Asteroid Redirect Crewed Mission Space Suit and EVA System Architecture Trade Study

Raul A. Blanco, Jonathan T. Bowie, Richard D. Watson, Stephanie A. Sipila
NASA Johnson Space Center, Houston, TX 77058

The Asteroid Redirect Crewed Mission (ARCM) requires a Launch/Entry/Abort (LEA) suit capability and short duration Extra Vehicular Activity (EVA) capability for Orion. The EVAs will involve a two-person crew for approximately four hours. Currently, two EVAs are planned with one contingency EVA in reserve. Providing this EVA capability is very challenging due to system level constraints and a new and unknown environment.

The goal of the EVA architecture for ARCM is one that builds upon previously developed technologies and lessons learned, and that accomplishes the ARCM mission while providing a stepping stone to future missions and destinations.

The primary system level constraints are to 1) minimize system mass and volume and 2) minimize the interfacing impacts to the baseline Orion design. In order to minimize the interfacing impacts and to not perturb the baseline Orion schedule, the concept of adding "kits" to the baseline system is proposed. These kits consist of: an EVA kit (converts LEA suit to EVA suit), EVA Servicing and Recharge Kit (provides suit consumables), the EVA Tools, Translation Aids & Sample Container Kit (the tools and mobility aids to complete the tasks), the EVA Communications Kit (interface between the EVA radio and the MPCV), and the Cabin Repress Kit (represses the MPCV between EVAs). This paper will focus on the trade space, analysis, and testing regarding the space suit (pressure garment and life support system).

Historical approaches and lessons learned from all past EVA operations were researched. Previous and current, successfully operated EVA hardware and high technology readiness level (TRL) hardware were evaluated, and a trade study was conducted for all possible pressure garment and life support options. Testing and analysis was conducted and a recommended EVA system architecture was proposed.

Pressure garment options that were considered for this mission include the currently in-use ISS EVA Mobility Unit (EMU), all variations of the Advanced Crew Escape Suit (ACES), and the Exploration Z-suit. For this mission, the pressure garment that was selected is the Modified ACES (MACES) with EVA enhancements.

Life support options that were considered included short closed-loop umbilicals, long open-loop umbilicals, the currently in-use ISS EMU Portable Life Support System (PLSS), and the currently in development Exploration PLSS. For this mission, the life support option that was selected is the Exploration PLSS.

The greatest risk in the proposed architecture is viewed to be the comfort and mobility of the baseline MACES and the delicate balance between adding more mobility features while not compromising landing safety. Feasibility testing was accomplished in low fidelity analogs and in the JSC Neutral Buoyancy Laboratory (NBL) to validate the concept before a final recommendation on the architecture was made.

The proposed architecture was found to meet the mission constraints, but much more work is required to determine the details of the required suit upgrades, the integration with the PLSS, and the rest of the tools and equipment required to accomplish the mission. This work and further definition of the remaining kits will be conducted in government fiscal year 14.