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GETTING TO MARS: A COMPARISON OF THE PREDICTED PHYSIOLOGIC EFFECTS FROM PROPOSED LAUNCH VEHICLES

ARRIVER À MARS: UNE COMPARAISON DES EFFETS PHYSIOLOGIQUES PRÉDISÉS SUR LA BASE DES VÉHICULES DE LANCEURS PROPOSÉS

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Introduction: Sending a spacecraft to Mars will likely require heavy lift propulsion capabilities. An examination of the anticipated physiologic stress profiles of the proposed launch vehicles is an early consideration for the mitigation of these effects on the flight crew. Indeed, the failure of the initial attempts at a retro design of the Saturn J-2 engines revealed that the acoustic (vibration) profile was outside the tolerance for the human body, and would have likely killed or injured the crew. Anticipation of these effects can help avoid wasted time and resources as we proceed with our efforts to explore beyond our earth.

Methods: A review of the known launch profile parameters of the candidate vehicles was undertaken including the Space X Falcon Heavy and the NASA SLS. Although other groups have proposals they did not yet have flight-tested hardware.

Results: Based upon the profile of the Falcon 9, the space X Falcon Heavy (consisting of three Falcon 9s) is expected to produce a G load profile of 6 to 8.5 Gs along the longitudinal axis with an acoustic vibratory profile of 0.5 to 0.9 Gs spread across a 5 - 100 Hz spectrum with lateral vibrations of 0.5-0.6 Hz. This duration will be around 500 seconds.

Based upon the known RS-25 (formerly Shuttle) engines and solid rocket boosters of the first stage of the NASA SLS, we expect a 3 G axial load similar to Shuttle and applied for 450 seconds, with vibration experienced in the 0.5-0.7 range, again across a 5 - 100 Hz spectrum. However, the second stage JX-2 engine profile has not been completely confirmed, and is not yet released. The first attempt on the JX-2 resulted in vibrations exceeding human tolerances in the 8-15 Hz range.

Conclusion: The currently proposed Mars expeditionary vehicle Space X Falcon Heavy appears compatible with human physiology as projected with the SLS status pending.