46th STUDENT CONFERENCE (E2)
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Author: Mrs. Pauline Delande
ISAE - Institut Supérieur de l'Aéronautique et de l'Espace, France, pauline.delande@gmail.com

Mr. David Gaudin
ISAE - Institut Supérieur de l'Aéronautique et de l'Espace, France, david.gaudin@student.isae-supaero.fr
Mr. Antoine Carré
ISAE - Institut Supérieur de l'Aéronautique et de l'Espace, France, antoine.carre@student.isae-supaero.fr

MARS 10: A LANDER CAPABLE OF DELIVERING A TEN METRIC TON PAYLOAD SAFELY TO THE SURFACE OF MARS BY 2026

Abstract

The latest years have seen a renewed interest in the human colonization of Mars carried by both public and private sector. In this particular context, the Mars Society started last year the "Red Eagle" Contest to encourage the development of heavy Mars Entry Descent and Landing (EDL) vehicles allowing to deliver scientific rover and sample return as well as habitats, oxygen and fuel extraction facilities, rovers, cargos and crew vehicles to the surface of Mars. The requirements include a payload capability of 10 metric tons and a potential first launch in 2026 with a reasonable price.

The Mars 10 preliminary design, developed by a team of 7 students as part of this competition, comes in two configurations. While the Manned Mars 10 configuration relies on a Mothership (like the Deep Space Gateway) to arbor the human crew during the interplanetary trip, the Unmanned Mars 10 configuration will be equipped with a Cruise Module in order to achieve TMTC, AOCS and Power Supply during this phase.

The Entry Sequence starts with the separation with the Cruise Module or with the Mothership on an entry trajectory. The hypersonic deceleration will be achieved by a 32m-diameter multi-torus inflatable shield until a velocity of Mach 2 is reached. An offset between the symmetry axis and the center of gravity is implemented to create a lift capability allowing the reduction of the landing ellipse by compensating the Mars atmosphere uncertainties. After Mach 2 is reached, three 30m-diameter parachutes will deploy, followed by the jettisoning of the deployable shield. Finally, at a velocity of 150m/s and an altitude of 1500m, controlled retrorockets coupled with an Autonomous Landing and Hazard Avoidance Technology (ALHAT) will ensure a safe landing at the targeted location.

This paper aims at presenting the Entry Sequence as well as the Mars 10 EDL components. Trade-offs on the critical subsystem (AOCS, TMTC and Thermal regulation) will be presented for both the EDL and the Cruise Module. A particular attention will be held for the structure and space accommodation that bears several critical design points such as aerodynamic stability, capability to free the payload after landing, accommodation in the launcher fairing, adaptability to different payloads, capability to offer a link with a mothership and optimization of the effort paths. Finally, the safety measures implemented to guarantee a safe human flight and landing in case of different failure scenario will be highlighted.