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Author: Mr. Matthew Ziglar
Boeing Defense Space & Security, United States

Mr. Jeffrey Eichinger
Boeing Co, The, United States
Mr. Kojo Sarkodie
Boeing Co, The, United States

CERTIFICATION OF A COMPOSITE HABITAT FOR DEEP SPACE

Abstract

Boeing has studied how to incorporate composite structures into long duration deep space habitats while maintaining the high level of safety required for human spaceflight. Composite structures in space applications has demonstrated the material's increased strength and decreased mass when compared to aerospace metallics. This paper defines the certification ground work and how it can be achieved in the near term.

Boeing has experience designing, manufacturing, and flying composite structures in space, but there are additional technical and safety related challenges for incorporation into a pressurized crewed habitation module. Unique considerations for composite habitats are deep space radiation, micro-meteoroid orbital debris impacts, permeation rate, and low electrical/thermal conductivity. Damage threats and environmental effects are the primary focus areas.

Certification entails establishing requirements for a composite structure and demonstrating that the 'as built' structure meets those requirements. Certification of composite crewed habitat have the same high-level requirements as composite passenger aircraft, with which Boeing has extensive experience.

A path to certifying a composite habitat includes: • Preliminary Design – materials selected with reliable producibility, built with controlled processes, and damage tolerant design properties used • Material and Manufacturing Process Controls – ensure material performance is repeatable • Life Cycle Survivability and Property Characterization - Define service environment threats and perform coupon testing to characterize NASA-STD-6016 properties (flammability, outgassing, fungus resistance, etc.) • Damage Threat Assessment - based on operational concept for the vehicle from fabrication through end-of-life. • Damage Tolerant Design Property Definition - developed by testing articles with varying types and levels of damage. Generates an impact damage protection plan (IDPP) • Manufacturing Scale-Up – Tooling and manufacturing plans established, risk reduction activities executed. Full-scale verification article built, inspected, and destructively tested to evaluate quality. • Analysis Methodology Demonstration – demonstrate by analysis structure meets requirements with damage conditions defined in IDPP. • Full Scale Validation Testing - demonstration that production manufacturing process yields a part with performance consistent with analysis • First Article Production - focus on Quality Assurance. Production documentation demonstrates requirements are met before part is released for flight

The certification of a composite habitat is not well worn, but is well understood. Damage threats are unique but quantifiable through focused development. Despite the perception of challenges to certify a crewed habitat structure, there are no preventative technical barriers. The certification of a composite habitat will yield significant mass benefits enabling greater habitat capability and vehicle performance.