SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM (D2)
Upper Stages, Space Transfer, Entry and Landing Systems (3)

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ROLE OF HIGH THRUST LIQUID PROPULSION STAGES IN HUMAN EXPLORATION OF THE SOLAR SYSTEM

Abstract

Large transfer stages to propel high payload masses are an inevitable building block element for future Human exploration of Earth's "backyard" (Moon, Mars and Near-Earth Asteroids). For such applications, high thrust liquid propulsion stages allow short mission durations. However, the most suitable propellant combination is not an obvious choice, since no commonly used propellant is advantageous in all design driving characteristics such as specific impulse, propellant density and storage temperatures. Therefore, a consortium led by OHB System conducted a feasibility study funded by ESA to design three transfer stages based on LOX/LH2, LOX/Methane and storable propellants and evaluate their mission capabilities for solar system exploration. Given an assumed performance of future Super Heavy Lift Launcher, the transfer stage has a mass of 100 metric tons and is designed to dock with the payload in orbit. The enabling mission capabilities are evaluated for a stack with one transfer stage (short stack) and with two transfer stages (long stack), where the transfer stages are only used for the Earth escape. As payload, a crew, service and habitation module as well as a storable propulsion stage for the return leg are considered. A mission analysis is performed to determine how much payload mass can be propelled to Moon, Mars and Near-Earth Asteroids. For each propellant combination and target, the achievable payload mass determines how many Astronauts can eventually be sent for the given stack configurations, which serves as a performance indicator. Overall, it can be identified which propellant combination is most suitable for this enabling building block for future human exploration of the solar system.