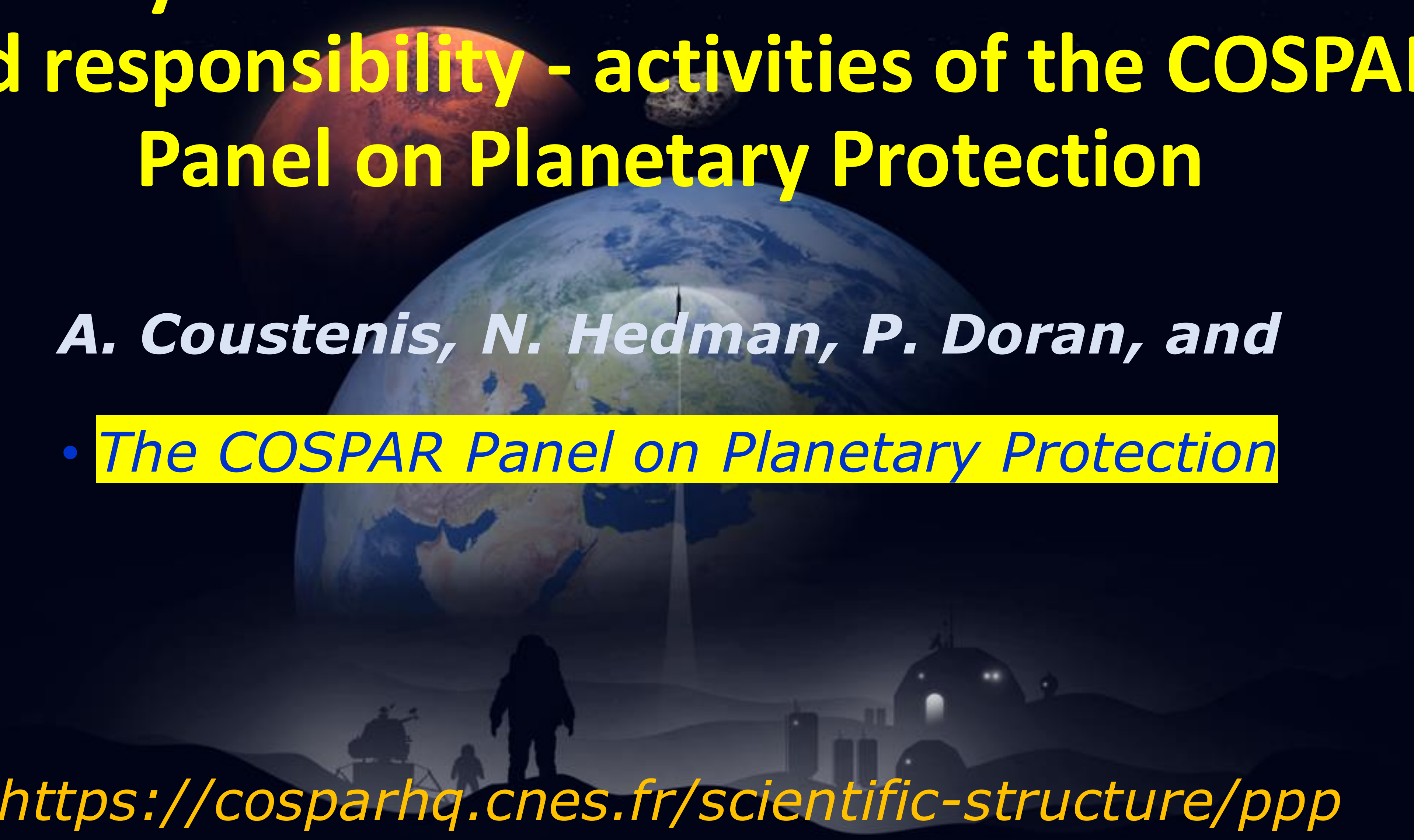
Planetary Protection: an international concern and responsibility - activities of the COSPAR Panel on Planetary Protection

A. Coustenis, N. Hedman, P. Doran, and

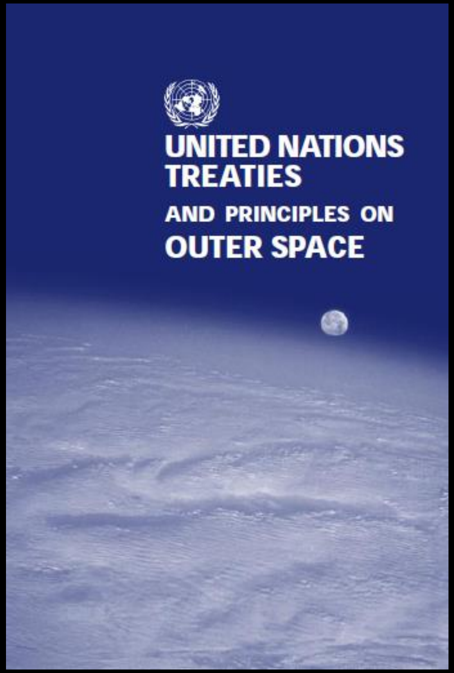
- *The COSPAR Panel on Planetary Protection*



https://cosparhq.cnes.fr/scientific-structure/ppp

Framework for planetary protection

The legal basis and the goal for planetary protection was established in Article IX of the Outer Space Treaty



Article IX "...parties to the Treaty shall pursue studies of outer space including the Moon and other celestial bodies, and conduct exploration of them so as to avoid their harmful contamination and also adverse changes in the environment of the Earth resulting from the introduction of extraterrestrial matter and, where necessary, shall adopt appropriate measures for this purpose..."

Article VI: "States Parties to the Treaty shall bear international responsibility for national activities in outer space, including the Moon and other celestial bodies, whether such activities are carried on by governmental agencies or by non-governmental entities, and for assuring that national activities are carried out in conformity with the provisions set forth in the present Treaty. The activities of non-governmental entities in outer space, including the Moon and other celestial bodies, shall require authorization and continuing supervision by the appropriate State Party to the Treaty."

COSPAR planetary protection Panel & Policy

A special case among the Commissions and Panels in the COSPAR structure is the Panel of Planetary Protection (PPP) which serves an important function for space agencies pursuing the exploration of the planets. The primary objective of the COSPAR PPP is to develop, maintain, and promote the COSPAR policy and associated requirements for the reference of spacefaring nations and to guide compliance with the Outer Space Treaty ratified today by 114 nations, to protect against the harmful effects of forward and backward contamination, i. e.

- The conduct of scientific investigations of possible extraterrestrial life forms, precursors, and remnants must not be jeopardized.
- In addition, the Earth must be protected from the potential hazard posed by extraterrestrial matter carried by a spacecraft returning from an interplanetary mission.

