Editorial to the 2026 version of the COSPAR Policy on Planetary Protection

We introduce here a new version of the International COSPAR Policy on Planetary Protection which is maintained and updated by the COSPAR Panel on Planetary Protection. The former 2024 version of the COSPAR Policy on Planetary Protection was validated by the COSPAR Bureau on 20 March 2024 and published in the COSPAR journal *Space Research Today* in July 2024 (*SRT* 220, pp. 14-36). That version constituted a comprehensive editorial revision of the Policy compared to the earlier version from 2021. With the 2024 version, the Policy represented a modern instrument for contemporary implementation and application. In that revision process the COSPAR Panel on Planetary Protection decided to wait with substantive changes concerning missions to the outer Solar System bodies. It was agreed to pause with such revisions until full consensus was reached, including by scientific publication, scientific community review, and Panel considerations of those results. The introduction of "Icy Worlds" into the Policy has been a dedicated process within the Panel, including comprehensive discussions and interactions with all stakeholders at the Inaugural COSPAR Planetary Protection Week in London in April 2024 and at the subsequent Planetary Protection Week in Cologne in April 2025.

Upon endorsement of the new 2026 version of the Policy by Panel members on 6 October 2025, the text was submitted to the COSPAR Bureau for validation and was approved on 7 November 2025. Below is a brief explanation to the introduction of "Icy Worlds" into the new version of the Policy, which is published hereafter in this issue of *Space Research Today*.

The new 2026 version comprises a number of editorial changes relative to the 2024 version to improve consistency, readability, understanding and application of the Policy, and substantive new guidelines for missions to Icy Worlds. The latter is a groundbreaking new introduction into the Policy instrument.

To support the implementation of the Policy, additional tables and appendices have been introduced to enhance the clarity and usability of this instrument. These include a new updated Figure 1 on planetary protection process overview in establishing the planetary protection categorization and resulting guidelines and mission documentation definition; a new Table 2 on planetary protection categories sorted by Target (note that Table 1 is retained in the Policy, thus in combination sorting the categorization by categories and by target bodies). Figure 2 is new and constitutes a flow diagram of first steps in determining categorization of an Icy World. Appendix D is also new and contains a list of known Icy Worlds.

Icy Worlds

With regard to Icy Worlds (for which a new definition is now implemented in the Policy[1]), the previous COSPAR Policy on Planetary Protection focused specifically on Europa and Enceladus, which were assigned to Category III because their subsurface liquid water oceans are thought to be relatively close to the surface and in contact with a silicate core, increasing their potential habitability and accessibility. New findings from extended data analysis from several space missions indicate that other Icy Worlds could be of concern in these regards, even though their subglacial oceans may be deeper (such as on Ganymede and Titan) or ancient (like for Ceres). However, the former Policy did not reflect this diversity or provide sufficient clarity for mission planners designing landers, orbiters, or sample return missions.

A specific Icy World categorization in the new Policy provides sufficient clarity for mission planners designing landers, orbiters, or sample return missions. We have introduced a formal definition of Icy Worlds which captures bodies that were previously unclassified or assigned Category II with special requirements for final assignment (commonly referred to as Cat. II*) within the Policy's existing hierarchy (Mars, Moon, planets, Europa, Enceladus, small bodies), and developed a corresponding

[1]Icy Worlds in our Solar System are defined as all bodies with an outermost layer that is predominantly water ice by volume and that have enough mass to assume a nearly round shape [Doran et al. 2026].

categorization framework. Our new approach, where all Icy Worlds are by default assumed a category III unless a mission team can justify reclassification to Category II, addresses these concerns and removes the need for the previous and cumbersome II* process in the Policy.

While the new framework draws from the existing Europa and Enceladus guidelines, we replaced the original "trigger" for concern from the presence of water to temperature. Because no known Earth organism can replicate below −28°C, temperature serves as a clearer boundary for potential biological activity. On Earth, some brines remain liquid below −40°C but are still uninhabitable due to extremely low water activity. Thus, relying solely on the presence of liquid water risks misidentifying regions that could not actually support Earth life. Using temperature as an index allows us to more accurately define where terrestrial organisms might proliferate in outer Solar System bodies and to base contamination probability calculations on scientifically meaningful limits. The Policy now includes guidance on sample return from these bodies which was previously absent even for Europa and Enceladus.

By providing a definition of Icy Worlds, incorporating new thresholds for biological activity (e.g., the lower temperature limit for life), establishing probability-based contamination assessments, and guidelines for sample return from these bodies, COSPAR can better ensure that planetary protection offers a structured, evidence-based approach that adapts to new discoveries. There was also the benefit of removing II* from the Policy which was often deemed unclear and difficult to implement. Note that the new Policy does not apply to missions already *en route* or in advanced stages of development.

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COSPAR Policy on Planetary Protection

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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 [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 [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 Planetary Protection 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.

2. Policy Statement

COSPAR,

Referring to COSPAR Resolutions 26.5 and 26.7 of 1964 [COSPAR 1964], and COSPAR Recommendation 3/2002 [COSPAR 2003],

Notes with appreciation and interest the extensive work done by the COSPAR Panel on Standards for Space Probe Sterilization and its successors the COSPAR Panel on Planetary Quarantine and the current COSPAR Panel on Planetary Protection, and

Accepts that for certain missions, controls on contamination should be imposed in accordance with a specified range of guidelines, based on the following policy objectives:

The scientific investigation of the process of chemical evolution and/or the origin and evolution of life must not be compromised. In addition, the Earth must be protected from the potential hazard posed by extraterrestrial matter carried by a spacecraft returning from a planetary mission.

Emphasises, therefore, that all entities conducting space activities beyond Earth orbit must implement controls commensurate with the mission type and targeted body's significance for understanding the process of chemical evolution and/or the origin and evolution of life in the Solar System, and the potential for adverse impacts to the Earth's biosphere.

Recognises that, for specific missions, controls can be tailored allowing the mission to accomplish its science objectives while still meeting planetary protection objectives.

3. Role of the COSPAR Panel on Planetary Protection

COSPAR has established the Panel on Planetary Protection (hereafter referred to as the COSPAR PPP) to develop, maintain, and promote the COSPAR Planetary Protection Policy and associated guidelines for the reference of spacefaring nations and to assist them with compliance with the Outer Space Treaty, specifically with respect to protecting against the harmful effects of forward and backward contamination. The COSPAR PPP includes a number of agency representatives and experts in various fields attached to planetary protection such as astrobiology, planetary sciences, geology and geophysics, microbiology, aerospace engineering and operations, contamination control, space law and space policy, among others, and relies on information brought forward by the various communities through workshops and peer-reviewed studies [Coustenis et al. 2019, 2023].

The COSPAR PPP's main function is to regularly review the latest available, peer-reviewed/expert scientific knowledge that is provided by external groups or by a subcommittee of the COSPAR PPP. Based on this information, the COSPAR PPP will produce recommendations to the COSPAR Bureau and Council as to whether a change in the COSPAR Planetary Protection Policy is required. Such recommendations, when validated by the COSPAR Bureau and Council, are then implemented into the Policy.

To increase transparency and promote inclusion, the activities and reports from the COSPAR PPP such as meeting minutes, presentations, subcommittee reports, and panel peer-reviewed journal articles are made available on the COSPAR PPP's website as appropriate.

