Spacewalk odysseys: the aerospace professional face uncertain challenges of getting a grip of interplanetary travel due to the manufactured Extra-Vehicular mobility unit suit that can impact a risk to space explorers health from the generated solar radiation. How can space suits shield against cosmic rays? `NASC18` University of South Australia☆

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Abstract

This discussion paper presents an examination of current space research, which was commissioned by the University of South Australia into a scientific study of astronautic tool and on board hardware capabilities of the Extra-Vehicular Mobility Unit (EMU). The aim of the research is to raise scientific awareness of the key issues concerning space travel, these include: barriers to interplanetary travel, and an overview analysis of the cosmic radiation spectrum. The documented findings revealed that there is a high level of empirical study conducted into the area of EMU's, which is promising in terms of shielding technology properties. Studies also suggests that the positives include developing approaches to this kind of technology may open the door to future space walking success. The recommendations are is that the aerospace professionals should share new understandings of the space insurance policies with other crews on board the International Space Station (ISS) and beyond Earth, so that it will strengthen contractors'skills. Therefore, this minimises the risk to space professionals of any biological contamination and any high ionized galactic cosmic rays (GCR's). It is recommended that health hazards be observed in the U.S rationale of ongoing auditing into the professional training sessions of (NASA) personnel. Finally, the aerospace team will be prepared well in advance with the skills needed for 'realistic gravity simulations', whilst also acknowledging shield-HIT technology so that the aerospace professionals wearing the EMU layered garment can withstand a certain amount of GCR's in its threshold.

Keywords: Astronauts, Extra-Vehicular Mobility Unit, Interplanetary travel, NASA, Solar Radiation Spectrum

1. Introduction

Astronautics is defined as the scientific study of the navigation of the solar system with the use of space vechicles. This field of space research is also related to, concerned with other branches of the sciences such as astrobiology, astronomy, astrophysics that ultimately describes the correlation between fundamental laws of the physical or chemical characteristics of the heavenly bodies in the cosmos with blended conventions of space travel.(Merriam-Webster, n.d.). It is fundamental for aerospace professionals in the space industry to understand these branches of the sciences to see how scientific inquiry works when problem solving into the feasibility of future endeavours of interplanetary travel. In addition, these scientific concepts help how to connect to understand the associated challenges and/or hazards that can be directed towards cosmonaut crew working on board the ISS and outside the parameters of Earth (Moyers, Saganti & Nelson 2006, p. 1216). The bombardment of cosmic rays which originates outside the earths atmosphere remains a probable threat to the life support system of astronauts in space. Numerous empirical research into the architecture of the EMU demonstrates the various impacts of cosmic radiation risks that can be forwarded on to the explorers has an uncertain amount of risk. This paper discusses and outlines brief EMU mobility unit history of design, the professional training qualification of EMU attainment, plus what is cosmic radiation? And how can space suit technology and design help shield the aerospace professional against cosmic rays?

2. Extra-Vehicular Mobility Unit History of Design

ILC, Dover Industries Inc., first began designing and tailor making astronaut suits in 1961; then later developed the prototype suits in 1961; which started the process of manufacturing for the Apollo astronauts in 1966 (NASA 1994). Spacesuit technology offers astronauts work safety cover while being exposed to the various elements, such as biological contamination and cosmic rays. EMU Spacesuits over the last twenty years or so have seen a great amount of design changes on the trend line. Much of the design process is a result from technological advancements in the space industry that ultimately can further aeronautic schematic modelling (Jordan, Saleh & Newman 2006, p.1136). The complicating factor that can affect the production and market values of EMU equipment is that variables in the design, operational environment, and U.S requirements which are liable to change. Another trend is whether monetary constraints could cause either upgrading an engineering system that should fulfil the need of the designers (Jordan, Saleh & Newman 2006, p. 1136). For the design team flexibility of the design features is the likely key objective in that the EMU system should be capable of modification and adaptation whilst also observing cost efficiency (Jordan, Saleh & Newman 2006, p. 1136). Initially, the EMU was originally drafted in spacelab history to function as a suit that could handle serious emergencies that

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needed immediate action (Jordan, Saleh & Newman 2006, p. 1137). It was later on that it was to be utilized by space shuttle explorers and for crew onboard the ISS. In the designing and testing of EMU products, U.S standards and hardware capabilities are verified. The total testing time is estimated to be on average four thousand hours in between flights (Jordan, Saleh & Newman 2006, p. 1137). A brief overview of the EMU provides an insight into the many functions of abilities and configured setup of the overall components vested into the product. The many functions an EMU performs can be observed as the following: . . . 'providing a breathable atmosphere, mobility, temperature control, and protection from radiation and particle impacts'(Jordan, Saleh & Newman 2006, p. 1138). Design changes are only implemented when sections of NASA activities change, for example, 'hardware failure', 'obsolescence', 'hardware upgrade', or 'goal change'(Jordan, Saleh & Newman 2006, p. 1139).

