# Standardized MMOD Shielding for Robotic Spacecraft

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## ABSTRACT

NASA robotic spacecraft are required to assess the potential for small debris induced failure for all disposal-critical components. Additional shielding might then be necessary in order to meet the acceptable risk requirement for the overall mission. Traditionally this requirement has been met with little or no additional shielding. Since the introduction of a high density debris population in ORDEM 3.0, some missions, especially those in higher portions of Low Earth Orbit, have needed additional MMOD-specific shielding in order for the mission to meet the requirement. This is a costly design effort performed late in the project life cycle, which adds unexpected mass to the spacecraft components during the integration phase, and could disrupt thermal management.

A proposal is discussed to develop a more cost-effective approach to MMOD-shielding, which can be employed earlier in the hardware design phase. The development and adoption of standardized shielding assemblies allows early tailoring of the shielding around a component, so that the mass is accounted for, as well as the small particle penetration risk, at a point in the design phase when the cost is more manageable. A set of several assemblies can be developed with a range of protection thresholds, in order to control mass where less shielding is needed. Such shielding assemblies would be developed in collaboration with blanket assembly specialists and thermal control engineers to ensure manufacturability and thermal performance challenges are known and acceptable. One clear benefit of such an approach is that hypervelocity testing can be performed on each of the standard shield assemblies to refine and confirm their performance prior to use.

The challenges inherent in designing supplemental MMOD shielding will be discussed, including performance prediction, manufacturability, and testing, as well as the mass and thermal considerations such shielding bring to the spacecraft design. The benefits of a standardized shielding approach and example applications will also be presented.