The COSPAR PPP encourages the entities conducting activities in outer space to seek guidance/assistance from the COSPAR PPP on the interpretation of this COSPAR Planetary Protection Policy as necessary.

The COSPAR PPP also supports States, on their voluntary request, in performing mission-specific review and assessment to encourage international cooperation in planetary protection matters.

4. Key Assumptions

4.1. Exploration Assumptions

To meet the objective of protecting the future search for life [e.g. Coustenis et al. 2025], the preferred approach is to limit the probability of contamination when that contamination could be harmful for understanding of the process of chemical evolution and/or the origin and evolution of life in the Solar System.

The probabilities of viable terrestrial microorganisms proliferating on a Solar System body during planetary missions are extremely low. This directly reflects the fact that most surface and shallow sub-surface environments at these bodies appear hostile to all known biological processes (although pockets or regions may exist that are compatible with, or could support growth of terrestrial microorganisms). These environments do not preclude the possibility of extinct or extant indigenous life forms.

The search for life is a central objective in the exploration of the Solar System [e.g., Coustenis et al. 2025].

The organic chemistry of these bodies remains of paramount importance to our understanding of the process of chemical evolution and its relationship to the origin and evolution of life.

The study of the processes of the pre-biotic organic syntheses under natural conditions should not be compromised.

4.2. Environmental Conditions for Replication

Given current understanding, the limiting physical environmental parameters in terms of water activity and temperature thresholds that should be satisfied at the same time to allow the replication of terrestrial microorganisms are [Rummel et al. 2014, Kminek et al. 2016 and Doran et al. 2024]:

- Lower limit of water activity (LLAw): 0.5
- Lower limit of temperature (LLT): -28°C

Both of these limits include margins below the reported limits of terrestrial biology [Rummel et al. 2014, Kminek et al. 2016].

4.3. Bioburden Constraints

All bioburden constraints for Mars missions are defined with respect to the number of mesophilic, heterotrophic, aerobic microorganisms that survive a heat shock of 80°C for 15 minutes (hereinafter "spores") and are cultured on Tryptic-Soy-Agar (TSA) at 32°C for 72 hours [National Academies of Sciences, Engineering, and Medicine 2021, Olsson-Francis et al. 2023].

Rationale: Bacterial spores were selected as a biological indicator early in the Viking Mars Program due to their general hardiness to survive harsh environmental conditions and resistance to sterilization processes like dry heat microbial reduction [National Aeronautics and Space Administration 1967].

4.4 Period of Biological Exploration

The period of biological exploration (PBE) is the period in which contamination sensitivities are considered a driving importance to preserve the native state of a planetary body for initial biological exploration.

The PBE for Icy Worlds (see definition in Section 6.1.2.1) is 1000 years; this period should start at the beginning of the 21st century [National Research Council 2012, Kminek et al. 2019, COSPAR 2020].

The PBE for Mars is defined to be 50 years from spacecraft launch [COSPAR 1969, National Academies of Sciences, Engineering, and Medicine 2006].

4.5 Life Detection and Sample Return "False Positives"

A "false positive" could prevent distribution of the sample from containment and could lead to unnecessary increased rigour in the guidelines for all later missions.

4.6 Crewed Missions to Mars

The intent of planetary protection is the same whether a mission to Mars is conducted robotically or with human explorers. Accordingly, planetary protection goals should not be relaxed to accommodate a human mission to Mars. Rather, they become even more directly relevant to such missions - even if specific implementation guidelines should differ [Beaty et al. 2005, Criswell et al. 2005, Hogan et al. 2006, Kminek et al. 2005, Race et al. 2008, National Research Council 2002, Spry et al. 2024]. General principles include:

- 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.
- For a landed mission conducting surface operations, it will not be possible for all human-associated processes and mission operations to be conducted within entirely closed systems.

5. Categorization

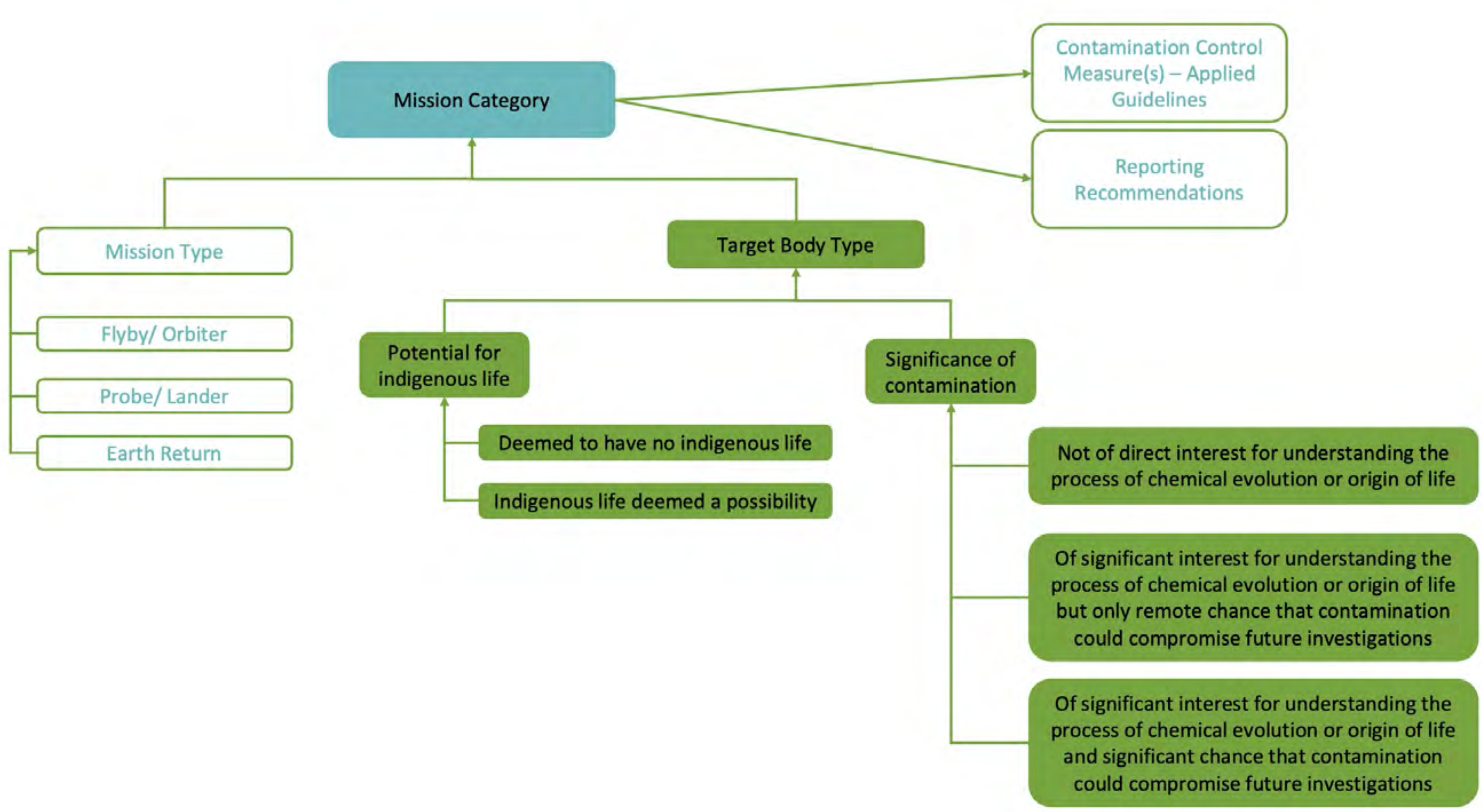
There are five categories for target body/mission type combinations and the assignment of categories for specific mission/body combinations is to be determined by the best multidisciplinary scientific advice. Planetary protection categorization is a risk-informed decision-making process involving scientific consensus to assess the risk of planetary missions introducing harmful contamination of a target body or the possibility that extraterrestrial materials returning to Earth could have adverse impacts on the terrestrial biosphere (Figure 1). The type of mission and the target body type are the key parameters to establish a mission category. The type of mission includes flyby/orbiters (this term is used hereafter and includes gravity assists) where there is less likelihood for the scientific investigation of 1) the process of chemical evolution and 2) the origin and evolution of life becoming compromised, compared to a probe/lander coming into direct contact with the target body. The target body type is evaluated on the potential for indigenous life and the significance that the scientific investigation of the process of 1) chemical evolution and 2) the origin and evolution of life would be compromised. Planetary protection guidelines and reporting to COSPAR recommendations can then be identified through the categorization process. The main categories are subdivided in some cases in order to allow for more precise guidelines.