A study by Jordan, Saleh and Newman (2006, p. 1138) argue there are the needs for quality extendable life cycle of the EMU product. The study suggested computational data on the cost requirements and efficiency is firstly met with precision to outline if any design changes are required to boost EMU mobility unit capabilities. Overall, the professional workshop consumable stages that carefully model possible engineered system designs which are central to the four stages in the design cycle are as follows: Testing is matched against 'conceptual', 'preliminary ', 'detailed ', and finally 'production'teamwork (Jordan, Saleh & Newman 2006, p. 1136).The requirements of all the design features are developed carefully so they meet the current space policies as per recommendation by the U.S international space agency NASA, which coordinates on the field delivery of U.S based aeronautical and space activities.

3. Professional EMU Training Qualification

In order to qualify for astronaut training, astronauts have to carry out simulation motions first(Li, Jin & Wang 2012, p. 118).Training NASA personnel for hard strenuous spaceflight missions means that the environment itself is hard to work with due greatly to the decompression sickness encountered in space (Katuntsev et al. 2009, p. 682). Thus, the space vehicle may on occasions experience periods of decompression in the vaccum of space itself. Astronauts registered with NASA train for the task of training for long awaited levels of manned space flights. This can include a long list of approaching studies that enlists potential NASA personnel in the training operations that includes aptitude tests, whereas the training mode consists of using a 'accurate partial gravity simulator'.All space walkers have to be assigned a suit qualification in order to operate an EMU. Successful applicants firstly go through purpose built 'generic'skills based training, and then it is customary to take on the initial role of attaining a suit qualification (Gast & Moore 2011, pp. 318-319). Once handy with the model features of the suit, crew members then get clear instructions on any further adjustments that need to be made on how to use the suits, as well as learning how to use specific tools that cover hardware knowledge (Gast & Moore 2011, p. 321). On successful achievement of training for a EMU suit qualification, all successful applicants are provided with an accreditation award.

The EMU suit qualification existing body of knowledge within the working operations of the entire techniques in training mode routinely consists of the order of operations. The orders that are typical of NASA operations are provided as follows : 'translation adaptation,reach limitation, basic EMU tool Operations, articulating portable foot restraint'(Gast & Moore 2011, p. 323).

4. What are Cosmic Rays?

When assessing present-day knowledge of the cosmos, scientists can trace the quantity of particles and matter of the universe. The solar radiation spectrum and related phenomena include galactic cosmic rays, anomalous cosmic rays, and solar energetic particles. Active galactic cosmic rays are primarily composed of high energetic ionized and atomic nuclei particles, which composition also includes hydrogen and uranium (De et al. 2006, p. 1098). GCR's are a significant barrier to the plans of manned spacecraft missions (interplanetary travel). GCR's pose a threat to the on board electronic implements that are used by current and future space voyagers (Sihver 2008, p. 253). Protective shielding is of highest priorities for NASA because the main objective of interplanetary travel is to probe and search for extra-terrestrial life beyond the solar system. Scientific theories suggest that beyond the frontiers of earth the solar energetic particles are fundamentally particles made up of the solar flares coming from the sun (Sihver 2008, p. 254).

5. The Risks of Cosmic Radiation

Radiation is a safety concern for cosmonauts who wear an EMU because the amount of radiation exposure that can be calculated on the affects to critical human organs. It is critical to take into account how the EMU shields cosmic rays whilst it also has to protect the organs inside the suit(Petrov et al. 2011, p. 1148). The EMU suit structure shields the delivery dose of radiation through the barrier built into the suit that shields the radiation belt(Petrov et al. 2011, p. 1448). The dose of radiation is calculated with a certain method of accuracy. Empirical research into the Orlan-M,for example, shows the description of the origin of cause of space radiation. The results obtained from the dose distribution in relation to the anthropomorphic phantom model under experimental conditions shows the factors carried out informs aerospace professionals that the recent study needs to illustrate better understanding of ... 'additional shielding on the space station constructions, the body attitude to the space station surface ('standing', 'lying'), the body orientation to the east-west direction, and others'(Petrov et al. 2011, p. 1448). However, the simulated data that can be applied to the EMU conditions also calculate the doses have a depth of 'uncertainty'(Petrov et al. 2011, p. 1448). Calculated estimations of the quantitative relationship between the dose ratios and in relation to critical organs shows for example, Orlan-M phantom spacesuit radiation doses diversify from 0.1 to 1.8 depending on the corresponding real human organs and the solar events(Petrov et al. 2011, p. 1453).

