Project Icarus Subscale Summary

Project Icarus Team

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The objective for the Project Icarus Subscale Demonstration is to support the eventual full-scale Project Icarus launch, to complete the following objectives - one, design, construct, and launch a rocket to reach 100 km ASL altitude, commonly referred to as the Karman Line or the edge of space, and two, safely recover the launch vehicle in such condition that it can be flown again. The subscale demonstration flight will use the same basic two-stage design with a minimum diameter upper stage, aluminum and fiberglass transition, and composite airframe, as well as functioning as a test bed for much of the recovery electronics designed to be flown on the full scale vehicle.

However, the subscale will be substantially smaller than the full scale, with only a 75 mm diameter booster and 55 mm diameter upper stage. It will consequently reach a much lower apogee on its planned test flight, only reaching approximately 4.5 kilometers AGL. However, motor selection was tailored to match peak accelerations and dynamic loads which approximate the conditions expected during the full scale flight, especially during the booster phase (for the purpose of validating our in-house transition design). The maximum altitude limit of 4.5 km was determined such that the subscale launch vehicle could still be safely flown in New York, in particular with the Upstate Research Rocketry Group in Penn Yan.

The two other major differences in the subscale demonstrator as compared to the current full scale vehicle design are the use of a filament wound fiberglass airframe, rather than carbon fiber, and an integrated motor mount in the booster. Both of these changes allow for significant cost reduction by reducing material costs for both the airframe and motors for the subscale demonstration flight, without significantly impacting the useful data that can be extracted from the subscale. In particular, the designs for parachute deployment on both the upper stage and booster of the full scale will be tested on the subscale booster, the structural integrity of an aluminum and fiberglass composite transition segment will be tested by simulating the accelerations experienced during the full scale booster's flight window, the suitability of the upper stage ignition techniques for use at high altitudes and velocities will be confirmed, and the design for the full scale's motor retention system will be tested on the upper stage of the subscale vehicle.

The subscale demonstration's performance will be evaluated based on the successful performance of all aspects of the construction, ground testing, and the subscale flight. Particular attention will be paid to those subsystems which will be necessary for the subsequent launch of the full scale flight, as failures or deficiencies in those subsystems will require re-evaluation and potential re-testing prior to the launch of the full scale vehicle. By conducting this subscale demonstration flight, the Project Icarus team is able to minimize the financial, project, and safety risks associated with the full scale launch attempt, as the demonstration flight allows for much cheaper and safer testing of most critical components of the launch vehicle.

Several components purchased and/or constructed for the subscale demonstration flight are designed to also be used for the full scale flight. In particular, all of the ground support equipment from the subscale flight, including the launch pad, launch control hardware, and tracking ground station and software, are designed to be compatible with both the subscale and full scale launch vehicles. The launch pad is designed to be easily adjustable between a 3" and 4" diameter airframe, and the wireless launch control system will be tested to the same range as is necessary for the full scale prior to the subscale launch. The tracking system being utilized for the subscale's upper stage is very similar in design to the proposed tracking system for the full scale's booster, and will use the same ground station and software for in-flight tracking. Deployment hardware will also be shared between the two vehicles, with the subscale's upper stage electronics being repurposed as part of the full scale's redundant deployment and upper stage ignition system.