Category I concerns all types of missions to a target body which is not of direct interest for understanding the process of chemical evolution and/or the origin and evolution of life.

Category II concerns all types of missions to those target bodies where there is significant interest relative to the process of chemical evolution and/or the origin and evolution of life, but where scientific consensus provides a remote[1] chance of contamination by organic or biological materials which could compromise future investigations of the process of chemical evolution and/or the origin and evolution of life.

Category II for Earth's Moon is subdivided into II, IIa, and IIb [COSPAR 2021]:

- Category II. For orbital and flyby missions.
- Category IIa. Landed missions not accessing a Permanently Shadowed Region (PSR) and/or the lunar poles, which are defined as locations in particular south of 79°S latitude and north of 86°N latitude [National Academies of Sciences, Engineering, and Medicine 2020].
- Category IIb. Landed missions targeting a PSR and/or the lunar poles, which are defined as locations in particular south of 79°S latitude and north of 86°N latitude [National Academies of Sciences, Engineering, and Medicine 2020].



▲ *Figure 1:* **Planetary protection process overview in establishing the planetary protection categorization and resulting guideline and mission documentation definition.**

[1] "Remote" here implies the absence of environments where terrestrial organisms could survive and replicate, or a very low likelihood of transfer to environments where this could occur.

The guidelines are for documentation of the mission's organics and trajectory, as applicable. Preparation of a short planetary protection plan is required for these flight projects primarily to outline intended or potential impact targets, brief Pre- and Post-launch analyses detailing impact strategies, and a Post-encounter and End-of-Mission Report which will provide the location of impact if such an event occurs. Solar System bodies considered to be classified as Category II are listed in Tables 1 and 2.

NOTE: The small bodies of the Solar System not elsewhere discussed in this COSPAR Planetary Protection Policy represent a very large class of objects. Imposing forward contamination controls on these missions is not warranted except on a case-by-case basis, so most such missions should reflect Categories I or II [National Research Council 1998, National Academies of Sciences, Engineering, and Medicine 2021, COSPAR 2021, Coustenis et al. 2023].

Category III concerns certain types of missions (flyby/orbiter) to a target body for which scientific consensus provides a significant[1] chance of contamination by organic or biological materials compromising future investigations of the process of chemical evolution and/or the origin and evolution of life.

Guidelines will consist of documentation (more involved than Category II) and some implementing procedures, including trajectory biasing, the use of cleanrooms during spacecraft assembly and testing, and possibly bioburden reduction. Although no impact is intended for Category III missions, an inventory of bulk constituent organics is required if the probability of impact is significant.

Category IV concerns certain types of missions (mainly probe/lander) to a target body for which scientific consensus indicates a significant chance of contamination by organic or biological materials, which could compromise future investigations of the process of chemical evolution and/or the origin and evolution of life.

Category IV for Mars is subdivided into IVa, IVb, and IVc:

- Category IVa. Lander systems not carrying instruments for the investigations of extant Martian life.
- Category IVb. For probe/lander systems designed to investigate extant Martian life.
- Category IVc. For missions which investigate Mars Special Regions (see definition in Appendix A), even if they do not include life detection experiments.

Guidelines imposed require rather detailed documentation (more extensive than for Category III), including bioassays to enumerate the bioburden, a probability of contamination analysis, an inventory of the bulk constituent organics and an increased number of implementing procedures. The implementing procedures required may include trajectory biasing, cleanrooms, bioburden reduction, partial sterilization of the direct contact hardware and a bioshield for that hardware.

Category V concerns all missions returning samples to the Earth-Moon System (hereafter we only refer to Earth return) and is assigned in addition to the outbound (I-IV) categorization. The concern for these missions is the protection of the terrestrial system, the Earth and the Moon. The Moon should be protected from backward contamination of other celestial bodies to ensure unrestricted Earth-Moon travel. For Solar System bodies deemed by scientific consensus to have no indigenous life forms, a subcategory "Unrestricted Earth return" is defined. For all other Category V missions, a subcategory is defined as "Restricted Earth return".

For missions assigned Category V "Unrestricted Earth return", planetary protection guidelines are on the outbound phase only, corresponding to the category of that phase (typically Category I or II).

For missions assigned Category V "Restricted Earth return" the highest degree of concern is expressed by the absolute prohibition of destructive impact upon return, the need for containment throughout the return phase of all unsterilized returned hardware which directly contacted the target body and of unsterilized material from the body, and the need for containment of any unsterilized sample collected and returned to Earth. Post-mission, there is a need to conduct timely analyses of any unsterilized sample collected

[1] "Significant" here implies the presence of environments where evidence of chemical evolution would be compromised by terrestrial contamination or where evidence of the origin or evolution of life could be corrupted by the introduction of terrestrial organisms to an environment where they could survive and replicate, and some likelihood of transfer to those places by a plausible mechanism.

and returned to Earth, under strict containment, and using the most sensitive techniques. If any detection of the existence of a non-terrestrial replicating entity is found, the returned sample should remain contained unless treated by an effective sterilizing procedure. Category V concerns are further reflected in guidelines that encompass those of Category IV plus a continuing monitoring of project activities, studies and research (i.e., in sterilization procedures and containment techniques).

6.Guidelines

6.1 Biological Contamination Control

The objective for biological control of missions is to provide a means of reducing the probability of contamination that might harm future scientific investigations. Biological control for a mission can either be addressed through a probability of contamination calculation or direct measurement of the biological cleanliness of an outbound mission.

