

IAF SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM (D2)  
Small Launchers: Concepts and Operations (7)

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BLUE WHALE 1: SYSTEM ENGINEERING AND INTEGRATION RESULTS FOR SOUTH KOREAN  
MICRO LAUNCHER**Abstract**

Small launchers often require different design approaches compared to those of large, conventional launch vehicles, since many mass-critical components are not linearly scalable, and the amount of contribution of the external disturbances to the vehicle control scheme becomes more significant on the vehicles with smaller sizes. Perigee Aerospace Inc., a technical initiative originated from KAIST Department of Aerospace Engineering, is making a radically different approach compared to the already existing small launch vehicle developers to address these issues.

Perigee is currently preparing for the maiden flight of its first launch vehicle, Blue Whale 1, by the end of 2020. The vehicle is designed to carry 50 kg of payload into 450 km Sun-Synchronous Orbit with a GTOW of 1,800 kg and a dry mass of only 90 kg, making it one of the lightest, mass-effective, and thus easiest-to-operate vehicles in the world. On this paper, several key technologies and systematic approaches to develop such an efficient launcher is presented; the world's smallest ORSC methane engine where  $P_c = 12$  MPa, a new hybrid turbopump system to feed both preburner ( $P_c = 25$  MPa) and the main combustion chamber at high pressure without sacrificing hydraulic efficiency, fully closed-loop vehicle GNC for more disturbance-prone small launchers, a braided CFRP structure to optimize mass budget, and finally, an agile system engineering management approach for commercial small launch vehicle projects.

The paper also describes some essential current development status of the launch vehicle subsystems; the results of the qualification firings of the first stage engine are presented in this paper with final Isp of 288 seconds and 349 seconds at sea level and altitude, respectively. Also, in terms of the second stage motor, some test firing result on the ATF (Altitude Test Facility) at 35 km altitude condition was provided, demonstrating a specific impulse of 353 seconds with a niobium nozzle extension. Blue Whale 1 strives to be the optimal solution to the Korean access to space, with its first commercial flight scheduled by the end of 2021.