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METALLIC VS INFLATABLE PRIMARY STRUCTURE: A COMPREHENSIVE TRADE FOR A MARS TRANSIT HABITAT

Abstract

Large diameter inflatable habitat solutions are hypothesized to have an advantage over traditional metallic habitats of equal volume and functional requirements in terms of minimizing mass. A fair and comprehensive trade of metallic primary structure versus inflatable softgoods primary structure for a Mars Transit Habitat was conducted by The Boeing Company under the NASA NextSTEP Phase 3 Extension contract in order to determine the minimum mass option from a system level. A Mars Transit Habitat is a major system mass driver because small increases in the mass can create large mass changes in the propulsive stage, adding complexity and cost to the mission.

Three different vehicle configurations were traded using a fixed volume constraint and the same Ground Rules and Assumptions provided by NASA. The configurations were 1) 5.5 m diameter metallic habitat, 2) 7.0 m diameter metallic habitat, and 3) 7.63 m diameter inflatable habitat. In order to complete the trade, each configuration was analyzed and sized, but a system level approach had to be taken to ensure other aspects and subsystems besides the structure were captured.

The primary functions (i.e. restraint layer, bladder, MLI, MMOD) and strength advantages of softgoods are well understood, but there were other system level impacts that were discovered or addressed that are unique to softgoods. For the metallic structure, a modern and mass optimal material and manufacturing process was adopted to ensure the lightest weight options were evaluated. Two different aluminum lithium structures were evaluated, a longer length 5.5 m diameter and a shorter length 7 m diameter structure.

The trade demonstrates that each configuration is feasible and close to the target dry mass for the Mars Transit Hab at Trans-Martian Injection burn. System level mass was the primary consideration, but since the three concepts were close in total mass, a clear winner did not arise. Secondary factors were evaluated such as architecture habitability (human factors), development considerations, on-orbit activation and outfitting, extensibility to other applications, and configuration flexibility. The aggregation of the lowest mass, most benefits, and fewest challenges resulted in the 5.5m diameter metallic configuration being the most favorable.