

A Historical Overview of International Space Station Extravehicular Activity Meteoroid and Orbital Debris Risk

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ABSTRACT

Nearly 300 spacewalks have been conducted over the last 25 years to help build and maintain the International Space Station (ISS). During the nearly 2,000 hours of extra-vehicular activity (EVA), crew members wear extra-vehicular mobility unit (EMU) “spacesuits” to mitigate hazards of the space environment including impacts from meteoroid and orbital debris (MMOD) particles. NASA includes detailed EMU MMOD risk analyses as part of the ISS EVA review and approval process.

This paper provides a general historical overview of the ISS EVA MMOD risks and the associated risk assessment process. The NASA Johnson Space Center (JSC) Hypervelocity Impact Technology (HVIT) Team produces the ISS EVA MMOD risk analyses using the Bumper3 MMOD risk analysis code in conjunction with detailed information about the EVA including crew-member EVA work sites, crew translation paths, suit orientation, and durations. Detailed physical models of the EMU spacesuits and the ISS are included and tailored for each EVA analysis. Two types of MMOD risk are included: (1) Penetration, and (2) Catastrophic. Penetration risk is for any size leak in the EMU suit. Catastrophic risk is a subset of Penetration Risk and only includes penetrations that cause a 4mm diameter hole (or larger) in the inner “bladder” layer of the EMU suit. This size hole will exceed the ability of the EMU suit to compensate. The MMOD risk analyses also utilize the latest orbital debris environment and meteoroid environment models including additional transient factors to account for recent satellite break-ups and annual meteor storms. These additional factors and the associated increase in EVA MMOD risk are considered when scheduling EVAs to reduce EMU MMOD risk.