- *This policy must be based upon the most current, peer-reviewed scientific knowledge, and should enable the exploration of the solar system, not prohibit it. The Panel has several meetings and invites all stakeholders including the private sector.*

- *It is not the purpose of the Panel to specify the means by which adherence to the COSPAR Planetary Protection Policy and associated guidelines is achieved; this is reserved to the engineering judgment of the organization responsible for the planetary mission, subject to certification of compliance with the COSPAR planetary protection requirements by the national or international authority responsible for compliance with the Outer Space Treaty.*

COSPAR Panel on Planetary Protection Members

Chair: Athena **Coustenis** (Paris Observ., FR; planetary sciences, astrobiology)

Vice-Chairs: Niklas **Hedman** (space law and policy) &

Peter **Doran** (LA State Univ., USA; Hydrogeology, Extreme Environments)

12 members appointed by space agencies, **11 experts + 3 ex-officio**

Canada/CSA	**Tim Haltigin** (planetary sciences)	France	**Olivier Grasset** (geodynamics, planetology)
Germany/DLR	**Petra Rettberg** (microbiology, astrobiology)	USA	**Alex Hayes** (planetology)
China/CNSA	**Jing Peng** (engineering)	Russia	**Vyacheslav K. Ilyin** (microbiology, medicine)
ESA	**Silvio Sinibaldi** (astrobiology)	Spain	**Olga Prieto-Ballesteros** (geology, astrobiology)
France/CNES	**Christian Mustin** (astrobiology)	France	**François Raulin** (chemistry, planetology)
India/ISRO	**Praveen Kumar K** (engineering science)	Japan	**Yohey Suzuki** (microbiology)
Italy/ASI	**Eleonora Ammannito** (planetologist)	Canada	**Lyle Whyte** (Cold regions microbiology)
Japan/JAXA-ISAS	**Masaki Fujimoto** (space plasma physics)	China	**Kanyan Xu** (microbiology, biochemistry)
Russia/Roscosmos	**Natalia Khamidullina** (Radiation conditions)	Russia	**Maxim Zaitsev** (astrochem, organic chemistry)
UAE	**Omar Al Shehh** (engineering)	UAE	**Jeremy Teo** (mechanical and bio engineering)
UK/UKSA	**Karen Olsson-Francis** (astrob., microbiology)	UK	**Mark Sephton** (astrobiology, organic geochem.)
USA/NASA	**Frank Groen** (Bayesian data analysis, engineering)		
		COSPAR CIR Ex-officio	**Michael Gold**
NASEM Ex-officio	**Colleen Hartman** SB, ASEB & BPA Director	UNOOSA Ex-officio	**Michael Newman**

Working sessions of the COSPAR Panel on Planetary Protection

The Panel provides, through workshops and meetings at COSPAR Assemblies and elsewhere, an international forum for the exchange of information on the best practices for adhering to the COSPAR planetary protection requirements. The PPP has strong ties with other relevant bodies world-wide (e.g. NASEM SSB/CoPP). Through COSPAR GA, focused meetings with Open Sessions and publications the Panel informs the international community, including holding an active dialogue also with the private sector.

The COSPAR Panel on Planetary Protection, invited guests and attendees in Vienna in December 2023 and at The Inaugural International COSPAR Planetary Protection Workshop (April 22-25, 2024), and at the COSPAR General Assembly 2024 in Busan, South Korea

Planetary protection categories

The different planetary protection categories (I-V) reflect the level of interest and concern that contamination can compromise future investigations or the safety of the Earth; the categories and associated requirements depend on the target body and mission type combinations

Category I: All types of mission to a target body which is not of direct interest for understanding the process of chemical evolution or the origin of life; *Undifferentiated, metamorphosed **asteroids**; others*

Category II: All types of missions (gravity assist, orbiter, lander) to a target body where there is significant interest relative to the process of chemical evolution and the origin of life, but where there is only a remote[1] chance that contamination carried by a spacecraft could compromise future investigations; ***Venus; Moon (with organic inventory only for landed missions at the poles and in PSRs)*** *Comets; Carbonaceous Chondrite Asteroids; Jupiter; Saturn; Uranus; Neptune; Ganymede†; Titan†; Triton†; Pluto/Charon†; Ceres; Kuiper-Belt Objects > 1/2 the size of Pluto†; Kuiper-Belt Objects < 1/2 the size of Pluto; others TBD*

Category III: Flyby (i.e. gravity assist) and orbiter missions to a target body of chemical evolution and/or origin of life interest and for which scientific opinion provides a significant[2] chance of contamination which could compromise future investigations; ***Mars; Europa; Enceladus; others TBD***

Category IV: Lander (and potentially orbiter) missions to a target body of chemical evolution and/or origin of life interest and for which scientific opinion provides a significant[2] chance of contamination which could compromise future investigations. 3 subcategories exist (IVa,b,c) depending on instruments, science investigations, special regions etc.; *Mars; Europa; Enceladus; TBD*

Category V: All Earth return: 2 subcategories - unrestricted return for solar system bodies deemed by scientific opinion to have no indigenous life forms (***e.g. Martian Moons***) and restricted return for all others

[1]*Implies the absence of environments where terrestrial organisms could survive and replicate, or a very low likelihood of transfer to environments where terrestrial organisms could survive and replicate*

[2]*Implies the presence of environments where terrestrial organisms could survive and replicate, and some likelihood of transfer to those places by a plausible mechanism*

Planetary protection standards
(examples from ESA ECSS-Q-ST-70 and NASA-STD-8719.27)

THE FRAMEWORK PROGRAMME FOR RESEARCH AND INNOVATION
HORIZON 2020

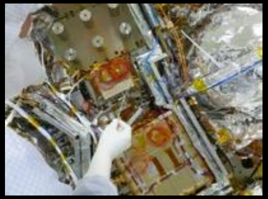
Materials and hardware compatibility tests for sterilization processes, ECSS-Q-ST-70-53C
→ Describes how to test hardware compatibility and provides examples


Credit: ESA/ExoMars

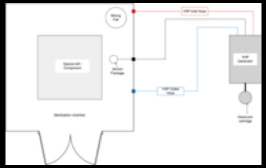
Ultra cleaning of flight hardware, ECSS-Q-ST-70-54C
→ Describes procedures how to clean flight hardware, in particular for life detection


Credit: ESA/ExoMars

Microbial examination of flight hardware and cleanrooms, ECSS-Q-ST-70-55C
→ Describes procedures how to measure the biological contamination (bioburden & biodiversity)


Credit: ESA/ExoMars

Vapour phase bioburden reduction for flight hardware, ECSS-Q-ST-70-56C
→ Describes hydrogen peroxide sterilisation procedures



Dry heat bioburden reduction for flight hardware, ECSS-Q-ST-70-57C
→ Describes high temperature sterilisation procedures

Bioburden control for cleanrooms, ECSS-Q-ST-70-58C
→ Describes how to set-up and operate bioburden controlled cleanrooms



Credit: ESA/ExoMars

Overview of COSPAR Panel on Planetary Protection Recent activities

COSPAR PPP reported activities 2019-2023

- ***Updated Planetary Protection for the Moon*** **:** *Space Res. Today Aug. 2021, 211, 14-20*

New subcategories for landers

- ***No change in Planetary Protection category for small bodies***

  PPP took the CoPP report into account and noted that the findings were compatible with the current policy. After thorough considerations and discussion by the Panel experts, it was decided that there was no need currently to change anything in the Policy as concerns small bodies.

