IAC-08-D2.3.6

ANALYSIS AND DESIGN OF CARGO TRANSPORT ARCHITECTURES FOR MANNED MARS MISSIONS USING ELECTRIC PROPULSION

Jörn Spurmann
RWTH Aachen University, Germany
joern.spurmann@rwth-aachen.de

Sebastian Willems
RWTH Aachen University, Germany
sebastian.willems@rwth-aachen.de

Uwe Derz
RWTH Aachen University, Germany
uwe.derz@rwth-aachen.de

Michael Quatmann
Institut für Leichtbau, RWTH Aachen University, Germany
quatmann@ilb.rwth-aachen.de

ABSTRACT

Manned Mars missions are in the focus of all space agencies' current plans, as NASA's Mars Exploration Program or ESA's Aurora Programme. For such missions, the transportation of cargo from Earth to the Martian surface is a major aspect of the mission design.

In this paper the idea of electrically propelled cargo transport on energy-efficient trajectories and corresponding Mars entry, descent and landing is analyzed. The use of two different launch orbits, below and above the inner Van Allen Belt, and a trade-off between reusable and expandable transfer stages are examined. In both scenarios the transfer stages spiral out of the Earth's sphere of influence, accelerate towards Mars and detach the payload shortly before direct atmospheric entry. At this point the reusable transfer stage will perform a Mars swing-by and return to an Earth orbit. Different thrusters are regarded for both spacecrafts, according to thrust, efficiency and specific impulse. Furthermore, the power system is preliminarily designed and mass budgets for other major spacecraft subsystems are estimated. The required systems for direct Mars entry, descent and landing - including inflatable heatshields, super- and subsonic parachutes and chemical rockets - are designed. As reference scenario a Hohmann transfer with direct entry from interplanetary flight at Mars is chosen.

The dispensable scenario achieves payload to surface fractions of 47.4 % within a flight time of 1.95 years, or 28.4 % within 1.14 years. For those results the RIT-22 thrusters are used with accelerations of $0.2\,\frac{\mathrm{mm}}{\mathrm{s}^2}$ and $0.4\,\frac{\mathrm{mm}}{\mathrm{s}^2}$ respectively. The reusable scenario is not advisable, as it is not superior compared to the dispensable one.