▼ *Table 1:* **Planetary Protection Categories in relation to target bodies. Please note that target body lists and categorizations are updated as needed to reflect new discoveries and the most current scientific understanding.**

Category	Mission Type	Target Body
I	Flyby[1]/Orbiter, Probe/Lander	Undifferentiated, metamorphosed asteroids; Io
II	Flyby, Orbiter, Probe/Lander	Venus[2]; Moon (Cat. II, IIa & IIb); Comets; Carbonaceous Chondrite Asteroids; Jupiter; Saturn; Uranus; Neptune; Icy Worlds[3]; Kuiper-belt objects that are not classified as Icy Worlds
III	Flyby/Orbiter	Mars; Icy Worlds[3]
IV	Probe/Lander	Mars (Cat. IVa, IVb,&.IVc); Icy Worlds[3]
V "Unrestricted Earth return"	-	Venus; Moon; Small Solar System Bodies and Icy Worlds without an answer of "no" or "uncertain" to all 6 questions in section 6.5.2
V "Restricted Earth return"	-	Mars; Small Solar System Bodies and Icy Worlds with an answer of "no" or "uncertain" to all 6 questions in section 6.5.2

[1] "Flybys" include gravity assist manoeuvres.
[2]For the categorization of Venus, see Zorzano-Meier et al. [2023].
[3]By default, missions to Icy Worlds are considered either Cat. III (Orbiter) or Cat. IV (Lander). Assignment of these missions to category II must be supported by an analysis that determines the probability of introducing any component of the spacecraft into >LLT environments that may exist beneath their surfaces within the PBE of 1000 years. See Section 6.1.2.1 for more details.

▼ *Table 2:* **Planetary Protection Categories sorted by Target. Please note that target body lists and categorizations are updated as needed to reflect new discoveries and the most current scientific understanding.**

	LOCATION	TARGET BODY	MISSION TYPE	CATEGORY
INNER SOLAR SYSTEM	**MERCURY**	Mercury	Flyby[1]/Orbiter, Probe/Lander	**I**
			Earth sample return	**V** Unrestricted
	VENUS	Venus[2]	Flyby/Orbiter, Probe/Lander	**II**
			Earth sample return	**V** Unrestricted
	EARTH	Moon	Flyby/Orbiter, Probe/Lander	**II, IIa, IIb**
			Earth sample return	**V** Unrestricted
			Crewed missions	**II, IIa, IIb**
	MARS	Mars	Flyby/Orbiter	**III**
			Probe/Lander	**IVa, IVb, IVc**
			Earth sample return	**V** Restricted
			Crewed missions	See Sections 4.6 and 6.6
	ASTEROID BELT	Undifferentiated, metamorphosed asteroids	Flyby/Orbiter, Probe/Lander	**I**
			Earth sample return	**V** Unrestricted
		Carbonaceous Chondrite Asteroids	Flyby/Orbiter, Probe/Lander	**II**
			Earth sample return	**V** Unrestricted / Restricted
		Icy Worlds – Ceres[3]	Flyby/Orbiter	**II / III**
			Probe/Lander	**II / IV**
			Earth sample return	**V** Unrestricted / Restricted
	OTHERS	To-be-defined (TBD)	All	**TBD**
OUTER SOLAR SYSTEM	**GIANT PLANETS**	Jupiter, Saturn, Uranus, Neptune	Flyby/Orbiter, Probe/Lander	**II**
		Io	Flyby/Orbiter, Probe/Lander	**I**
		Icy Worlds[3] - Moons	Flyby/Orbiter	**II / III**
			Probe/Lander	**II / IV**
			Earth sample return	**V** Unrestricted / Restricted
		Irregular moons	Flyby/Orbiter, Probe/Lander	**II**
			Earth sample return	**V** Unrestricted / Restricted
	TRANS-NEPTUNIAN REGION[4]	Comets	Flyby/Orbiter, Probe/Lander	**II**
			Earth sample return	**V** Unrestricted / Restricted
		Icy Worlds[3] - Transneptunian objects	Flyby/Orbiter	**II / III**
			Probe/Lander	**II / IV**
		Icy Worlds[3] - Dwarf planets & their moons	Flyby/Orbiter	**II / III**
			Probe/Lander	**II / IV**
		Kuiper-belt objects that are not classified as Icy Worlds	Flyby/Orbiter, Probe/Lander	**II**
	OTHERS	To-be-defined (TBD)	All	**TBD**

[1]Flybys include gravity assist manoeuvres.
[2]For the categorization of Venus, see Zorzano-Meier et al. [2023].
[3]By default, missions to Icy Worlds are considered either Cat. III (Orbiter) or Cat. IV (Lander). Assignment of these missions to category II must be supported by an analysis that determines the probability of introducing any component of the spacecraft into >LLT environments that may exist beneath their surfaces within the PBE of 1000 years. See Section 6.1.2.1 for more details.
[4]Trans-Neptunian Region refers to the vast expanse of the Solar System beyond Neptune where, for example, the Kuiper Belt is located.

▼ *Table 3:* **An example of the guidelines that may be considered based on planetary protection categories.**

Guidelines						
Category	**Mission Documentation**	**Cleanroom**	**Trajectory Biasing**	**Inadvertent Impact**	**Organic Inventory**	**Biological Control**
I	Yes	-	Yes	-	-	-
II (II,IIa, & IIb)	Yes	Only outer planets and their satellites; refer to Section 6.3	Yes	-	IIa & IIb; refer to Section 6.2.1	-
III	Yes	Yes	Yes	Yes	Yes	Yes
IV (IV,IVa, IVb, IVc)	Yes	Yes	Yes	Yes	Yes	Yes
V "Restricted Earth return"	Yes	Yes	Yes	-	Yes	Yes
V "Unrestricted Earth return"	Yes	-	Yes	-	-	-

6.1.1 Numerical Implementation for Forward Contamination Calculations

To the degree that numerical guidelines are used to support the overall policy objectives of this document, and except where numerical guidelines are otherwise specified, the guideline to be used is that the probability that a planetary body will be contaminated during the PBE should be no more than 1×10^{-3}. The PBE can be assumed to be no less than 50 years after a Category III or IV mission arrives at its protected target. While there is no specific format for probability of contamination calculations, a performance-based, risk-informed, safety case assured approach such as probabilistic risk assessments or assurances cases may be considered [National Academies of Sciences, Engineering, and Medicine 2021, Olsson-Francis et al. 2023].

6.1.2 Category III and IV Missions

6.1.2.1 Missions to Icy Worlds

Icy Worlds in our Solar System are defined as all bodies with an outermost layer[1] that is predominantly water ice by volume and that have enough mass to assume a nearly round[2] shape [Doran et al. 2026]. A list of currently known Icy Worlds appears in Appendix D.

By default, missions to Icy Worlds are considered either Category III (Flyby/Orbiter) or Category IV (Lander/Probe). Icy Worlds may be classified as a Category II mission but must be substantiated by an analysis that demonstrates that the probability of introducing any component of the spacecraft into >LLT environments within the PBE of 1000 years is <1 x 10^{-4} (Figure 2). This analysis should address both the existence of such environments as well as the prospects of accessing them. This probability calculation should include, at a minimum:

- The probability of the spacecraft reaching the surface of either the target body or any other body of interest in the target system (e.g., another satellite in a Giant Planet system);
- Worst-case assumptions for impact conditions (angle, velocity, etc.) with the target body, and;
- The mechanisms and timescales of transport to an environment where temperatures exceed LLT.

Note: While the effects of transient thermal anomalies caused by landing or inadvertent impact should be considered in this assessment, if they do not cause a connection to presumably deeper environments with in situ environmental temperatures > LLT, they will not be considered a contamination risk.

