

Small Launch Vehicle Concept Development for Affordable Multi-Stage Inline Configurations

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The Advanced Concepts Office at NASA's George C. Marshall Space Flight Center conducted a study of two configurations of a three stage, inline, liquid propellant small launch vehicle concept developed on the premise of maximizing affordability by targeting a specific payload capability range based on current industry demand. The initial configuration, NESC-1, employed liquid oxygen as the oxidizer and rocket propellant grade kerosene as the fuel in all three stages. The second and more heavily studied configuration, NESC-4, employed liquid oxygen and rocket propellant grade kerosene on the first and second stages and liquid oxygen and liquid methane fuel on the third stage. On both vehicles, sensitivity studies were first conducted on specific impulse and stage propellant mass fraction in order to baseline gear ratios and drive the focus of concept development. Subsequent sensitivity and trade studies on the NESC-4 configuration investigated potential impacts to affordability due to changes in gross liftoff weight and/or vehicle complexity. Results are discussed at a high level to understand the severity of certain sensitivities and how those trade studies conducted can either affect cost, performance or both.