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### Title

## Achievements and Development Status of the H<sub>2</sub>O<sub>2</sub> based Roll and Attitude Control System for VEGA launchers

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### Abstract

Since 2008, Nammo Raufoss has heavily invested into the development of propulsion systems based on Hydrogen Peroxide (H<sub>2</sub>O<sub>2</sub>) as propellant [1], [2]. Thanks to the acquired expertise and in an effort to replace the current hydrazine based system with a safer and greener one, Nammo has been awarded by ESA and AVIO in 2019 an ESA funded contract for the development of the H<sub>2</sub>O<sub>2</sub> based Roll and Attitude Control System (RACS) for the VEGA launcher family.

The RACS is located in the AVUM+, the launcher upper stage. Its mission is to provide fine attitude and trajectory adjustments during the full launch mission. It shall thus be extremely versatile, allowing both long steady state firing and very short pulses and providing the required performance both at sea level and in hard vacuum. Appropriate firing of monopropellant thrusters, divided in two cluster modules (TCM), generates the forces required to perform the attitude and trajectory adjustments. An aero-thermal cover (ATC) envelops each TCM, protecting it from environmental agents and the aerothermal effects during the atmospheric phase of the launch. The thrusters are connected to the Aluminum PED tank via a feeding system of tubing, valves and monitoring equipment, all clamped to the structure of the AVUM+. Two filters are located between the tank and the thrusters to ensure adequate propellant cleanliness. A set of three service valves provides the on-ground fluidic connections required for filling, pressurizing and testing of the system.

Nammo is in charge of the design, the testing and the qualification of the “propulsion system” RACS and of its main components. On the other hand, the avionics, the structural support, the telemetry and the GSE are under the responsibility of the prime contractor, AVIO, which collaborates with Nammo to ensure a seamless integration of this novel propulsion system in the already qualified AVUM+ stage. The development is overseen by ESA, which provides access and support from experts in all related fields.

During the first phase of the project, Nammo performed extensive components test campaigns and development work at system level, which enabled a successful PDR in 2020 [3]. Since then, Nammo continued with sub-assembly and component PDRs while simultaneously advancing with the system development in preparation for a full propulsion system test campaign to be performed during Q1-Q2 2023. This test will combine in one set-up all the components being developed to-date and will consist of a full wet dress rehearsal and a first performance characterization of the propulsion system. With the simultaneous activation of up to three thruster valves, this campaign will allow testing specific feed system behaviors like water hammer and cross talk.

This paper will provide an overview of the status of the RACS design, development and testing and its to-date main achievements, connecting its progress with the joined development of the main components. It will as well give an overview of the remaining planned activities to obtain a fully qualified, ready to launch system.

## References

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