  Coustenis et al., 2023. Front. Astron. Space Sci. 10:1172546.

frontiers | Frontiers in Astronomy and Space Sciences

TYPE Review
PUBLISHED 30 May 2023
DOI 10.3389/fspas.2023.1172546

Check for updates

OPEN ACCESS

EDITED BY
Miriam Rengel,
Max Planck Institute for Solar System Research, Germany

REVIEWED BY
John Rummel,
FH Partners LLC, United States
Elisa Maria Alessi,
National Research Council (CNR), Italy

*CORRESPONDENCE
Athena Coustenis,
athena.coustenis@obspm.fr

RECEIVED 23 February 2023
ACCEPTED 15 May 2023
PUBLISHED 30 May 2023

Planetary protection: an international concern and responsibility

Athena Coustenis[1*], Niklas Hedman[2], Peter T. Doran[3], Omar Al Shehhi[4], Eleonora Ammannito[5], Masaki Fujimoto[6], Olivier Grasset[7], Frank Groen[8], Alexander G. Hayes[9], Vyacheslav Ilyin[10], K. Praveen Kumar[11], Caroline-Emmanuelle Morisset[12], Christian Mustin[13], Karen Olsson-Francis[14], Jing Peng[15], Olga Prieto-Ballesteros[16], Francois Raulin[17], Petra Rettberg[18], Silvio Sinibaldi[19], Yohey Suzuki[20], Kanyan Xu[21] and Maxim Zaitsev[22]

- ***No change in Planetary Protection category for Venus*** **:** *the environmental conditions within the Venusian clouds are orders of magnitude drier and more acidic than the tolerated survival limits of any known terrestrial extremophile organism. Because of this, future orbital, landed or entry probe missions to Venus do not require extra planetary protection measures.: Zorzano Meier et al., 2023. LSSR 37, 18-24*

Life Sciences in Space Research 37 (2023) 18–24

Contents lists available at ScienceDirect

Life Sciences in Space Research

journal homepage: www.elsevier.com/locate/lssr

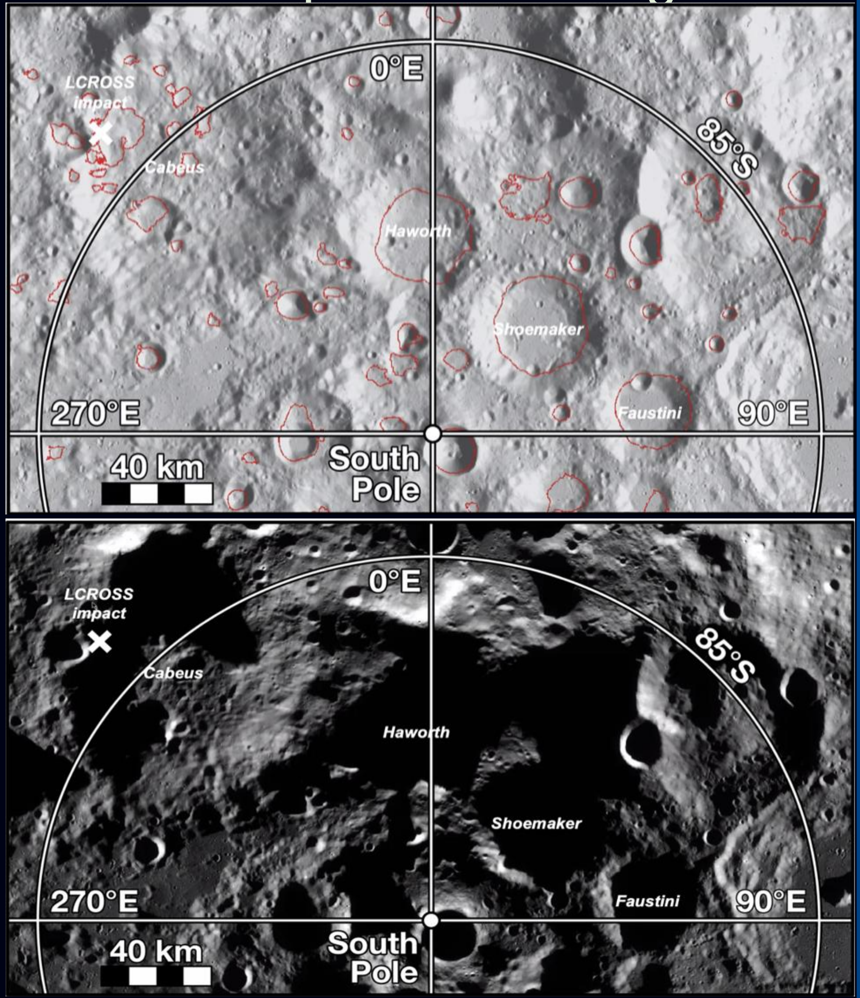
ELSEVIER

The COSPAR planetary protection requirements for space missions to Venus

María Paz Zorzano[a,*], Karen Olsson-Francis[b], Peter T. Doran[c], Petra Rettberg[d], Athena Coustenis[e], Vyacheslav Ilyin[f], Francois Raulin[g], Omar Al Shehhi[h], Frank Groen[i], Olivier Grasset[j], Akiko Nakamura[k], Olga Prieto Ballesteros[a], Silvio Sinibaldi[l], Yohey Suzuki[m], Praveen Kumar[n], Gerhard Kminek[o], Niklas Hedman[p], Masaki Fujimoto[q], Maxim Zaitsev[r], Alex Hayes[s], Jing Peng[t], Eleonora Ammannito[u], Christian Mustin[v], Kanyan Xu[w]

Updated planetary protection Policy for the Moon

Orbiter and fly-by missions to the Moon: *Category II*: no need to provide an organic inventory



Lander missions to the Moon :

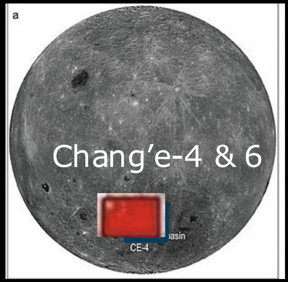
- *Category IIa*. All missions to the surface of the Moon whose nominal mission profile does not access areas defined in Category IIb shall provide the planetary protection documentation and an organic inventory limited to organic products that may be released into the lunar environment by the propulsion system (relaxed requirements),
- *Category IIb*. All missions to the surface of the Moon whose nominal profile access Permanently Shadowed Regions (PSRs) and/or the lunar poles, in particular latitudes south of 79°S and north of 86°N shall provide the planetary protection documentation and full organic inventory

Updated COSPAR Policy published in Space Res. Today ***211****, 14-20 (Aug. 2021);* https://doi.org/10.1016/j.srt.2021.07.009.

Category II: *All types of missions (gravity assist, orbiter, lander) to a target body where there is significant interest relative to the process of chemical evolution and the origin of life, but where there is only a remote[1] chance that contamination carried by a spacecraft could compromise future investigations. The requirements are for simple documentation only.*

Landing sites on the Moon and protected areas

Chang’e-3 : 44.1214°N 19.5116°W
Chang’e-4: 45.444°S 177.599°E
Chang’e-5 : 43.0576°N 51.9161°W
Chang’e-6 : 41.6385°S 153.9852°W



Chandrayaan-3
landing site:
Shiv Shakti point
69.373°S 32.319°E

Odysseus – IM
landing site:
80.13°S, 1.44 E

Mars and its moons
(sample return era)

COSPAR PPP Mars-related recent activities

- ***Mars Robotic missions*** **:** Although the science underpinning the Policy is advancing, as highlighted in recent reports (e.g. NASEM 2021, Spry et al. 2021) and in the Panel's work, there are still several knowledge gaps that need to be addressed before they can be directly applied to accommodate the interest of the user. They fall within three main themes, all of which will benefit from more measurements by space missions and ground-based observations: *Biocidal effects, contamination transport model and Mars environmental conditions*

Olsson-Francis et al., 2023. LSSR 36, 27-35

- ***Mars sample return and JAXA's Martian Moon Explorer (MMX)*****:** assigned planetary protection category : outbound Cat III and inbound Cat V: unrestricted Earth return. Full studies in *Life Sci. Space Res. 23 (2019)*

- ***Mars Crewed missions*** **:** with COSPAR support. This paper highlights the scientific measurements and data needed for knowledge gap closure.

