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HUMAN EXPLORATION OF THE SOLAR SYSTEM SYMPOSIUM (A5)
Going Beyond the Earth-Moon System: Human Missions to Mars, Libration Points, and NEO's (4)

Author: Mr. Andrea Ruggiero
Sitael Spa, Italy, a.ruggiero@alta-space.com

Dr. Pierpaolo Pergola
Alta, Italy, p.pergola@alta-space.com
Mrs. Chiara Finocchietti
Università di Pisa, Italy, c.finocchietti@alta-space.com
Prof. Mariano Andrenucci
Sitael Spa, Italy, m.andrenucci@alta-space.com

INTERPLANETARY MANNED ROUNDTRIP MISSIONS BASED ON LIQUID PROPULSION STAGES

Abstract

During the last decades the scientific interest for Near Earth Asteroids (NEAs), rocky or metallic bodies orbiting in heliocentric trajectories passing closely or intersecting Earth's orbit, has relevantly increased. The reasons behind this interest are not just of scientific nature for their status as remnant debris from the Solar System formation process, but are also due to the potential hazard these bodies could and to the possibility of utilizing in-situ resources for space habitats construction or fuel production. Recently, several space agencies gathered in the ISECG have identified in the Global Exploration Roadmap both NEAs and the Moon as fundamental destinations in preparation for a future human mission to Mars to gain experience in deep-space operations and interplanetary human expeditions beyond LEO. Accessibility of such bodies is highly dependent from their specific orbits and from the performance of launcher and transfer vehicle but, in general, high-thrust chemical engines for space-to-space operations would greatly broaden the range of targets reachable in limited time, paving the way to human exploration beyond Earth-Moon system. In this study, the classical patched conic approximation and the ephemeris model have been used to explore high thrust transfer solutions for a manned roundtrip mission from Earth to a set of few accessible NEAs considering less than 1 year of mission in the 2020–2030 timeframe. The manned nature of the mission requires to explore the whole range of transfer length both for the forth and for the return leg and determine the more suitable stay time at the target to have convenient global solutions. An ISS-like departure orbit represents a valid parking and assembly (if required) location offering limited orbital decay, suitable inclination for the escape hyperbola and relevant heritage for rendezvous, launch and in-space operations. Assuming as reference an actual liquid propellant engine (e.g. Vinci motor), the minimum total velocity increment solution and the corresponding propellant mass consumption are presented as results of grid search and local solution refinements. Some of the results obtained for three target NEAs selected based on their accessibility (e.g. 99942 Apophis, 2000 SG344 and 1999 AO10) suggest that, despite the large velocity increments required (4–15 km/s) for the forth and back legs within the maximum duration assumed, the spacecraft available dry mass might be sufficient to equip the spacecraft with the life support systems and the shielding equipments, two fundamental aspects characterizing the manned nature of the mission envisaged.