

21st IAA SYMPOSIUM ON SPACE DEBRIS (A6)  
Mitigation - Tools, Techniques and Challenges - SEM (4)

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EVOLUTION OF SPACE DEBRIS MITIGATION PRACTICES IN ESA'S DEBRIS MITIGATION  
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**Abstract**

The very dynamic nature of space flight activity, in combination with a progressive growth in space debris, requires associated space debris mitigation standards and practices to co-evolve. Similarly, there is a strong need for the development of tools to assess and verify compliance with those standards and derived requirements for specific satellite missions. The Debris Mitigation Facility (DMF) includes a set of activities run by the European Space Agency (ESA) to address those needs. The well-known and widely used Meteoroid and Space Debris Terrestrial Environment Reference (MASTER) model and the Debris Risk Analysis and Mitigation Assessment (DRAMA) tool suite are being combined into a single framework following the model-based engineering paradigm to facilitate mission-centric design and execute dedicated workflows tailored towards the verification of space debris mitigation requirements. In this paper, the status of DMF will be presented and the achievements highlighted that were made since the first activity has kicked-off in 2020. Expected to run until the end of 2024, the new DMF software is going into a beta-testing phase this year including volunteers from ESA's industrial partners that have been using DRAMA for many years in mission design. Due to the complex nature of assessing aspects like the aerothermal breakup and demise, damage due to hypervelocity impacts or drafting a collision avoidance plan for a future mission, activities in the frame of DMF have always emphasised on stakeholder exchanges. Supported by community workshops and the development of a new user forum for multi-lateral exchanges, this paper is also going to highlight the achievements in the support, interaction and strengthening of the community. One example is the development of the DRAMA (or DMF) Python package to facilitate parameter dispersion (Monte Carlo) analyses in line with common practices and experiences gained from previous missions. ESA's space debris mitigation compliance verification guidelines (ESSB-HB-U-002) have been updated recently, adopting the latest ISO 24113:2019 standard and providing comprehensive guidance to mission designers in that respect. Building on established practices, ESA has complemented those guidelines with technical notes supporting the design of a collision avoidance plan, perform damage assessments and re-entry analyses. This paper will discuss the available guidelines and associated technical notes that have matured over many years, as well as on the major upgrades on the different tools via the individual DMF activities, the lessons learnt so far and how the new features are being applied already today to upcoming space missions.