To: The Experimental Sounding Rocket Association
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Subj: SA Cup initial progress report

Body

The Idaho State University 2019 SA cup team had a design and parts ordered for the completion of the rocket to be used in the competition; however, the competition was canceled due to Covid 19. The team was considering how to test the rocket prior to the competition as Idaho State University lacks a faculty member with a L3 certification required to launch the rocket.

The 2020 Idaho State University team has made the decision to scale the full-size rocket by 1/10 with the consideration of the design of the previous year's team for the rocket. This scaled rocket will allow the 2020 team to make and test changes to the previous year's design without the need of a L3 certification for test launches.

The choice to scale the rocket to be launched at the SA cup includes the following objectives:

- Calculate the most accurate size to scale the rocket for testing
- Order components that closely match the size and weight of the components to be used in the full-size rocket
- Build the scaled rocket to match the construction of the full-sized rocket.
- Test the scaled rocket and consider modifications to improve the performance of the design.
- Implement parts for both the scaled and full-sized rocket into the design and recalculate the simulation of the rocket.
- Complete construction of the full scaled rocket to match the construction of the final configuration of the scaled rocket.
- Invite the L3 certified member of the team to witness the final launching of the tested scaled rocket and to advise and witness the launching of the full-scale rocket prior to the competition.

A brief description of what experimentation was performed as well as a description of the setup. The use of figures (showing the mechanical and electrical setup) and tables (showing the list of equipment used) is required and may suffice in some situations. It is appropriate to place these figures/tables in the appendix and reference them from the text.

To best create an accurate model rocket to simulate the launch of the large rocket, the engine must be capable of lifting a scaled down weight which reaches a scaled down apogee of 1000 ft. In order to best replicate the effects of the large rocket, the dynamic similitude calculations [1] were used to determine acceptable velocities for the model's engine. It was determined the C, D, and E class model rocket engines were possible options for the design of the model rocket.

OpenRocket simulation software was used in order to determine which particular C, D, or E class engine would be best suited. The C11-7 engine would be the best choice for matching a scaled down version of the large rocket's size, but it did not produce enough thrust to be a viable option. Ultimately, the D10-7 was chosen to be the best engine for the model rocket.

Decision matrix for the engine options. 3 is the highest score and 1 is the lowest

Engine				
	Thrust	Impulse	Lift	Total Weight
E12-6	2	3	2	7
C11-7	1	1	1	3
D10-7	3	2	3	8

From this decision, and the consideration of the size of the body tube, the nosecone, fins and payload components were then chosen. In using this process to select the components, the scaled rocket will closely match the size and weight of the full-sized rocket.

Through the use of a closely scaled rocket, the 2020 Idaho State University team is able to test the designs included in the full sized rocket without the need for the Idaho club member driving across state or the risk of damaging the full sized rocket prior to the competition in June 2021.

The following table includes the parts that were ordered by the previous senior design team as well as the remaining parts that were ordered by this team. As of December 2020, all parts have arrived and are currently being assembled.

Kit/Part	Use	Amount	Cost	Link
CPR-MAX for 6.0 inch	Recovery System	1	$164.95	https://publicmissiles.com/product/cpr3000systems
KS-98-MOT TUB	Motor Tube	1	$30.99	https://publicmissiles.com/product/motormounts
PAR-36	Main Parachute	1	$35.95	https://publicmissiles.com/product/recoverycomponents
LRL-15-2	Launch Rail	1	$12.95	https://publicmissiles.com/product/hardware
BBONE-AI	Controller	1	$127.43	https://www.mouser.com
StratoLogger CF	Altimeter	1	$79.95	http://www.perfectflitedirect.com/stratologger-altimeter/
RTx/GPS System	Radio/GPS Tracking	1	$259.95	https://www.missileworks.com/products/
Arducam Sony	Camera	1	$64.99	https://www.robotshop.com
Salon RPi Power Relay Module	Power	1	$16.99	https://www.amazon.com/Electronics-Salon-Power-Expansion-Module-Raspberry
Wireless Launch Control System	Launch Control	1	$45.78	https://www.apogeerockets.com/
PAR-18	Drogue Chute	1	$25.95	https://publicmissiles.com/product/recoverycomponents
CFAF-6.0-UL-90	Body Tube	2	$299.95	https://publicmissiles.com/secure/compo

				nents.asp?groupid=223200310094593
ABS Nosecone	Nosecone	1		3D Printed
ABS Fins	Fins	4		3D Printed

Appendix

References:

[1] P. M. Gerhart, *Fundamentals of Fluid Mechanics Munson*. Hoboken, NJ: Wiley, 2016.

Equations:

Equations for fluid comparison [1]

	$Re = \left(\frac{\rho V L}{\mu}\right)$	[Eq. 7.1] [Fund. Fluid Mech]
	$V_{model} = V_{experimental} * \left(\frac{\rho_{exp}}{\rho_{model}}\right) * \left(\frac{L_{exp}}{L_{model}}\right) * \left(\frac{\mu_{exp}}{\mu_{model}}\right)$	[Eq. 7.2] [Fund. Fluid Mech]