44th SYMPOSIUM ON SAFETY AND QUALITY IN SPACE ACTIVITIES (D5)
A Big Challenge : Safety in Aerospace Missions (1)

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DEMONSTRATION OF A PARTICLE IMPACT MONITORING SYSTEM FOR CREWED SPACE EXPLORATION MODULES

Abstract

When micrometeorite or debris impacts occur on a space habitat, crew members need to be quickly informed of the likely extent of damage, and be directed to the impact location for possible repairs. The goal of the Habitat Particle Impact Monitoring System (HIMS) is to develop a fully automated, end-to-end particle impact detection system for crewed space exploration modules, both in space and on the surfaces of Solar System bodies. The HIMS uses multiple thin film piezo-polymer vibration sensors to detect impacts on a surface, and computer processing of the acoustical signals to characterize the impacts. Development and demonstration of the HIMS is proceeding in concert with NASA's Habitat Demonstration Unit (HDU) Project. The HDU Project is designed to develop and test various technologies, configurations, and operational concepts for exploration habitats.

This paper describes the HIMS development, initial testing, and HDU integration efforts. Initial tests of the system on the HDU were conducted at NASA's 2010 Desert Research and Technologies Studies (Desert-RATS). Four sensor locations were assigned near the corners of a rectangular pattern. To study the influence of wall thickness, three sets of four sensors were installed at different layer depths: on the interior of the module wall, on the exterior of the same wall, and on the exterior of a layer of foam insulation applied to the exterior wall. Once the system was activated, particle impacts were periodically applied by firing a pneumatic pellet gun at the exterior wall section. Impact signals from the sensors were recognized by a data acquisition system when they occurred, and recorded on a computer for later analysis. Preliminary analysis of the results found that the HIMS system located the point of impact to within 8 cm, provided a measure of the impact energy / damage produced, and was insensitive to other acoustic events. Based on this success, a fully automated version of this system will be completed and demonstrated as part of a crew "Caution/Warning" system at the 2011 Desert-RATS, along with a crew response procedure.