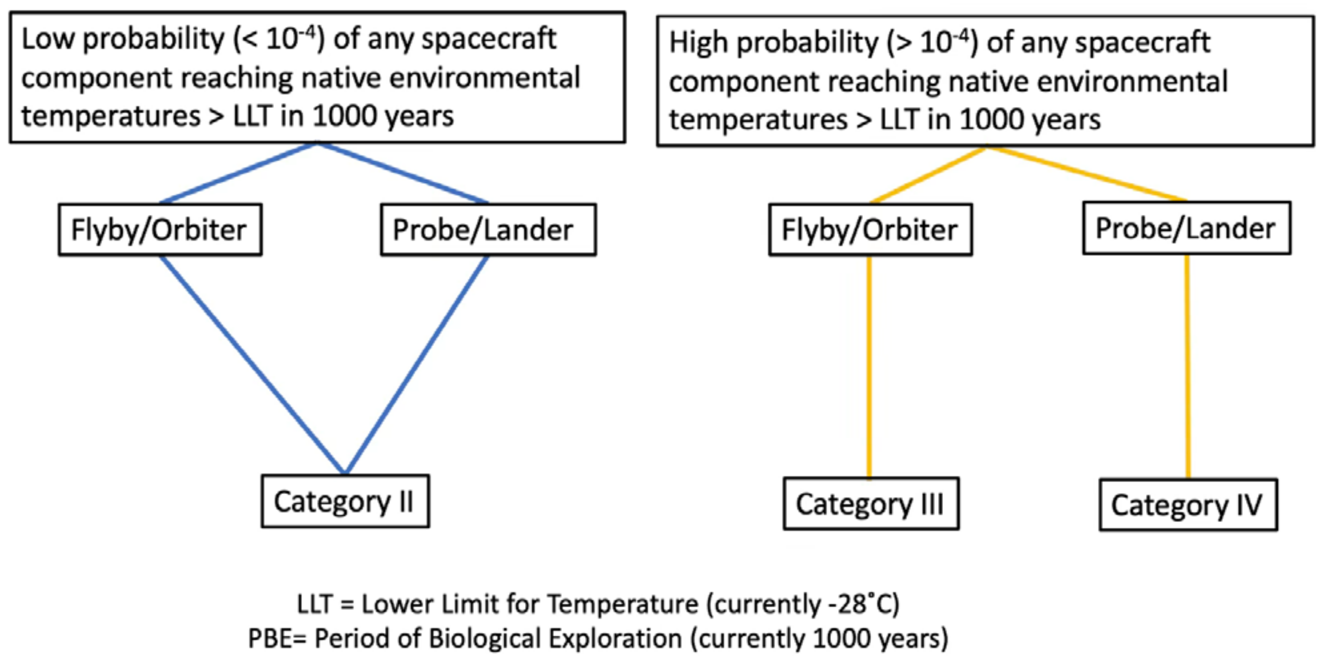
For guidance on best-practices for determining the above parameters, see the NASA (https://ntrs.nasa.gov/api/citations/20240016475/downloads/PlanetaryProtection_Hdbk_2024_Final_For508ing_comp.pdf) or International (https://cosparhq.cnes.fr/assets/uploads/2021/02/PPOSS_International-Planetary-Protection-Handbook_2019_Space-Research-Today.pdf) handbooks. Examples of calculations that have supported the assignment of Category II to Icy World missions include Grasset et al. [2013] for the JUICE mission to Ganymede, and Lorenz et al. [2026] for the Dragonfly mission to Titan. Grasset et al. [2013], in particular, demonstrated that transport to in situ environments in Ganymede's ice shell with temperatures > LLT would take at least 7,000 years for a range of impact conditions.

The potential presence of shallow subsurface water pockets and plumes on Europa [Schmidt et al. 2011, Sparks et al. 2016] and Enceladus [Hansen et al. 2006, Postberg et al. 2011] suggest that it would be very difficult to successfully demonstrate that the probability of introducing any component of the spacecraft into >LLT environments within the PBE of 1000 years is < 10^{-4}. For missions to these bodies, the default assignment of Category III (flyby/orbiter) or Category IV (probe/lander) will likely be maintained and planetary protection measures such as bioburden reduction would then be necessary. Such missions will require the use of cleanroom technology, as well as the monitoring of spacecraft assembly facilities to understand the bioburden and its microbial diversity, including specific relevant organisms. Relevant organisms are Earth organisms potentially present on the spacecraft that could survive the spaceflight environment, the environment at the icy moon and can replicate in Icy Worlds subsurface >LLT environments. Specific methods should be developed and validated to identify, enumerate and eradicate problematic relevant organisms as necessary to achieve the 1 x 10^{-4} requirement.

For the purposes of this Policy, Ceres is included as an Icy World. While current knowledge suggests that there are regions of Ceres' surface and near-subsurface that may not be predominantly composed of water ice [Kurokawa et al. 2020, McCord et al. 2022] and water activity may be below LLAw, the general community consensus is that Ceres is an icy body with an outermost layer that is greater than 50% water ice by volume [Park et al. 2020] and which shows evidence for the presence of regional, possibly extensive liquid at depth, and local expressions of recent and potentially ongoing activity [Castillo-Rogez et al. 2025]. From a Policy perspective, categorizing Ceres as an Icy World represents a conservative approach.

[1] "Outermost layer" here refers to the shell of the body, or what would canonically be considered the crust of a terrestrial planet. We are explicitly excluding thin extrinsically derived veneers, such as the organic regolith on Titan or meter-scale dark dust that covers Iapetus.

[2] Here "nearly round" refers to a shape that is consistent with hydrostatic equilibrium, i.e., a body that has sufficient mass such that self-gravity has overcome rigid body forces.



▲ *Figure 2:* **Flow diagram of first step in determining categorization of an Icy World [from Doran et al. 2026].**

6.1.2.1.1 Category III for Icy Worlds

Category III missions to Icy Worlds must demonstrate that the probability of introducing a viable terrestrial organism into environments with T>LLT (i.e., creating a potential biological inoculation event) within the PBE of 1000 years is $<1 \times 10^{-4}$. This analysis should expand upon the calculations in Section 6.1.2.1 used for categorization that assessed the probability of the spacecraft accessing >LLT environments and include a conservative estimate of poorly known parameters and address factors such as:

- Bioburden at launch;
- Cruise survival for contaminating organisms;
- Organism survival in the space environment adjacent to the target body;
- The probability of contaminating organisms surviving landing/impact, and;
- Organism survival and proliferation before, during, and after subsurface transfer.

6.1.2.1.2 Category IV for Icy Worlds

Category IV missions to Icy Worlds should demonstrate compliance with the following bioburden cleanliness constraints:

- All of the constraints listed for Category III missions to Icy Worlds in Section 6.1.2.1.1 above, and;
- In the case that an environment with temperature > LLT is accessed through horizontal or vertical mobility we note that the entire landed system must meet the 10^{-4} probability of contamination over the PBE. For any subsystems that directly contact the environment with temperature > LLT, the probability calculation must consider potential recontamination during the mission prior to accessing the region.

6.1.2.2 Missions to Mars

6.1.2.2.1 Category III for Mars

Category III flyby/orbiter missions to Mars should demonstrate contamination avoidance of Mars through one of the following approaches [DeVincenzi et al. 1996, European Cooperation for Space Standardization 2019];

- A probability of impact on Mars by any part of a spacecraft of $\leq 1 \times 10^{-2}$ for the first 20 years after launch and $\leq 5 \times 10^{-2}$ for the time period from 20 to 50 years after launch, for nominal and non-nominal flight conditions, OR;
- Bioburden constraints for a Category IVa mission as detailed in Section 6.1.2.2.2.

