SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM (D2)
Going To and Beyond the Earth-Moon System: Human Missions to Mars, Libration Points and NEO's (8-A5.4)

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EVOLUTION OF THE SPACE LAUNCH SYSTEM: LIQUID PROPULSION OPTIONS AND ENABLING CAPABILITIES FOR EXPLORATION

Abstract

NASA is currently underway developing the Space Launch System (SLS) to carry crew and cargo beyond low Earth orbit (LEO). The heavy lift capabilities of the SLS will enable spacecraft and mission architecture flexibility not achievable with current or proposed alternative, medium and heavy lift launch vehicles. The SLS is being designed in an evolutionary approach to provide increased performance as NASA's Exploration program advances. This approach will see the SLS grow from an initial version capable of lifting more than 70mT to LEO to an intermediate version capable of 105mT to LEO, and ultimately evolving to a configuration capable of 130mT to LEO. The ultimate configuration will serve as an enabling capability for human missions to Mars. Aerojet Rocketdyne (AR) currently supplies the Core and Upper Stage propulsion for the 70mT SLS configuration, the RS-25 and RL10 respectively. In this paper, AR will describe liquid propulsion options for the evolutionary configurations of SLS and present associated vehicle performance trades. For the SLS Upper Stage evolution, the RL10, the AR-30, the J-2X, and the MARC-60 will be studied. The RL10 is currently the upper stage engine on the ULA Atlas and Delta launch vehicles and the SLS's Interim Cryogenic Propulsion Stage (ICPS). The AR-30 represents a potential evolution of the RL10 incorporating new technology to increase performance and improve affordability. The J-2X is currently in development as part of the SLS Program. The MARC-60 engine represents an ongoing partnership between AR and Mitsubishi Heavy Industries (MHI) of Japan to develop an upper stage engine. For the Advanced Booster, an element of the ultimate 130 mT SLS configuration, AR will study the F-1B and the AR-1E6 kerosene booster engines, both currently executing Risk Reduction activities under NASA's Advanced Booster Engineering Demonstration and/or Risk Reduction (ABEDRR) program. The paper will also study the SLS's performance with respect to a reference manned Mars mission architecture developed by Aerojet Rocketdyne. This will highlight the unique capabilities of the SLS to enable human exploration of deep space by NASA and its International Partners.