Spry et al. (2024, Astrobiology, 24(3):230-274. doi: 10.1089/ast.2023.0092)

The COSPAR planetary protection Policy for robotic missions to Mars

- In 2021, the Panel evaluated recent scientific data and literature regarding the planetary protection requirements for Mars and the implications of this on the guidelines. The group focused on three key areas:

1) Biocidal effects of the martian environment, 2) water stability, and 3) transport of spacecraft bioburden.

- These areas were discussed in the context of survival of dormant cells (where cells are either dormant or in a state of maintenance) vs proliferation (cells are actively defining) (National Academies of Sciences, Engineering, and Medicine. 2015; Rummel et al., 2014).

Life Sciences in Space Research 36 (2023) 27–35

Contents lists available at ScienceDirect

Life Sciences in Space Research

journal homepage: www.elsevier.com/locate/lssr

ELSEVIER

The COSPAR Planetary Protection Policy for robotic missions to Mars: A review of current scientific knowledge and future perspectives

Karen Olsson-Francis[a,*], Peter T. Doran[b], Vyacheslav Ilyin[c], Francois Raulin[d], Petra Rettberg[e], Gerhard Kminek[f], María-Paz Zorzano Mier[g], Athena Coustenis[h], Niklas Hedman[i], Omar Al Shehhi[j], Eleonora Ammannito[k], James Bernardini[l], Masaki Fujimoto[m], Olivier Grasset[n], Frank Groen[l], Alex Hayes[o], Sarah Gallagher[p], Praveen Kumar K[q], Christian Mustin[r], Akiko Nakamura[s], Elaine Seasly[l], Yohey Suzuki[s], Jing Peng[t], Olga Prieto-Ballesteros[g], Silvio Sinibaldi[f], Kanyan Xu[u], Maxim Zaitsev[v]

The COSPAR Panel on Planetary Protection will continue to work with the different national and international space agencies, the scientific community, and other stakeholders (e.g., the private sector and industry) to develop a roadmap for coordinating research activities addressing the identified knowledge gaps. This will include further characterisation of the biocidal effects at the surface of Mars, which needs to be addressed before *in-situ* reduction can be considered as an approach for bioburden control for robotic missions. Although the science underpinning the Policy is advancing, as highlighted in more recent reports (e.g. National Academies of Sciences, Engineering, and Medicine 2021, Spry et al. 2021) and in this paper, there are still several knowledge gaps that need to be addressed before they can be directly applied to accommodate the interest of the user. In brief, these knowledge gaps fall within three main themes, all of which will benefit from more measurements by space missions and ground-based observations: *Biocidal effects, contamination transport model and Mars environmental conditions*

Olsson-Francis et al., 2023. LSSR 36, 27-35

Martian & Moons exploration: sample return era

COSPAR
COMMITTEE ON SPACE RESEARCH

JAXA's MMX mission categorisation

→ In 2019 ESA and JAXA studied sample return missions from Phobos and Deimos

→ To support a categorization, ESA initiated an activity with a science consortium to evaluate the level of assurance that no unsterilized martian material naturally transferred to Phobos (or Deimos) is accessible to a Phobos (or Deimos) sample return mission. NASA supported the activity from the very beginning providing test materials and expert advice, followed by JAXA with their own experimental and modelling work supporting the overall assessment

→ The ESA-JAXA-NASA coordinated activities finished with an independent review by the NAS and the European Science Foundation presented to the ESA Planetary Working Group (PPWG) and to COSPAR

→ COSPAR was involved throughout the multi-year-long process and at the end assigned a planetary protection category specifically for the MMX mission (outbound Cat III and inbound Cat V: unrestricted Earth return)

*"Planetary protection: New aspects of policy and requirements", 2019. **Life Sci. Space Res.** 23*

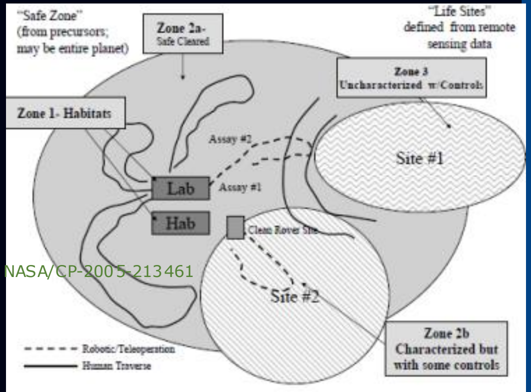
Principles for human missions to Mars

- The intent of the planetary protection policy is the same whether a mission to Mars is conducted robotically or with human explorers
- Planetary protection goals should not be relaxed to accommodate a human mission to Mars, i.e. they become even more directly relevant to such missions—even if specific implementation requirements must differ. Human exploration of Mars will require additional planetary protection considerations to those for robotic missions.
- Safeguarding the Earth from potential back contamination is the highest planetary protection priority in Mars exploration
- The greater capability of human explorers can contribute to the astrobiological exploration of Mars only if human-associated contamination is controlled and understood

Establish engineering requirements through a series of NASA and COSPAR co-sponsored workshops on Planetary Protection for Human Missions to Mars to address knowledge gaps for planetary protection in the context of future human missions to Mars.

Credit: ESA

Credit: NASA/Apollo 12



Credit: NASA/CP-2005-213461

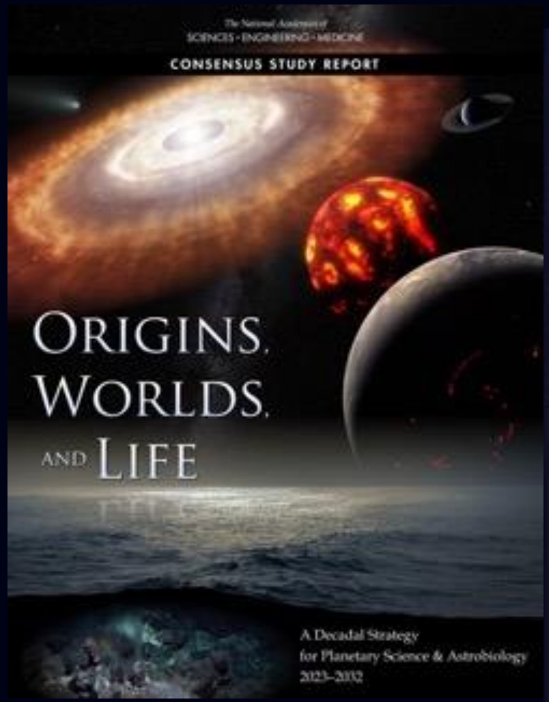
Mars Human exploration

- These interdisciplinary meetings considered the next steps in addressing knowledge gaps for planetary protection in the context of future human missions to Mars. Reports from these workshops are posted under Conference Documents at https://sma.nasa.gov/sma-disciplines/planetary-protection/.
- The knowledge gaps addressed in this meeting series fall into three major themes: "*1. Microbial and human health monitoring; 2. Technology and operations for biological contamination control, and; 3. Natural transport of biological contamination on Mars.*" *(Kminek et al., 2017)*
- A report was issued after the June 2022 COSPAR Meeting on "Planetary Protection Knowledge Gaps for Crewed Mars Missions" and represented the completion of the COSPAR series. This report aims to identify, refine, and prioritize the knowledge gaps that are needed to be addressed for planetary protection for crewed missions to Mars, and describes where and how needed data can be obtained.
- The approach was consistent with current scientific understanding and COSPAR policy, that the presence of a biological hazard in Martian material cannot be ruled out, and appropriate mitigations need to be in place. The findings were published in *Spry et al. (2024, Astrobiology, 24(3):230-274. doi: 10.1089/ast.2023.0092)* with COSPAR support. This paper highlights the scientific measurements and data needed for knowledge gap closure.

