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ESPRIT XENON REFUELING SYSTEM: A VITAL TECHNOLOGY BUILDING BLOCK FOR THE GATEWAY AND FUTURE MISSIONS

Abstract

Electric propulsion thrusters have become state of the art as reliable propulsion systems for a variety of applications, such as geostationary satellites, LEO constellations, and interplanetary missions. These engines excel in their specific impulse and can enable a good propellant mass fraction at the expense of engine thrust. This makes them ideal for high Δv as well as high mass missions, such as robotic and Human exploration missions beyond LEO. Electric propulsion is currently baselined for the Lunar Gateway; a large scale international project being jointly developed by ESA, NASA, JAXA, CSA and ROSCOSMOS. A key objective of the Gateway is to sustain long term human presence beyond LEO, which requires the development of reliable, reusable, and affordable systems. The capability to refuel the electric propulsion system of the Gateway is a major technology building block to achieve these objectives for Gateway and missions beyond. Furthermore, this capability would also enable refueling missions to Earth orbiting satellites. As a key element of the Gateway, the “European System Providing Refueling Infrastructure and Telecommunication” or ESPRIT is planning to provide refueling capability to Gateway in order to extend its lifetime, and to enable potential other use cases for Gateway in the future.

For the most part, electric propulsion systems, including the Gateway, rely on Xenon as propellant, which has many inherent characteristics that make its transfer between spacecraft very complex and challenging. The required flow rates for refueling are an order of magnitude above common Xenon based propulsion systems. These problems can already be seen in the ground operations to fill spacecraft tanks with Xenon as propellant, where complex fluid transfer and thermal control systems are employed. Together with TAS in France, OHB conducted the early development of the Xenon refueling system and compressor for ESPRIT in the framework of one of two competitive parallel phase A/B1 studies for ESA. This included the design and development of a refuelling system breadboard to demonstrate the Xenon transfer and verify key performance parameters on ground, thereby advancing the overall TRL.

This paper will describe the challenges introduced by Xenon characteristics as well as system constraints with respect to in orbit refueling. In addition, several design options that have been traded to derive an overall effective design for ESPRIT will be discussed including critical aspects of the baseline design that were tested on the breadboard. Finally, potential future use cases are investigated and

outlined.