Note: In addition to Mars-targeted missions, inadvertent impact calculations/considerations as described in this section are also applicable to any mission (Category I, II, III, IV) where the primary target is not Mars, but with risk to unintentionally introduce parts of the flight system into the Mars environment (as a result of Mars gravity assist manoeuvres or flybys in nominal and credible non-nominal flight trajectory scenarios).

6.1.2.2.2 Category IVa for Mars

Category IVa missions to Mars should demonstrate compliance with the following bioburden cleanliness constraints:

- A total bioburden of the spacecraft on Mars, including surface, mated, and encapsulated bioburden, is ≤ 5 x 10^5 bacterial spores;
- The surface bioburden level is ≤ 3 x 10^5 spores, and;
- An average of ≤ 300 spores per square meter.

Note: the values indicated in this section for spore density and total number of spores are a result of the evolution of a probability-based approach over the years to ascertain a probability of 1 x 10^{-4} of suitable growth conditions at Mars [National Research Council 1992, National Academies of Sciences, Engineering, and Medicine 2021].

6.1.2.2.3 Category IVb Life Detection and Sample Return Missions for Mars

All of the guidelines of Category IVa apply, along with the following requirement:

- The entire landed system is restricted to a surface bioburden level of ≤ 30* spores, or to levels of bioburden reduction driven by the nature and sensitivity of the particular life-detection experiments, OR;
- The subsystems which are involved in the acquisition, delivery, and analysis of samples used for life detection should be sterilized to these levels, ≤ 30* spores and a method of preventing recontamination of the sterilized subsystems and the contamination of the material to be analyzed is in place.

6.1.2.2.4 Category IVc Special Region Access for Mars

All of the guidelines of Category IVa apply, along with the following requirement:

- Case1. If the landing site is within the special region, the entire landed system is restricted to a surface bioburden level of ≤ 30* spores.
- Case 2. If the special region is accessed through horizontal or vertical mobility, either the entire landed system is restricted to a surface bioburden level of ≤ 30* spores, OR the subsystems which directly contact the special region should be sterilized to these levels, and a method of preventing their recontamination prior to accessing the special region should be provided.

NOTE: *This value considers the occurrence of hardy organisms with respect to the microbial reduction modality. This specification assumes attainment of Category IVa surface cleanliness, followed by at least a four order-of-magnitude reduction in viable organisms. Verification of bioburden level is based on pre- microbial reduction bioburden assessment and knowledge of reduction factor of the modality.

6.2 Organic Inventory

The objective for an organic inventory from hardware is to capture knowledge of the hardware materials for use by future scientific investigators as a reference to avoid any misinterpretation of terrestrial organics as indigenous biosignatures. While these guidelines do not preclude organic constituents for planetary protection, they do identify mission documentation parameters where organics may be perceived as a potential risk of harmful contamination.

An organic inventory should be provided for Category II, III & IV missions. For missions to the Moon, some exceptions apply (see Section 6.2.1).

6.2.1 Category II, IIa and IIb Missions to the Moon

Category II. Orbiter and flyby missions to the Moon should provide only the planetary protection documentation described in Appendix C. There is no need to provide an organic inventory.

Category IIa. All missions to the surface of the Moon whose nominal mission profile does not access areas defined in Category IIb should provide the planetary protection documentation and an inventory of volatile organic material, propellant residuals and combustion products that remain or have been released into the lunar environment by the propulsion, attitude control and other spacecraft systems.

Category IIb. All missions to the surface of the Moon whose nominal profile accesses Permanently Shadowed Regions (PSRs) and/or the lunar poles, in particular latitudes south of 79°S and north of 86°N should provide the planetary protection documentation and a complete organic inventory (greater than 1 kg), which should consider contributions from all spacecraft hardware elements including subsidiary payloads that may be present in nominal and credible off-nominal scenarios. This is in line with Section 7 [National Academies of Science, Engineering and Medicine 2020, COSPAR 2021].

Note: Category IIb applies to all PSRs, irrespective of latitude, and non-PSR regions in particular within the latitudes south of 79°S and north of 86°N [National Academies of Sciences, Engineering, and Medicine 2020]

6.2.2 Category III and IV Missions

A spacecraft organic inventory includes a listing of all organic materials carried by a spacecraft that are present in a total mass greater than 1 kg.

6.3 Cleanroom

The objective of utilizing a cleanroom during hardware assembly, integration and testing is to manage contamination and recontamination thereby minimizing the potential risk of harmful contamination.

To manage contamination of hardware COSPAR recommends the use of cleanroom technology (ISO 8 or better)
for all category III and IV missions, see table C1 [International Organization for Standardization 2004].

6.4 Trajectory Biasing

The objective of trajectory biasing through mission design considerations is to prevent unwanted contamination from launch vehicle components. Launch vehicle end-of-mission disposal should be considered by each mission so as not to be an additional source of harmful contamination.

The probability of impact on Mars by any part of the launch vehicle should be $\leq 1 \times 10^{-4}$ for a time period of 50 years after launch. For Icy World impact considerations see note in Section 6.1.2.1.

6.5 Category V: Restricted Earth Return

The objective of the restricted Earth return guidelines for missions is to ensure missions have a means of handling high-risk extraterrestrial samples, and decreasing adverse impacts to the Earth's biosphere.

6.5.1 Return Missions

- Unless specifically exempted, the outbound leg of the mission should meet outbound category-specific organic and biological contamination control (or Category IVb for Mars surface missions) guidelines. This provision is intended to avoid "false positive" indications in a life-detection and hazard-determination protocol, or in the search for life in the sample after it is returned.
- The mission should provide a method to "break the chain of contact" with the target body. "Break-the-chain of contact" should apply to any hardware or sample that is exposed to an unsterilized extraterrestrial particle originating from the target body.
- For unsterilized samples returned to Earth, a program of life detection and biohazard testing, or a proven sterilization process, should be undertaken as an absolute precondition for the controlled distribution of any portion of the sample.

Note: determination of universal biohazard testing, proven sterilization processes or general risk management measures might not be credible without evaluating evidence of extinct or extant life on the samples. More realistic and tailored protocols can be developed once specific studies are performed on a detected extraterrestrial life form [Kminek et al. 2022].

If during the course of a Category V mission there is a change in the circumstances that led to its classification, or a mission failure, e.g.:

- New data or scientific consensus that would lead to the reclassification of a mission classified as "Unrestricted Earth return" to "Restricted Earth return," and safe return of the sample cannot be assured, OR;
- The sample containment system of a mission classified as "Restricted Earth return" is thought to be compromised, and sample sterilization is impossible,

then in either case the sample to be returned should be abandoned, and if already collected the spacecraft carrying the sample should not be allowed to return to the Earth or the Moon.

