UNIVERSITY OF KWAZULU-NATAL

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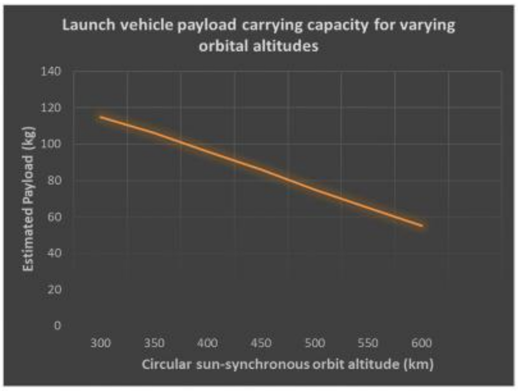
SAFFIRE

Overview of SAFFIRE

The SAFFIRE project – South African First Integrated Rocket Engine – is a design study by the University of KwaZulu-Natal's Aerospace Systems Research Group (ASReG). SAFFIRE is a compact liquid propellant rocket engine that can be clustered to power the first and second stages of a small-satellite launch vehicle. Each engine utilises liquid oxygen and kerosene propellants to produce 24 kN of thrust, but stands just 700 mm high with a mass of 55 kg. Advances in pico-satellite technology have led to a growing interest in smaller launch vehicles that can rapidly deploy cubesats to low Earth orbit (LEO) at low cost. For countries like South Africa that possess a fledgling satellite industry but no launch capacity, the outsourcing of payload delivery to foreign providers is costly and can also lead to unanticipated delays. SAFFIRE offers an achievable pathway to the development of a low-cost, indigenous launch vehicle for the deployment of commercial spacecraft in the pico- to micro-satellite range from African soil.

SAFFIRE Launch Vehicle

The small-sat launch vehicle, for which SAFFIRE is being developed, would consist of two stages. The vehicle payload capacity is 75 kg to accommodate at least 15 cubesats (including the auxiliary equipment needed to deploy them) to a target, sun-synchronous orbit of 400 km.



Engine Specifications

Thrust (Sea Level)	24 kN
Specific Impulse (Sea Level)	313 s
Propellant Flow Rate	8.9 kg/s
Oxidiser/Fuel Ratio	2.5

Electropump System

Conventional liquid rocket engines utilise turbopump (turbine and pump) technology to achieve the required mass flow rate and pressure rise of the propellants. SAFFIRE makes use of an electropump system which dispenses with the gas-driven turbine of a normal turbopump and replaces it with a much simpler electric drive system consisting of two high speed motors and high density battery banks. This reduces the complexity of the engine configuration and start-up procedure.
The electropump system allows for improved efficiency over time with advancements in battery technology.

1. LOX Pump
Delivers 6.1 kg/s of liquid oxygen to the injector. Powered by an electric motor, it can be manufactured on a 5 axis CNC machine.

2. Fuel Pump
Delivers 2.8 kg/s of refined kerosene to the injector for combustion and cooling. Powered by a separate electric motor, it can be manufactured on a 5 axis CNC machine.

3. Electromotor
Separate motors run each pump. The motors are driven by high power-density battery packs.

4. Injector
Atomises and injects fuel and oxidiser into the combustion chamber.
It can be manufactured on a 4 axis CNC machine.

5. Combustion Chamber
Produces engine thrust. Ablative cooling eliminates the metallurgical and manufacturing complexity of regeneratively cooled chambers. Can be manufactured from composite materials via filament winding.

6. Linear Actuator
Electrically driven linear actuators are used to gimbal the engine for trajectory and stability control.

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Visit our
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