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KEY EVA SUIT DESIGN AND OPERATIONAL RECOMMENDATIONS TO SUPPORT LONG-TERM HUMAN EXPLORATION

Abstract

The preparation of long-range human exploration will require the evaluation of key technology design and development considerations for EVA needs. The importance of on-board training and procedural changes are emphasised, specifically taking International Space Station (ISS) hardware and crew training lessons learned into account. The implications for a long-term extended duration exploration mission will bring unique challenges to the crew, without room for complacencies during EVA training or operations. An evaluation of crew communications will be discussed, including the need for crew autonomy during mission planning and troubleshooting. There will be a need to reset expectations of hardware and system longevity for long-term missions, without consistent system behaviour being taken for granted. Potential hazards and failure scenarios should be evaluated in detail ahead of time, depicted through the example of a recent high visibility close call during EVA. The fine line between maximising crew productivity during a long-range mission and adopting a safety conscious posture should be realised.

An increased capability and flexibility in the use of Extravehicular Mobility Units (EMUs), spacesuits, will be required, providing the ability to withstand the deep-space, Martian and lunar environments. Issues investigated in relation to EVA suit design include lunar and Martian dust. This in particular would pose a hazard to a human rated mission to the Moon or Mars and will be examined. The need for a solution was emphasised through the high degree of abrasion Apollo astronauts' spacesuits experienced whilst taking part in lunar EVA. Additional crew exposure to fine-grained particles of lunar dust has been indicated to be the cause of numerous health problems. These examples will be evaluated with recommendations discussed for future crew exploration environments. Hardware lessons learned during ISS operations including suit operation, part lifetime and wear in a microgravity environment should be incorporated into future suit design. These factors must be taken into account during the design process of an EVA suit for use on a planetary surface along with dust mitigation technologies.

Analyses from this review are modified and updated in the context of future exploration mission reference architectures, including the International Space Exploration Coordination Group (ISECG) Global Exploration Roadmap (2013). Based on the aforementioned review, recommendations for EVA training, suit design and operational procedures are suggested. Updates and extensions of original designs and recommendations based on my conclusions and successive independent analysis will be presented.