6.5.2 Sample Return from Small Solar System Bodies and Icy Worlds

Missions to small Solar System bodies and Icy Worlds should determine if a mission is classified "Restricted Earth return" or not. Such a mission assessment should be undertaken with respect to the best multidisciplinary scientific advice, using the framework presented in the 1998 report of the US National Research Council's Space Studies Board entitled, Evaluating the Biological Potential in Samples Returned from Planetary Satellites and Small Solar System Bodies: Framework for Decision Making [National Research Council 1998]. Specifically, such a determination should address the following six questions for each body intended to be sampled:

1. Does the preponderance of scientific evidence indicate that there was never liquid water in or on the target body?
2. Does the preponderance of scientific evidence indicate that metabolically useful energy sources were never present?
3. Does the preponderance of scientific evidence indicate that there was never sufficient organic matter (or CO2 or carbonates and an appropriate source of reducing equivalents) in or on the target body to support life?
4. Does the preponderance of scientific evidence indicate that subsequent to the disappearance of liquid water, the target body has been subjected to extreme temperatures (i.e., >160°C)?
5. Does the preponderance of scientific evidence indicate that there is or was sufficient radiation for biological sterilization of terrestrial life forms?
6. Does the preponderance of scientific evidence indicate that there has been a natural influx to Earth, e.g., via meteorites, of material equivalent to a sample returned from the target body?

For containment procedures to be necessary ("Restricted Earth return"), an answer of "no" or "uncertain" needs to be returned to all six questions.

6.6 Crewed Mars Missions

Implementation guidelines for human missions to Mars include [Hogan et al. 2006, Kminek et al. 2005, Race et al. 2008]:

- Human missions will carry microbial populations that will vary in both kind and quantity, and it will not be practicable to specify all aspects of an allowable microbial population or potential contaminants at launch;
- Once any baseline conditions for launch are established and met, continued monitoring and evaluation of microbes carried by human missions will be required to address both forward and backward contamination concerns;
- A quarantine capability and protocols for the crew should be provided during and after the mission, in case potential contact with a Martian life-form occurs;
- A comprehensive planetary protection protocol for human missions should be developed that encompasses both forward and backward contamination concerns and addresses the combined human and robotic aspects of the mission, including subsurface exploration, sample handling, and the return of the samples and crew to Earth;
- Any uncharacterized Martian site should be evaluated by robotic precursors prior to crew access. Information may be obtained by either precursor robotic missions or a robotic component on a human mission;

- Any pristine samples or sampling components from any uncharacterized sites or Special Regions on Mars should be treated according to current planetary protection Category V, Restricted Earth return, with the proper handling and testing protocols;
- An onboard crewmember should be given primary responsibility for the implementation of planetary protection provisions affecting the crew during the mission;
- Planetary protection guidelines for initial human missions should be based on a conservative approach consistent with a lack of knowledge of Martian environments and the possibility for extinct or extant life, as well as the performance of human support systems in those environments, and;
- Planetary protection guidelines for later missions should not be relaxed without scientific review, justification, and consensus.

7. Reporting on Mission Activities

COSPAR recommends that entities conducting activities in outer space provide to authorizing entities a reasoned argument that planetary protection objectives will be or have been satisfied.

COSPAR further recommends that entities conducting activities in outer space publish and share with the COSPAR PPP their approaches, certain mission parameters, and lessons learned for the benefit of future missions.

COSPAR recommends that such entities share with COSPAR their mission planetary protection plan for review and feedback prior to launch. It is further recommended that such entities provide information to COSPAR within a reasonable time not to exceed six months after launch about the procedures and computations used for planetary protection for each flight and again within one year after the end of a solar-system exploration mission about the areas of the target(s) which may have been subject to contamination.

Reports should include, but not be limited to, information regarding applicable guidelines for bioburden, organic inventory, and probability of impact. Appendix B provides the recommended reporting elements. Reports are made available in an open-source repository for the reference of the COSPAR PPP, mission implementers, and members of the science community.

Appendix C (with Tables C1 and C2) refers to mission documentation expected elements. These documents are intended to be captured as part of the internal mission documentation and not necessarily expected to be reported to COSPAR.

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Appendix A –Terms and Definitions

Bioassay. A collection and analysis of biological contamination with a specific procedure.

Bioburden. Number of viable organisms on or in spacecraft materials measured with a defined bioassay.

Biological Inoculation Event. Introduction of a viable organism to an environment within a Solar System body that is potentially capable of providing nutrients and environmental growth conditions such that the organism can replicate. For the purposes of this document, such an environment is defined as one with temperatures > LLT and water activity > LLAw.

Break the Chain of Contact. Prevent the transfer to the Earth-Moon System of all materials from another habitable world that are not either sterilized or contained.

Earth-Moon System. The Earth and the Moon (including artificial objects in orbit around either body) is considered as a single environment for planetary protection purposes in considering return from restricted return bodies (Mars, Europa, Enceladus, others to be determined) to protect the unrestricted travel within the system.

Encapsulated bioburden. Bioburden inside the bulk non-metallic materials not manufactured with additive layer manufacturing. Examples are bioburden inside paints, conformal coatings, thermal coatings, adhesives, composite materials, closed-cell foam, bulk liquids and bulk gasses.

Extant life. Form of life, or signatures thereof, whether metabolically active or dormant.

Extinct life. Form of life, or signatures thereof, that is unambiguously no longer metabolically active or dormant.

Exposed surfaces. Internal and external surfaces free for gas exchange.

False positive. In a life-detection and/or hazard-determination protocol, it is any unwanted organic contamination introduced to the sampling process. As a consequence of cross contamination in the sample under analysis, validity of the sample and associated scientific results will be affected. This may also be the case for future missions.

False negative. In a life-detection and/or hazard-determination protocol, it is any mis-characterization of sample content failing to identify evidence of biological entities and processes.

Mated surfaces. Surfaces joined by fasteners rather than by adhesives.

Non-nominal. These scenarios cover cases where some condition could occur that results in the system performing in a way that is different from normal. This includes failures, low performance, unexpected environmental conditions, or operator errors that would affect compliance with the probabilistic guidelines.

Organic Material. All carbon-containing compounds excluding carbides, carbonates, cyanides and simple oxides of carbon (i.e., CO and CO_2).

Organic Inventory. A complete organic inventory should consider contributions from all spacecraft hardware elements (greater than 1 kg), including subsidiary payloads that may be present in nominal and credible off-nominal scenarios inventory should include organic products that may be released into the environment of the protected Solar System body by propulsion and life support systems (if present) and this includes a quantitative and qualitative description of major chemical constituents and the integrated quantity of minor chemical constituents present. For Category IIa the organic inventory should only consider the volatile organic material, propellant residuals and combustion products that remain or have been released into the lunar environment by the propulsion, attitude control and other spacecraft systems.

Period of Biological Exploration (PBE). The anticipated period of time (decades to centuries) during which a Solar System body is explored for signs of the origin and evolution of life and the history of prebiotic chemistry based on current scientific understanding. For Mars the PBE is 50 years and for Icy Worlds it is 1000 years. The wide range in PBE between these bodies is caused by projected frequency of missions to them.

Planetary Protection Category. Category assigned to reflect the interest and concern that terrestrial contamination can compromise future investigations, and depends on the target body and mission type.
NOTE: Different requirements are associated with the various categories.

Probability of contamination (Pc). Probability of introducing into the environment of a Solar System body unwanted material present on or in the spacecraft.

Sample. Any intentionally collected or unintentionally adhering physical material (including solids, liquids, and gases) that is present on a spacecraft returning to the Earth-Moon system from another Solar System body.