Current and future considerations

After Venus, Mars Robotic exploration and small bodies…

- More Mars… (MSR, ExoMars, crewed missions etc…)
- Implementation of Icy Worlds findings in Policy
- Other updates to the Policy for better assessment of different cases
- Space resources (ISRU), other matters



Mimas

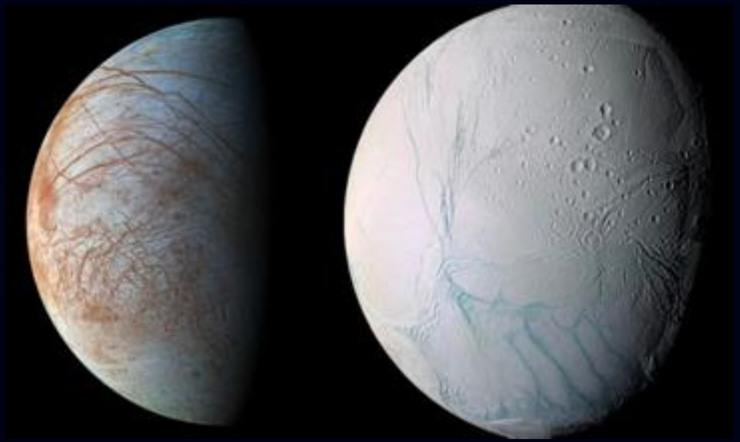
Some of these themes have been showcased in the NASEM OWL 2022 and ESA's Voyage 2050.

Icy Worlds
(not a cold case…)

Planetary Protection of the Outer Solar System (PPOSS)

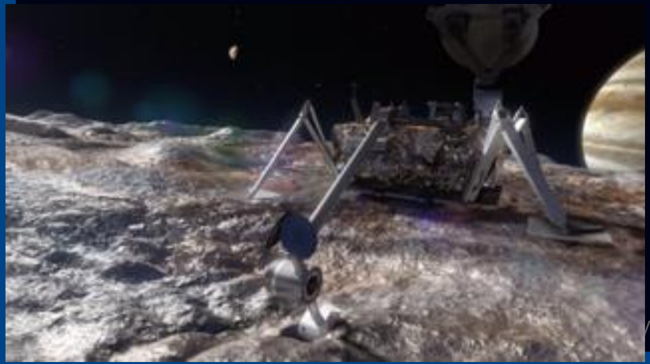
Project led by the European Science Foundation, funded by the EC with DLR/Germany, INAF/Italy, Eurospace, Space Technology/Ireland, Imperial College London (UK), China Academy of Space Technology and NAS-SSB

- Recommended a revision of the planetary protection requirements for missions to Europa and Enceladus, based partly on the NAS-SSB 2012 Icy Bodies Report and on an ESA PPWG recommendation
- COSPAR was involved throughout the multi-year-long process and at the end updated the requirements for missions to Europa and Enceladus



Europa *Enceladus*

- *Category III and IV: Requirements for Europa and Enceladus flybys, orbiters and landers, including bioburden reduction, shall be applied in order to reduce the probability of inadvertent contamination of a Europan or Enceladan ocean to less than 1 x 10^{-4} per mission*
- *The probability of inadvertent contamination of a Europan or Enceladan ocean of 1x10^{-4} applies to all mission phases including the duration that spacecraft introduced terrestrial organisms remain viable and could reach a subsurface liquid water environment*



Published in

Space Res. Today (2020) 208

"Planetary protection: New aspects of policy and requirements", 2019.

***Life Sci. Space Res.** 23*

& The Internl PP Handbook: Dec. 2018

Planetary Protection of the Outer Solar System (PPOSS)

COSPAR
COMMITTEE ON SPACE RESEARCH

THE INTERNATIONAL PLANETARY PROTECTION HANDBOOK

by

Gerhard Kminek (ESA, Noordwijk, The Netherlands), Jean-Louis Fellous (COSPAR, France), Petra Rettberg (DLR, Germany), Christine Moissl-Eichinger (Medical Univ. Graz, Austria), Mark A. Sephton and Samuel H. Royle (Imperial College London, UK), J Andy Spry (SETI Institute, CA, USA), Hajime Yano (ISAS/JAXA, Japan), Toshihiro Chujo (formerly JAXA, now Tokyo Institute of Technology, Japan), Diana B. Margheritis (Thales Alenia Space, Italy), John R. Brucato (INAF, Italy), and Alissa J. Haddaji (formerly COSPAR, now Harvard University, MA, USA)

An online-only supplement to *Space Research Today*, volume 205

"Planetary protection: New aspects of policy and requirements", 2019.

***Life Sci. Space Res.* 23**

& The Internl PP Handbook: Dec. 2018

Credit: NASA/JPL/Galileo

- *Policy should include a generic definition of the environmental conditions potentially allowing Earth organisms to replicate*
- *implementation guidelines should be more specific on relevant organisms*
- *implementation guidelines should be updated to reflect the period of biological exploration of Europa and Enceladus*
- *implementation guidelines should acknowledge the potential existence of Enhanced Downward Transport Zones at the surface of Europa and Enceladus.*

