HUMAN MARS ENTRY, DESCENT AND LANDING ARCHITECTURE STUDY OVERVIEW

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Landing humans on Mars will require entry, descent and landing (EDL) capability beyond the current state of the art. Nearly twenty times more delivered payload and an order of magnitude improvement in precision landing capability will be necessary. Several EDL technologies capable of meeting the human class payload delivery requirements are being considered. The EDL technologies considered include low lift-to-drag vehicles like Hypersonic Inflatable Aerodynamic Decelerators (HIAD), Adaptable Deployable Entry and Placement Technology (ADEPT), and mid range lift-to-drag vehicles like rigid aeroshell configurations. To better assess EDL technology options and sensitivities to future human mission design variations, a series of design studies has been conducted. The design studies incorporate EDL technologies with conceptual payload arrangements defined by the Evolvable Mars Campaign to evaluate the integrated system with higher fidelity than have been performed to date. This paper describes the results of the design studies for a lander design using the HIAD, ADEPT and rigid shell entry technologies and includes system and subsystem design details including mass and power estimates. This paper will review the point design for three entry configurations capable of delivering a 20 t human class payload to the surface of Mars.

NOMENCLATURE

ADEPT	=	Adaptable Deployable Entry and Placement Technology
EDL	=	Entry Descent and Landing
HIAD	=	Hypersonic Inflatable Aerodynamic Decelerator

INTRODUCTION

THE NASA Human Spaceflight Architectures Team is currently studying an Evolvable Mars Campaign[1] that aims to define an evolutionary path from current spaceflight infrastructure and capabilities to the ultimate goal of landing people on the surface of Mars and returning them to Earth. The Mars entry and landing systems design and mass drive the performance requirements for Earth launch and transportation to Mars. Three entry technology options have been evaluated for human Mars landings. Figures 1-3 show the entry vehicle configuration for HIAD, ADEPT and the rigid aeroshell respectively. The 20 t payload is assumed to be the Mars Assent Vehicle (MAV), an In-Situ Resource Utilization (ISRU) plant for ascent vehicle propellant production. The HIAD vehicle concept for 27t of payload is documented in reference 2. This paper summarizes that design with payload capability reduced to 20t.

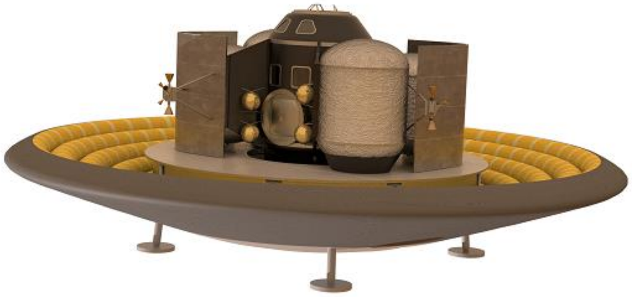

Figure 1. HIAD vehicle configuration

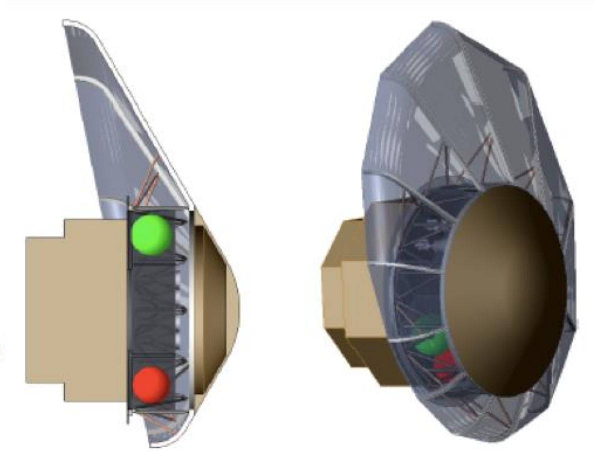

Figure 2. ADEPT Vehicle configuration

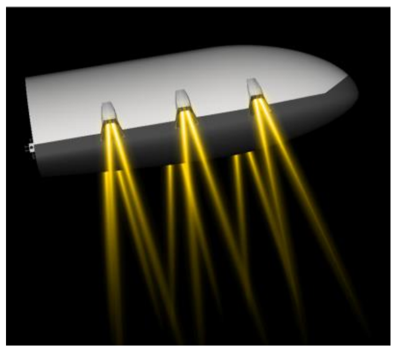

Figure 3. Rigid aeroshell configuration

. MISSION OVERVIEW

Launch and Transit to Mars

For missions in the 2030's, an evolved Block 2 configuration Space Launch System (SLS) launch vehicle with a 10-meter payload fairing is assumed. There are multiple transportation scenarios under consideration for the EMC involving different in-space propulsion systems and delivery orbits at Mars. See reference 3 for more information on transportation system options. This design study assumes the lander is launched into an elliptical Earth orbit with a Solar Electric Propulsion (SEP) stage that will transport the lander to Mars, see figure 4.

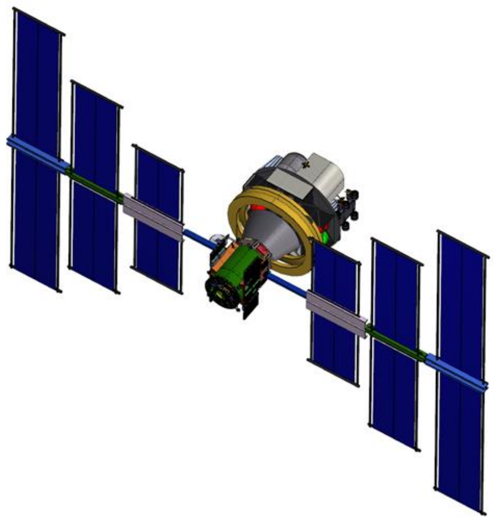

Figure 4. Earth to Mars Transit Configuration

Mars Arrival

At Mars arrival the SEP stage would be jettisoned, and the lander would perform aerocapture to achieve Mars orbit. For this study a 250 x 33,800 km orbit is assumed. This is referred to as a 1 sol orbit because it has an orbital period of one sol, or Martian day (24 h 40 min).

REFERENCES

[1] Craig, Douglas A., Herrmann, Nicole B., and Troutman, Patrick A. "The Evolvable Mars Campaign – Study Status," IEEE Aerospace Conference, Big Sky, MT, March 7-14, 2015.

[2] Polsgrove, Tara P., Dwyer Cianciolo, Alicia, et al., "Human Mars Lander Design for NASA's Evolvable Mars Campaign," IEEE Aerospace Conference, Big Sky, MT, March 5-12, 2016.

[3] Percy, T., McGuire, M., Polsgrove, T., "In-space Transportation for NASA's Evolvable Mars Campaign," *AIAA SPACE 2015*, Pasadena, CA, August 31-September 2, 2015