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Author: Mr. Gregory McClung
United Space Alliance, United States, g.k.mcclung@usa-spaceops.com

ALTAIR LUNAR LANDER CENTER OF GRAVITY MANAGEMENT

Abstract

Determining a spacecraft's center of gravity (cg) is critical to the control of any spacecraft during dynamic flight. Determining and managing the cg of the Altair Lunar Lander for lunar deorbit, terminal descent, and ascent has many unique challenges due to the nature of the mission. Altair will have a relatively small cg envelope (as compared to Shuttle). A significant portion of Altair's mass is comprised of propellant and the location of the cg will be very dynamic during the lunar landing phases as propellant is burned and subject to mass imbalance between propellant tanks. Additionally, the cg of the spacecraft will move higher as the propellant is burned. This will affect tip-over characteristics at landing and determine lateral speed and ground slope limits. During sortie and outpost missions, equipment will be moved within the lander or removed from the lander and used on the lunar surface. Some of the equipment will be left on the lunar surface while some will be returned. In other cases, outpost equipment or lunar surface samples may be returned. All these things will impact the mass properties and center of gravity of Altair during ascent. As a result, an approach for determining the cg near real-time without adversely affecting crew operations is needed.

This paper will present an approach for performing mass property and cg management for the Altair Lunar Lander. This includes design features that should be considered for Altair and discusses the analysis tools and techniques for managing mass properties and determining the cg of the Altair.