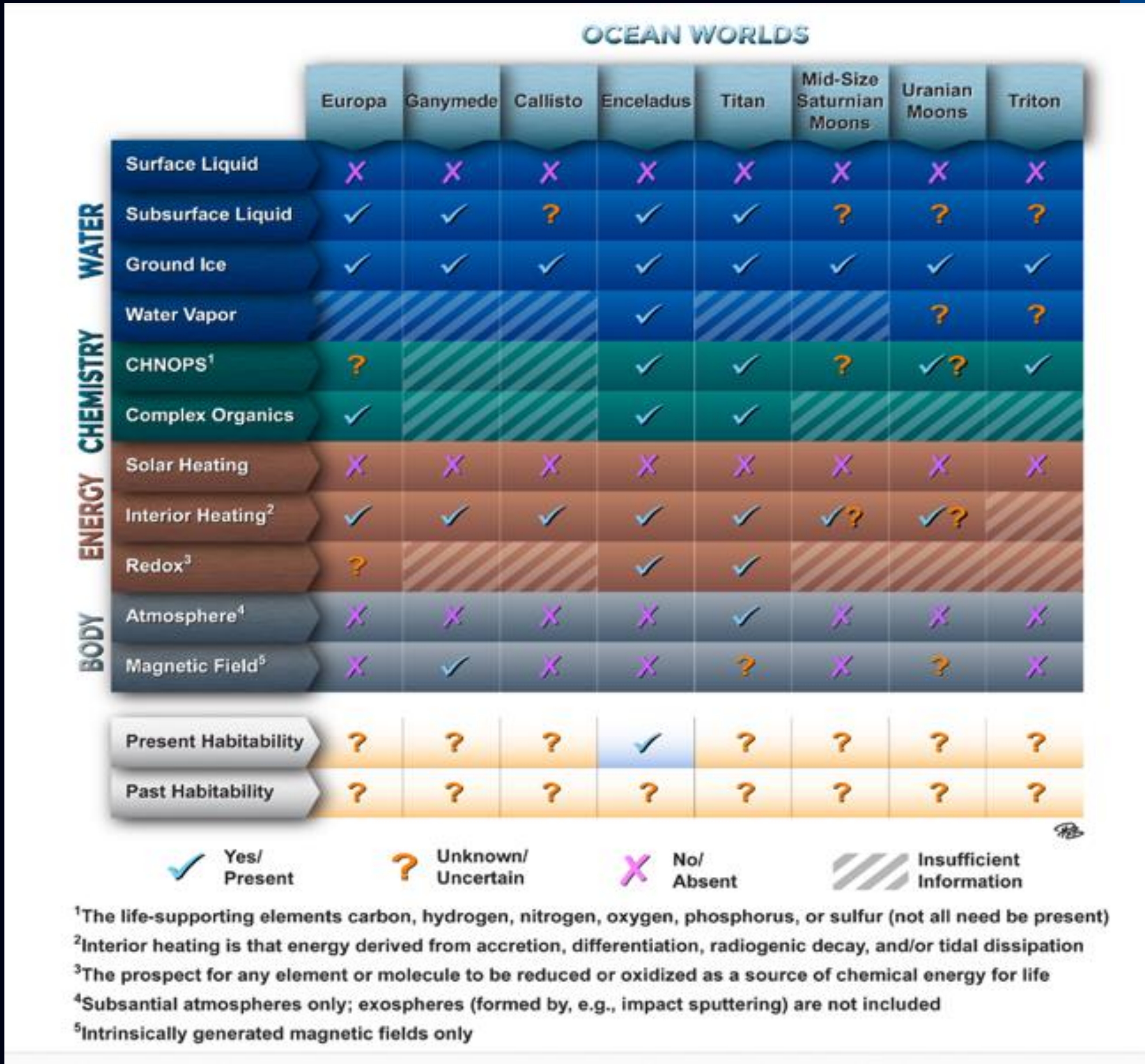
Future exploration of Icy Worlds

COSPAR
COMMITTEE ON SPACE RESEARCH

The PPOSS study (*The Internl PP Handbook (Dec. 2018) ; & "Planetary protection: New aspects of policy and requirements" (2019) in Life Sci. Space Res. 23 & Space Res. Today 208 (2020))* a Panel subcommittee considered the future exploration of Icy Worlds and Ceres

The Panel has been working on a thorough review of the current knowledge for Icy Moons+Ocean Worlds (**Icy Worlds**: *"Icy Worlds in our Solar System are defined as all bodies with an outermost layer that is believed to be greater than 50% water ice by volume and have enough mass to assume a nearly round shape."*) and is making proposals for a better coverage in the Policy

Findings were presented in different meetings and congresses. *(Doran et al., 2024, LSSR, 41 pp. 86–99)*



OCEAN WORLDS

		Europa	Ganymede	Callisto	Enceladus	Titan	Mid-Size Saturnian Moons	Uranian Moons	Triton
WATER	Surface Liquid	✗	✗	✗	✗	✗	✗	✗	✗
	Subsurface Liquid	✓	✓	?	✓	✓	?	?	?
	Ground Ice	✓	✓	✓	✓	✓	✓	✓	✓
	Water Vapor	▨	▨	▨	✓	▨	▨	?	?
CHEMISTRY	CHNOPS[1]	?	▨	▨	✓	✓	?	✓?	✓
	Complex Organics	✓	▨	▨	✓	✓	▨	▨	▨
ENERGY	Solar Heating	✗	✗	✗	✗	✗	✗	✗	✗
	Interior Heating[2]	✓	✓	✓	✓	✓	✓?	✓?	▨
	Redox[3]	?	▨	▨	✓	✓	▨	▨	▨
BODY	Atmosphere[4]	✗	✗	✗	✗	✓	✗	✗	✗
	Magnetic Field[5]	✗	✓	✗	✗	?	✗	?	✗
	Present Habitability	?	?	?	✓	?	?	?	?
	Past Habitability	?	?	?	?	?	?	?	?

✓ Yes/ Present   ? Unknown/ Uncertain   ✗ No/ Absent   ▨ Insufficient Information

[1]The life-supporting elements carbon, hydrogen, nitrogen, oxygen, phosphorus, or sulfur (not all need be present)
[2]Interior heating is that energy derived from accretion, differentiation, radiogenic decay, and/or tidal dissipation
[3]The prospect for any element or molecule to be reduced or oxidized as a source of chemical energy for life
[4]Subsantial atmospheres only; exospheres (formed by, e.g., impact sputtering) are not included
[5]Intrinsically generated magnetic fields only

Modified from NASEM Decadal. OWL, Courtesy of P. Byrne

Missions to Icy Worlds (findings)

COSPAR COMMITTEE ON SPACE RESEARCH

Doran et al., 2024.


Life Sciences in Space Research 41 (2024) 86–99

Contents lists available at ScienceDirect

Life Sciences in Space Research

journal homepage: www.elsevier.com/locate/lssr

ELSEVIER

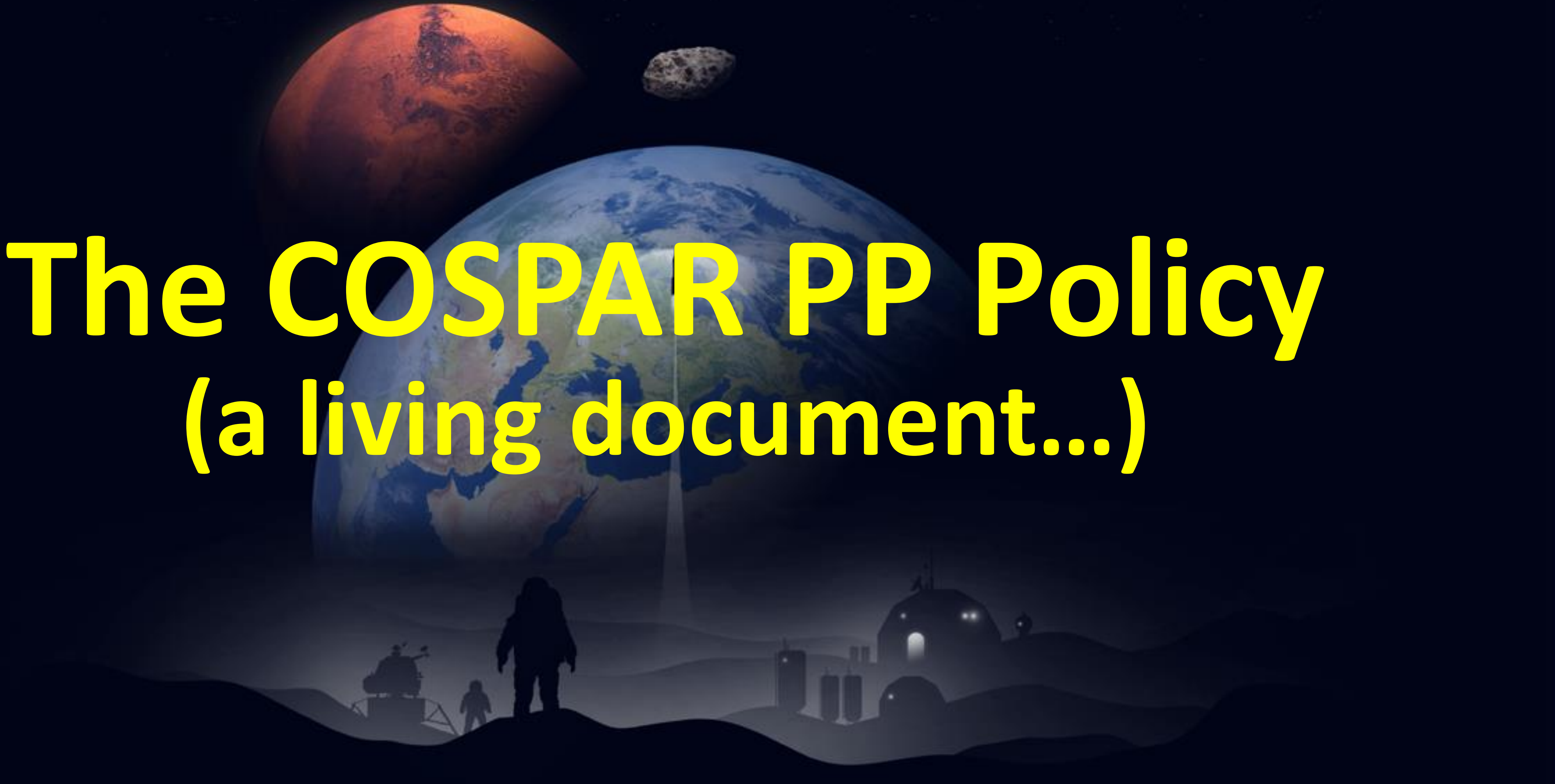
The COSPAR planetary protection policy for missions to Icy Worlds: A review of history, current scientific knowledge, and future directions