Special Region. A Special Region is defined as a region within which terrestrial organisms are likely to replicate. Any region which is interpreted to have a high potential for the existence of extant Martian life forms is also defined as a Special Region. Spacecraft-induced Special Regions are to be evaluated, consistent with these limits and features, on a case-by-case basis. Identified Mars limits, features, observational evidence and additional case-by-case evaluation considerations are further captured in Beaty et al. [2006], Kminek et. al. [2010], and Rummel et. al. [2014]. In the absence of specific information, no Special Regions are currently identified on the basis of possible Martian life forms. If and when information becomes available on this subject, Special Regions will be further defined on that basis [Kminek et. al. 2010].

Water activity. Ratio of the vapour pressure of water in a material to the vapour pressure of pure water at the same temperature. Often referred to as the biologically available water.

Appendix B – Reporting to COSPAR: Recommended Elements

The following points provide the kind of information that is recommended to be described within a reporting to COSPAR [COSPAR 1969, COSPAR 1984, COSPAR 1994, Rummel et al. 2009], as explained in Section 7.

- The estimated bioburden at launch, the methods used to obtain the estimate (e.g., assay techniques applied to spacecraft or a proxy), and the statistical uncertainty in the estimate (Category III, IV and V missions, as appropriate):
- The biodiversity, the probable composition (identification) of the biological contaminants, for Category IV missions, and for Category V "Restricted Earth return" missions.
- Methods used to control the bioburden, decontaminate and/or sterilize the space flight hardware.
- The organic inventory, as specified in Section 6.2.
- Intended minimum distance from the surface of the target body for launched components, for those vehicles not intended to land on the body.
- Approximate orbital parameters, expected or realized, for any vehicle which is intended to be placed in orbit around a Solar System body.
- For the end-of-mission, the disposition of the spacecraft and all of its major components, either in space or for landed components by position (or estimated position) on a planetary surface.

Appendix C – Mission Documentation Expected Elements

It is recommended that each mission provides documentation to ensure that Planetary Protection requirements are identified and to capture the mission's planning and execution throughout the project life cycle. Examples of the documentation and expected elements are listed in Table C1 and C2. Details within the missions internal documentation are not nessessarily expected to be reported to COSPAR, but may be used to satisfy reporting recommendations or capture reporting details to COSPAR as outlined in Appendix B.

▼ *Table C1:* **An example of a mission's documentation and deliverables that may be considered based on a mission's categorization.**

	Category I	Category II	Category III	Category IV	Category V
Type of Mission	Any but Earth Return	Any but Earth Return	No direct contact (flyby, some orbiters)	Direct contact (probe/ lander, some orbiters)	Earth Return
Target Body	See Category-specific listing	See Category-specific listing	See Category-specific listing	See Category-specific listing	See Category-specific listing
Degree of concern	None	Record of planned impact probability and contamination control measures End of mission scenario	Limit on impact probability End of mission scenario Passive bioburden control	Limit on probability of non-nominal impact Limit on bioburden (active control)	If restricted Earth return: No impact on Earth or Moon; Returned hardware sterile; Containment of any sample
Representative Range of Mission Documentation and Deliverables	None	Documentation only (all brief): PP plan; Pre-launch report; Post-launch report Post-encounter report End-of-mission report Implementing procedures such as: Cleanroom (only outer planets and their satellites; refer to Section 6.3) Organic inventory (as necessary); for the Moon refer to Section 6.2.1	Documentation (Category II plus): Contamination control Organic inventory (as necessary) Implementing procedures such as: Trajectory biasing Cleanroom Bioburden reduction (as necessary)	Documentation (Category II plus): Pc analysis plan Microbial reduction plan Microbial assay plan Organic inventory Implementing procedures such as: Trajectory biasing Cleanroom Bioburden reduction Microbial reduction of contacting hardware (as necessary) Bioshield Monitoring of bioburden via bioassay	Outbound Same category as target body/ outbound mission Inbound If restricted Earth return: Documentation (Category II plus): Pc analysis plan Microbial reduction plan Microbial assay plan Implementing procedures such as: ▪ Trajectory biasing ▪ Sterile or contained returned hardware ▪ Continual monitoring of project activities ▪ Project advanced studies and research If unrestricted Earth return: None

▼ *Table C2:* **An example of the objective and expected elements for a mission's documentation throughout a mission life cycle.**

Document type	Objective	Examples of Expected Elements
Planetary protection plan	To provide information on planned measures to implement planetary protection programs. It describes the "how".	General mission description, implementation approach, i.e. how planetary protection requirements are intended to be met.
Pre-launch planetary protection report	To provide evidence that mission meets planetary protection requirements prior to launch.	Results of analysis, probability of impacts / contamination, bioburden & contamination measures, as applicable for a given mission category.
Post-launch planetary protection report	To provide information of post launch activities and any potential impact of these on pre-launch planetary protection measures.	Description of launch activities and post launch events within the deployment and in orbit commissioning timeframe.
Post encounter report	To provide evidence of continued compliance with planetary protection requirements.	Updates (if any) on probabilities of impact and contamination (as applicable), deviations (if any) from planetary protection requirements and plan.
End-of-mission report	To provide evidence of compliance with planetary protection requirements throughout the complete mission.	Disposition of all launched flight hardware either orbiting in space or landed/ impacted on target body; any update on probability/analysis as applicable.
Organic inventory	To document the organic material on the spacecraft.	Identity; Chemical composition; Usage, with respect to product tree; Mass estimate; Outgassing properties (i.e RML - recovery mass loss, TML - total mass loss, CVCM - collected volatile condensable material); Supplier for each item.

Appendix D – List of Known Icy Worlds

▼ *Table D1:* **List of known or suspected Icy Worlds**

Body	Object Class
2002 MS_4	Dwarf Planet[1], Cubewano[2] (TNO[3])
Ariel	Moon of Uranus
Callisto	Moon of Jupiter
Ceres	Dwarf Planet
Charon	Moon of Pluto
Dione	Moon of Saturn
Enceladus	Moon of Saturn
Eris	Dwarf Planet, Scattered Disk Object (TNO)
Europa	Moon of Jupiter
Ganymede	Moon of Jupiter
Gonggong	Dwarf Planet, Scattered Disk Object (TNO)
Haumea	Dwarf Planet, Haumeid (TNO)
Iapetus	Moon of Saturn

Body	Object Class
Makemake	Dwarf Planet, Cubewano (TNO)
Mimas	Moon of Saturn
Miranda	Moon of Uranus
Oberon	Moon of Uranus
Orcus	Dwarf Planet, Plutino (TNO)
Pluto	Dwarf Planet, Plutino (TNO)
Quaoar	Dwarf Planet, Cubewano (TNO)
Rhea	Moon of Saturn
Salacia	Dwarf Planet, Cubewano (TNO)
Sedna	Dwarf Planet, Sednoid (TNO)
Tethys	Moon of Saturn
Titan	Moon of Saturn
Titania	Moon of Uranus
Triton	Moon of Neptune

[1]Dwarf Planets are based on the list of 10 bodies designated as being Dwarf Planet with "near certainty" at https://web.gps.caltech.edu/~mbrown/dps.html as of January 24, 2024.
[2]Classical Kuiper Belt Object.
[3]Trans-Neptunian Object.