



Planetary Protection Mars Sample Return and Curation Activities Publication Update

COSPAR Planetary Protection Week

Athens, Greece

January 21, 2026

Published

- *Giuseppe Cataldo, Kyle Grello, Amy Braverman, Peter Gage. Reliability analyses and risk assessments for restricted planetary sample return missions. Reliability Engineering & System Safety. 2026 269:112098.*
- *Cataldo, G., Borgonovo, E., Siddens, A., Carpenter, K., Nado, M., & Plischke, E. (2025). Global sensitivity analyses for test planning with black-box models for Mars Sample Return. Risk Analysis, 45, 2300–2322.*
- *Giuseppe Cataldo, Bruno Sarli, Peter Gage, Todd White, Brendan Feehan, Fernando Pellerano. Planetary protection trades and lessons learned from designing Mars Sample Return’s Capture, Containment, and Return System. Acta Astronautica. 2025 232:174-180.*
- *Giuseppe Cataldo, Lorenz Affentranger, Brian G. Clement, Daniel P. Glavin, David W. Hughes, John Hall, Bruno Sarli, Christine E. Szalai. The planetary protection strategy of Mars Sample Return’s Earth Return Orbiter mission. Journal of Space Safety Engineering, 2024 11(2)374-384.*
- *Hughes DW, Cataldo G, Pellerano FA, Hardwick TC, Micalizzi F, Chambers VJ, Bean BR, Braley BJ, Cook WB, Day R, et al. Lessons Learned in Designing a Proposed Ultraviolet Sterilization System for Space. Aerospace. 2024; 11(7):538.*
- *Bruno Sarli, Emily Bowman, Giuseppe Cataldo, Brendan Feehan, Thomas Green, Kerry Gough, Andria Hagedorn, Paul Hudgins, Justin Lin, Mark Neuman, Erfan Parvez, Julien Rondey, Christine Szalai, Calinda Yew. NASA’s Capture, Containment, and Return System: Bringing Mars samples to Earth. Acta Astronautica. 2024 223:270-303.*

Planned

- *Anderson, Braverman, Cataldo, Smith, Smith, “A Case Study on Quantifying Reliability under Extreme Risk Constraints in Space Missions”, Journal of Quality Technology, accepted with revisions*
- *Gage, Cataldo, “Probabilistic Allocations for Structural Integrity for Mars Sample Return’s Earth Entry System”, Journal of Spacecraft and Rockets, submitted*
- *Sarli, Squire, Schonberg, Cataldo, et al., “Micrometeoroid and Orbital Debris Risk Assessment and Mitigation for Mars Sample Return”, AIAA Journal, submitted*

Published

- Bronwyn L. Teece, David W. Beaty, Heather V. Graham, Gerald McDonnell, Barbara Sherwood Lollar, Sandra Siljeström, Andrew Steele, SSAP Tiger Team, Rachel Mackelprang. *The Abiotic Background as a Central Component of a Sample Safety Assessment Protocol for Sample Return*. *Astrobiology* 2025 25:10, 671-693
- A. Smith, McDonnell, G, NASA/ESA Sample Safety Assessment Protocol Tiger Team (SSAP-TT). *What can we learn from the Mars Sample Return mission on risk management and microbial life detection?* In, *KILMER Conference 2025: Next Generation Microbiological Quality & Sterility Assurance, Proceedings*. McDonnell G. & A. Benedict (eds). 2025. ISBN # 978-1-57020-913-0.

Planned

- McDonnell, G., et al. *Mars Sample Return Campaign: Biological Risk and a proposed Sample Safety Assessment*. *Applied and Environmental Microbiology (AEM)* - Submitted
- *Statistics Publication: Led by Rachel and Noel, Draft, target journal at present is PLOS One.*
- *Smith, A., et al. Draft Sample Safety Assessment Protocol (awaiting community feedback from the discipline specific peer-review process).*

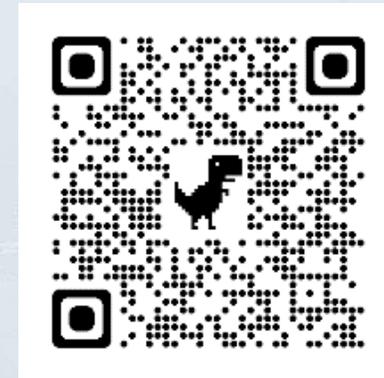
Resources Available Through The OPP Website



Planetary Protection requirements are specific to the type of mission and explored planetary bodies. Accordingly, NASA assigns each mission a **Planetary Protection Category** based on the type of planned encounter (e.g., flyby, orbiter or lander) and the type of planetary bodies that are encountered and explored during the mission (e.g., planet, moon, comet or asteroid). In general, the Planetary Protection Categories (Categories I-V) are organized to reflect the **degree a target (or encountered) planetary body may provide clues regarding life or prebiotic chemical evolution** and can be further refined through **planetary target and type of mission**.

When exploring a target body that may provide clues to the process of chemical evolution and/or the origin of life, spacecraft will have a higher level of cleanliness, with the mission providing detailed operating procedures. When exploring a target body that potentially supports Earth life, spacecraft will undergo stringent cleaning and sterilization processes and may be subject to certain operating restrictions. Planetary Protection requirements and mission categories are based on the scientific advice of the Space Studies Board and on NASA or international policy guidelines.

Category ^	Planetary Body ⇅	Mission ⇅	PP Report Available ⇅	Mission Status ⇅
I	Sun	Ulysses		Completed
II	Moon	Explorer	Yes	Completed
II	Moon	Apollo 6	Yes	Completed
II	Sun	Solar Orbiter Collaboration*		Planning Phase



<https://sma.nasa.gov/sma-disciplines/planetary-protection>