Paper ID: 45324
student

51st IAA SYMPOSIUM ON SAFETY, QUALITY AND KNOWLEDGE MANAGEMENT IN SPACE ACTIVITIES (D5)
Quality and safety, a challenge for traditional and new space (1)

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CAST ANALYSIS OF THE INTERNATIONAL SPACE STATION EVA 23 SUIT WATER INTRUSION MISHAP

Abstract

Enhancement of Extravehicular Activity (EVA) safety is explored using a high-fidelity safety assessment methodology, the Systems-Theoretic Accident Model and Processes, or STAMP. STAMP is a new accident causality model that is based on systems theory and control theory, as opposed to event-based modelling on which traditional methods such as Fault Tree Analysis (FTA), Event Trees, and Failure Mode and Effects Analysis are based. These traditional safety assessment techniques characterize accidents as a chain of individual failure events. However, a high level of complexity is present in engineered systems today, and this framework of analyzing vulnerabilities and accidents is often deficient in capturing failure causes emerging from complex interactions among the system components in those systems. This is particularly seen in systems where human operations, decision making, software, and technically complex hardware are interdependent. STAMP, on the other hand, regards safety as an emergent property of a system, and failures are considered a consequence of inadequate control over safe behaviour of system components. Treating risk and failure as a control problem in this way facilitates identifying complexities, conditional processes, and interdependencies, where event-based approach shows limited capability. This results in determining a wider set of failure scenarios and accident causes than that afforded by methods like FTA. The STAMP approach to accident analysis is called Causal Analysis based on STAMP (CAST) and is the basis of the study presented in this paper.

The CAST analysis is performed on the EVA 23 mishap aboard the International Space Station, wherein a hazardous condition was caused by water entering the EVA Astronaut Luca Parmitano's Extravehicular Mobility Unit suit helmet. The EVA was called to be terminated several minutes after presence of water was reported by Parmitano. The large amount of water suspended in the helmet caused breathing, visibility, and communication issues. Due to the severe nature of this hazard, this incident was classified as a High Visibility Close Call.

In this study, the socio-technical system associated with EVA operations and mission control is examined using CAST in order to determine safety improvements that can help prevent EVA mishaps and mitigate its severity should they occur. Additionally, this study has provided an opportunity to compare the results of a systems theory-based accident analysis approach with that of a traditional event-based method. The CAST process not only identified all the safety recommendations that were derived from the NASA investigation, but also yielded several significant additional ones.