P.T. Doran[a,*], A. Hayes[b], O. Grasset[c], A. Coustenis[d], O. Prieto-Ballesteros[e], N. Hedman[f,1], O. Al Shehhi[g], E. Ammannito[h], M. Fujimoto[i], F. Groen[j], J.E. Moores[k], C. Mustin[l], K. Olsson-Francis[m], J. Peng[n], K. Praveenkumar[o], P. Rettberg[p], S. Sinibaldi[q], V. Ilyin[r], F. Raulin[s], Y. Suzuki[t], K. Xu[u], L.G. Whyte[v], M. Zaitsev[w], J. Buffo[x], G. Kminek[q], B. Schmidt[b]

After reviewing the current knowledge and the histor of planetary protection considerations for Icy Worlds, the Panel subcommittee published its recommendations:

- Establish indices for the lower limits of Earth life wit regards to water activity (LLAw) and temperature (LLT) and apply them into all areas of the COSPAR Planetary Protection Policy (These values are currently set at 0.5 and -28 ◦C and were originally established for defining Mars Special Regions)
- Establish LLT as a parameter to assign categorization for Icy Worlds missions. The suggested categorization will have a 1000-year period of biological exploration, to be applied to all Icy Worlds and not just Europa and Enceladus as is currently the case.
- Have all missions consider the possibility of impact. Transient thermal anomalies caused by impact would be acceptable so long as there is less than 10^{-4} probability of a single microbe reaching deeper environments where temperature is >LLT in the period of biological exploration.
- Restructure or remove Category II* from the policy as it becomes largely redundant with this new approach,
- Establish that any sample return from an Icy World should be Category V restricted Earth return.

The COSPAR PP Policy
(a living document…)



COSPAR PP Policy editorial review and restructuring process

Objective to enhance the understanding and clarity of the Policy and associated guidelines for consistency and transparency, including by introducing a more objectives-driven and case-assured (vs. prescriptive) approach to the formulation and implementation of planetary protection controls.

- Clarifying the status of the Policy as a non-legally binding international standard; quoting both OST Article VI and IX.
- New chapters clarifying the role and function of COSPAR PPP; presenting key assumptions that form the basis for the technical guidelines; listing categorization considerations to capture the rationale and intent behind the categorization process.
- Restructuring the Policy and associated guidelines with explanatory text. including graphics/tables on a) Planetary protection process overview (categorization and corresponding guidelines); b) Planetary protection categories in relation to target bodies; c) Guideline specification; d) Example of expected elements for mission documentation.

Review undertaken by a PPP Subcommittee (PPP Leadership, NASA, ESA and independent scientist members). Submitted in March 2024 to the COSPAR Bureau for validation and the Bureau approved on 20 March.

No changes to the requirements or guidelines in this new Policy.
Any changes will only intervene after the careful process described before in other cases.
Published in the Space Research Today Journal (12 July 2024 issue)

COSPAR
COMMITTEE ON SPACE RESEARCH

COSPAR Policy on Planetary Protection

Table of Contents

COSPAR BUSINESS

1. Preamble

Noting that COSPAR has concerned itself with questions of biological contamination and spaceflight since its very inception,

noting that Article IX of the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies (also known as the Outer Space Treaty of 1967) states that [Ref. United Nations 1967]:

"States Parties to the Treaty shall pursue studies of outer space, including the Moon and other celestial bodies, and conduct exploration of them so as to avoid their harmful contamination and also adverse changes in the environment of the Earth resulting from the introduction of extraterrestrial matter and, where necessary, shall adopt appropriate measures for this purpose."

noting that Article VI of the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies (also known as the Outer Space Treaty of 1967) states that [Ref. United Nations 1967]:

"States Parties to the Treaty shall bear international responsibility for national activities in outer space, including the Moon and other celestial bodies, whether such activities are carried on by governmental agencies or by non-governmental entities, and for assuring that national activities are carried out in conformity with the provisions set forth in the present Treaty. The activities of non-governmental entities in outer space, including the Moon and other celestial bodies, shall require authorization and continuing supervision by the appropriate State Party to the Treaty."

therefore, to guide compliance with the Outer Space Treaty, COSPAR maintains this Policy on Planetary Protection (hereafter referred to as the COSPAR PP Policy) for the reference of spacefaring nations as an international voluntary and non-legally binding standard for the avoidance of organic-constituent and biological contamination introduced by planetary missions.

New Policy Published In SRT 12 July 2024


Spreading the word…

COSPAR PPP activities 2023-2024 – communications/Workshops

The ESA WS Planetary Protection Requirements
for future exploration missions Workshop

