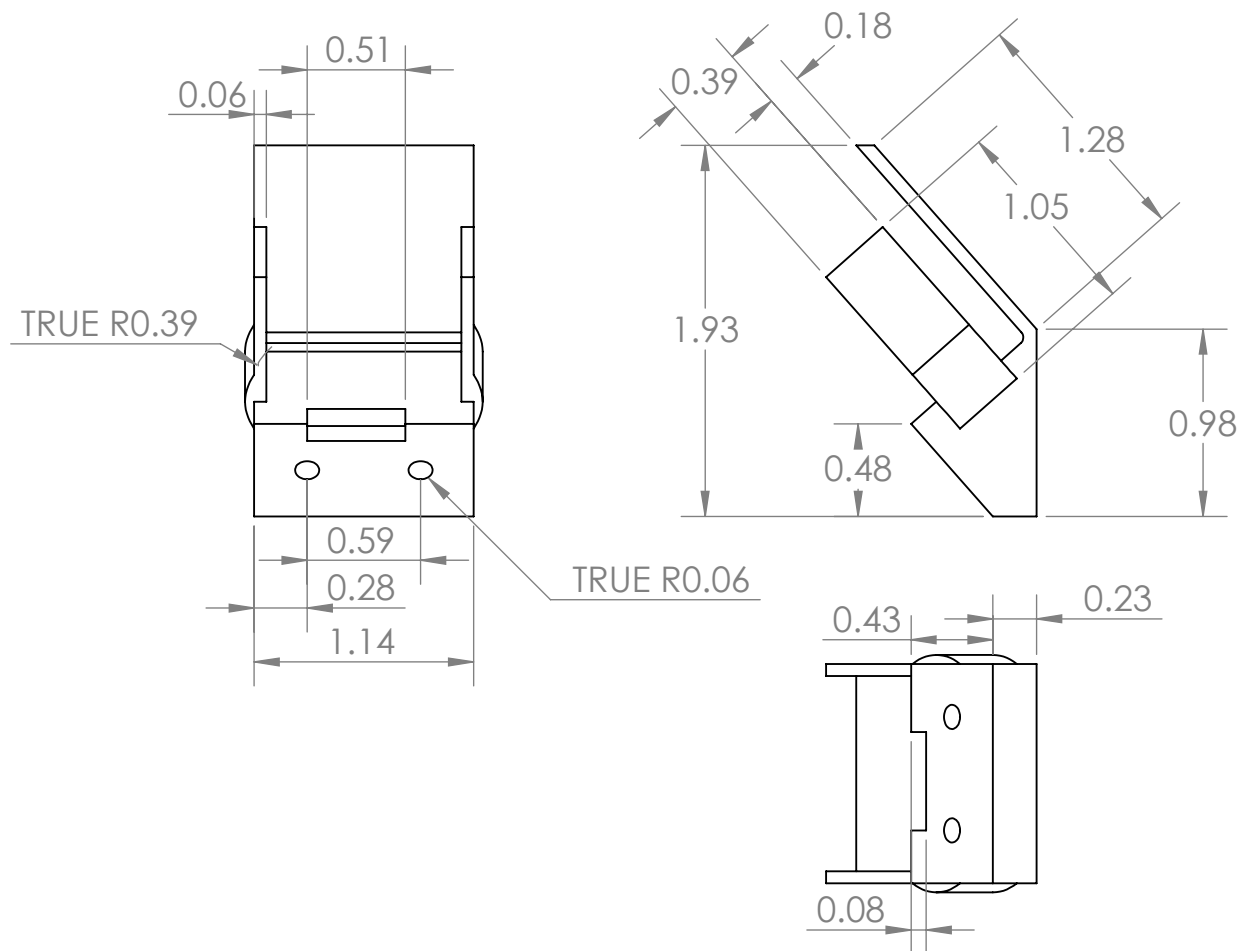
B

A

UNLESS OTHERWISE SPECIFIED:		NAME	DATE	 UVA Rocketry Team TITLE: TILTARM	
DIMENSIONS ARE IN INCHES		DRAWN	AC		
TOLERANCES:		CHECKED			
FRACTIONAL ±		ENG APPR.			
ANGULAR: MACH ± BEND ±		MFG APPR.			
TWO PLACE DECIMAL ±		Q.A.		SIZE	DWG. NO.
THREE PLACE DECIMAL ±		COMMENTS:		A	Tiltarm 9051 Servo
INTERPRET GEOMETRIC TOLERANCING PER:				SCALE: 2:1	WEIGHT:
MATERIAL					SHEET 1 OF 1
ABS PLASTIC					
FINISH					
AS PRINTED					
DO NOT SCALE DRAWING					

B

B



A

UNLESS OTHERWISE SPECIFIED:		NAME	DATE	 UVA Rocketry Team
DIMENSIONS ARE IN INCHES		DRAWN	CAC	
TOLERANCES:		CHECKED		
FRACTIONAL ±		ENG APPR.		
ANGULAR: MACH ± BEND ±		MFG APPR.		
TWO PLACE DECIMAL ±		Q.A.		TITLE: PL CAMERA HOLDER
THREE PLACE DECIMAL ±		COMMENTS:		
INTERPRET GEOMETRIC TOLERANCING PER:				SIZE A
MATERIAL				DWG. NO. videounitholder
FINISH				REV 1.0
ABS PLASTIC				SCALE: 1:1
AS PRINTED				WEIGHT:
DO NOT SCALE DRAWING				SHEET 1 OF 1

Acknowledgments

The UVA Rocketry Team would like to express sincere gratitude to all of the organizations and individuals who supported the development of *Sabre III* and its subsystems. First, the team would like to thank advisors Dr. Elaine Russell, Mr. Ben Russell, and Professor Mike McPherson. Elaine and Ben have worked with the team as Tripoli Level 3 Advisors since the 2024 Spaceport America Cup—the team’s first entry into the competition. Elaine has also served as the team’s Flier of Record for all three years. Professor McPherson has worked with the team as faculty advisor for the past three years as well, helping navigate relations with SEAS as well as providing technical advice to the team.

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