Extra-terrestrial Habitat Systems: Safety, Reliability, and Resilience

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ABSTRACT

Developing a resilient extra-terrestrial habitat with regards to long-term reliability and safety from hazards including radiation, meteorites, and quakes is necessary to ensure human survival during interplanetary exploration. The objective of this study is to examine conventional aerospace safety and reliability analysis techniques to investigate whether they are sufficient to achieve resilience in extra-terrestrial habitats. These results will be obtained to complete a strengths, weaknesses, opportunities, and threats (SWOT) analysis of compiled techniques to design a sustainable habitat system. Failure modes, effects, and criticality analysis (FMECA) and probabilistic risk assessment (PRA) with their past applications will be assessed to provide the SWOT analysis to define the requirements for a resilient analysis technique capable of measuring safety and reliability. An in-depth analysis of aerospace engineering analysis techniques will be performed for historical successes and failures and then applied to a simple case study. The research findings are intended to be used as one step toward determining the feasibility of living in other extra-terrestrial environments, including different settlement concepts in surface habitats or lunar lava tubes, by refining conventional safety and reliability analysis procedures. Techniques including FMECA and PRA can determine necessary improvements to increase safety but may lack long-term resiliency. For this reason, there is a need to merge existing risk-based techniques and other design considerations to assess long-term reliability and resilience.

KEYWORDS
Resilience, reliability, failure analysis, extra-terrestrial habitat, probabilistic risk assessment, moon