

IAF SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM (D2)  
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## LOW COST UK LAUNCHED SMALL SATELLITE BOOSTER FOR COMMERCIAL SPACEFLIGHT

### Abstract

Commercial spaceflight services are likely to be licensed from UK launch sites in the next 12-18 months. Early services will use vertical and horizontally launched rocket propelled vehicles, aiming to deliver small spacecraft (max 500kg mass) into orbit. No less than 5 launch service providers and 6 launch sites are preparing for commercial operation by 2025. The environmental impact of launch services is of primary concern to UK regulators, given the high UK population density. We have carried out an extensive trade off of technical and launch operations options to evaluate the most cost effective and environmentally benign approach to small satellite launch from a UK spaceport, of a vehicle able to deliver at least 200kg into a polar or near polar Earth orbit. A detailed design study into the booster stage of this vehicle, its upper stage options, and recovery plus preflight approaches has been underway in the School of Aerospace Transport Manufacturing since mid 2021, supported by UK space sector companies. A constraint to the project has been identifying UK based supply chain options that could support a fully indigenous launch vehicle able to meet a wide range of government academic and commercial needs. Design to cost and concurrent engineering methodologies have been applied throughout. The project has aimed to apply the most appropriate design, manufacturing and test methodologies, compared to innovative technologies which are often favoured by small launcher startups. We have sought to make the design attractive as a test vehicle for hypersonic air breathing propulsion such as the Reaction Engines SABRE. This paper will summarise the key trade-offs considered in the design process, the agreed design solution, a development manufacturing and operations cost estimate, and the roadmap necessary to reach initial test flights this decade.

The paper will present further details on

- Engine design options including a novel LOX / ethane combination and thermal management approach
- Small suborbital flight test vehicle to allow early testing of some of the key technologies,
- Downrange parachute recovery approaches for a small launcher and how this affects both economics of recovery and environmental impact,
- Guidance and control requirements for a low cost, robust, modular avionics system,
- Turbomachinery cycle options for pressurisation of the main engines.