Organised by S. Sinbaldi, presentation by P. Rettberg

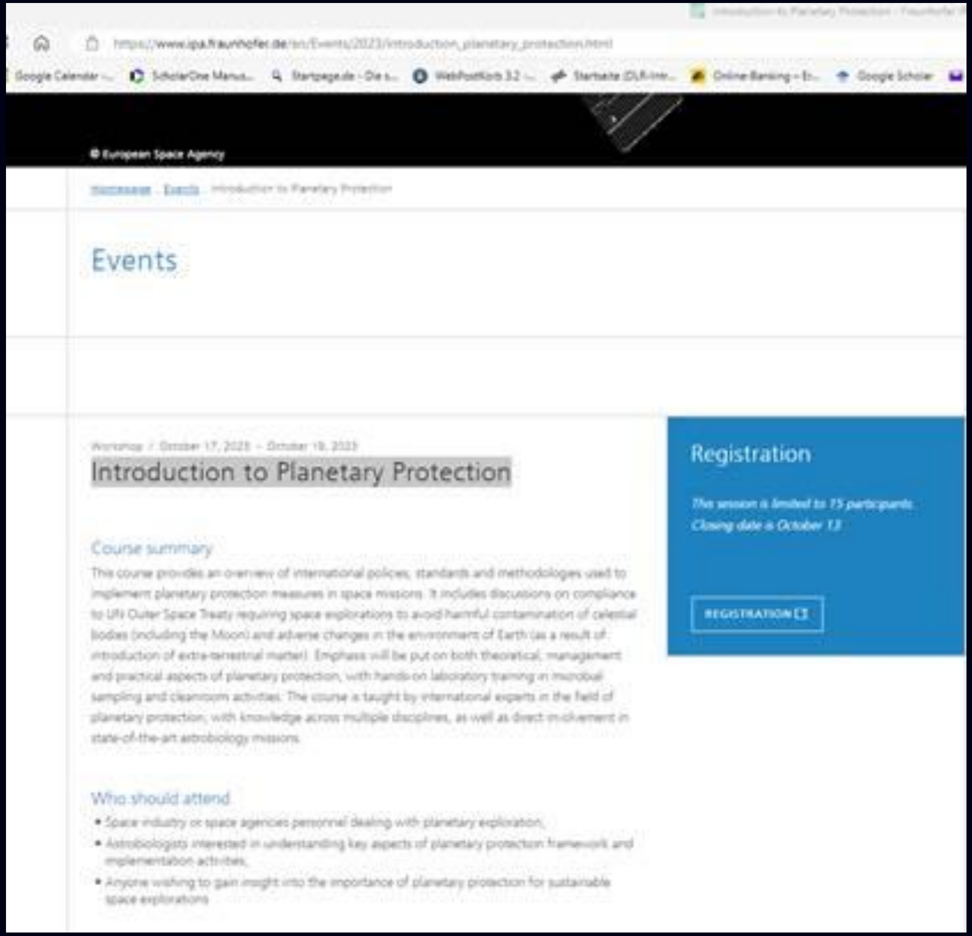
XIX International School of Astrobiology «Josep Comas i Solà».
Searching for Life on Ocean Worlds with a lecture titled:
Planetary Protection considerations for ocean worlds.

Talk by O. Prieto-Ballesteros

World Trade Institute (UniBE) Workshop on "The Economics and Law of Space-Based Commerce".
17-19 Jan. 2024 at ISSI, Bern

Talk by A. Coustenis, N. Hedman and J-C Worms

ESA PP course 'Introduction to Planetary Protection' (Fraunhofer Institute, Stuttgart)



Organised by S. Sinbaldi,
presentations by N. Hedman & P. Rettberg

COSPAR PPP activities 2023-2024

UN-UNLUX SRW 2024
Working Group on Legal Aspects of Space Resource Activities

Planetary Protection presentations by P. Rettberg & N. Hedman

VAAM (Association for General and Applied Microbiology) workshop 'Big Bang... Microbes! & GeoBerlin 2023 conference

Plenary discussion on "plenary discussion about PP 'Should we colonize Mars? by P. Rettberg

The ESA metagenomic Workshop

Talk by K. Olsson-Francis

COSPAR PPP activities 2023-2024

EANA 2023 Sept. 2023

Talks on Planetary Protection by P. Rettberg & K. Olsson-Francis

The International Mars Exploration Working Group (IMEWG) – Nov. 2023

invited talk about 'Planetary protection' by K. Olsson-Francis

OPAG Meeting, 29 Nov. 2023

Presentation of PP Icy Worlds Policy suggestions by A. Hayes

LPSC 2024 11-15 Mar. 2024

Presentation of PP Icy Worlds Study by P. Doran

NASEM SSB/CoPP Meeting, 21 March 2024

Presentation of PPP activitiies by P. Doran, N. Hedman, A. Coustenis

COSPAR
COMMITTEE ON
SPACE RESEARCH

The 2024 COSPAR General Assembly

:

13-21 July 2024, Busan, South Korea

https://www.cospar-assembly.org/assembly.php

PPP.1 Policy *(Conveners: A. Coustenis & N. Hedman)*
16 July 2024 (with **OPEN** and Closed sessions)

PPP.2 Planetary Protection Mission Implementation and Status *(Conveners: S. Sinibaldi & F. Groen)*
17 July 2024

PPP.3 Planetary Protection Research and Development *(Conveners: P. Doran & K. Olsson-Francis)*
14 July 2024

PPP Business Meeting : 17 July lunch time

Several talks from all interested parties at our PPP sessions !

COSPAR
COMMITTEE ON
SPACE RESEARCH

Future meetings

Several PPP Meetings with Open Session in 2025 and 2026

COSPAR
COMMITTEE ON
SPACE RESEARCH

Planetary protection:
For sustainable space exploration and to safeguard our biosphere

The Policy will continue to be updated but not in a rushed process. We give thorough consideration to all arguments and scientific inputs and make an informed decision

In the meantime, there is need for community input on science findings and research reserves or recent reports: Studies/Surveys/Workshop/Focused conferences?

- COSPAR maintains a non-legally binding planetary protection policy and associated requirements to guide compliance with the UN Outer Space Treaty. The COSPAR Policy is the only international framework for planetary protection

- **We invite anyone interested to contact any PPP member for interactions and information on the latest policy and requirements.**

PPP Recent publications (extract)

https://cosparhq.cnes.fr/scientific-structure/panels/panel-on-planetary-protection-ppp/

- COSPAR Panel on Planetary Protection, 2020. « COSPAR Policy on Planetary Protection ». *Space Res. Today* 208, Aug. 2020
- The COSPAR Panel on Planetary Protection, 2020. « Planetary Protection Policy: For sustainable space exploration and to safeguard our biosphere ». *Research Outreach* 118, 126-129.
- Coustenis, A., Hedman, N., Kminek, G., The COSPAR Panel on Planetary Protection, 2021. "To boldly go where no germs will follow: the role of the COSPAR Panel on Planetary Protection". *OpenAccessGovernment,* July 2021
- Fisk, L., Worms, J-C., Coustenis, A., Hedman, N., Kminek, G., the COSPAR PPP, 2021.Updated COSPAR Policy on Planetary Protection. *Space Res. Today* 211, August 2021. doi.org/10.1016/j.srt.2021.07.009
- Coustenis, A., The COSPAR Panel on Planetary Protection, 2021. « Fly me to the moon: Securing potential lunar water sites for research ». *OpenAccessGovernment,* Sept. 2021
- Olsson-Francis, K., Doran, P., et al., 2023. The COSPAR Planetary Protection Policy for missions to Mars: ways forward based on current science and knowledge gaps. *LSSR*, 36, p. 27-35.
- Zorzano M-P., et al., 2023. The COSPAR Planetary Protection Requirements for Space Missions to Venus. *LSSR*, 37, 18–24.
- Coustenis, A., et al., 2023. Planetary protection: Updates and challenges for a sustainable space exploration. *Acta Astron.*, 210, 446-452. https://doi.org/10.1016/j.actaastro.2023.02.035
- Coustenis, A., et al., 2023. Planetary Protection: an international concern and responsibility. Frontiers in Astronomy and Space Sciences, *Front. Astron. Space Sci. 10:1172546.*
- Spry, A., et al., 2024. Planetary Protection Knowledge Gap Closure Enabling Crewed Missions to Mars. Astrobiology, in press.
- Doran, P., et al. 2024. The COSPAR Planetary Protection Policy for missions to Icy Worlds: A review of current scientific knowledge and future directions. LSSR, 41 pp. 86–99.