6. How Can Space Suits Shield Against Cosmic Rays?

According to Sihver (2008), a risk assessment of the real dangers of cosmic radiation is needed. The total risk to humans is to be estimated in the relative order of uncertainty which equals to 400-1500 percent (Sihver 2008, p. 254). In order to minimise the damage to on board electronics and EMU suits on the space flight a transport code has been developed by the Langley Research Center at NASA headquarters (Gudowska & Sobolevsky 2006, p. 1091). Shield-HIT technology has been made available to the space industry as a safety net to aerospace contractors. Shield-HIT technology (including codes 'HZETRN'and 'BRNTRN') was invented as a heavy ion treatment for the use of accurate interactions of therapeutic use between rays of protons and ionized particles and with the contact site of living organic tissue (Gudowska & Sobolevsky 2006, p. 1091). It is understood; to counteract the effects of radiation exposure to the individual wearing an EMU, there is a basic procedure which limits ionizing radiation particles. The process starts at 1) 'increasing the distance from the radiation source 2) reducing the exposure time and 3) by shielding'(Sihver 2008, p. 255). To ensure consistency of the EMU shielding doses of cosmic radiation, the manufactured material a spacesuit should be made out of extensive 'shielding materials'so by comparison it can withstand heavy-ion particle exchanges which the number of frequencies could be reduced or limited all together. Therefore, cosmonauts on future manned space flights can be protected from the risks of radioactive particles in space. Before manned spaceflights are undertaken in space the Martian environment needs to be evaluated for levels of radiation and then analysed for ... 'environment models, shield evaluation codes, and radiation response models'for further assessment of the risks to humans on space exploring missions (Sihver 2008, p. 262). Radiation tests that measure how EMU shielding properties work suggest that despite the task of increasing spacesuit efficiency radiation it is difficult because by adding a quantity of matter (mass) may or may not reduce the health risk to humans as the dose of radioactive particles can increase. These findings also suggest skin can absorb the radiation particles directly into the contact site of living tissue(skin)(Zeitlin 2006, p. 1158). This is why radiation tests are imperative to be carried out before actual space flights are undertaken. Data measurements were recently conducted by the Lind University medical center (LLUMC) that assessed the phantom EMU model under simulated conditions of 155 and 250MeV proton beams which shows that typically, the EMU space suit shielding properties are what are known as 'inhomogeneous'(Zeitlin et al. 2006, p. 1158). The shielding properties are promising as the density of the suit is 0.2gcm, and suggests it is adequate to reduce the amount of low-energy protons and electrons in the radiation belt(Zeitlin et al. 2006, p . 1158). The four main components of the electromagnetic shielding standalone features are encouraging and are reflected in: 1)'electrostatic fields, 2) plasma shielding, 3) confined magnetic fields and 4) unconfined magnetic fields'(Sihver 2008, p. 257). Interestingly, astronauts shielding properties of the EMU functions a considerable lesser value when compared to the environment of the ISS(Sihver 2008, p.254).

7. Conclusion

Since the introduction of the tailor made EMU suits made in 1961, advances in design have changed space research and astronautics technology. Over a span of two decades, the space industry has seen the overall impacts GCR's can have on the health of vital human organs, as the exposure to cosmic rays is much higher than on board the ISS. As a result, a revisitation of a feasibility study may help space suit designers further close the gap between conceptualised design and refining the layers of the suit for being ready made for an open market in a new age of space travel. To provide the space industry with insurance policies and medical cover to all astronauts on the field, space suit training is necessary to provide planetary protection to all crew on board space flights (Conley & Rummel 2008, p. 1025). The other numbers of benefits include how the EMU mobility unit could function to be more structurally flexible, at the same time supporting space walkers standards of protective cover from the harsh conditions of the Martian environment. Together also protecting contractors from biological contamination, as well as highly energetic radioactive doses of cosmic rays. Despite the bombardment of cosmic rays, future technology (Shield-HIT) looks promising (Benton et al.2006, p. 1200). A greater emphasis on understanding the solar radiation spectrum with Shield-HIT technology will help ensure that the primary human life support system is not compromised in space.

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