



Planetary Protection Category & Requirements for Missions to the Moon

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Current Categorization for the Moon



Post 2008 robotic missions to the Earth's Moon are assigned Planetary Protection **Category II, with organic inventory**

- **Category II** because of the interest in chemical evolution
- **Category II, with organic inventory** because of the potential to contaminate volatiles that are used to study chemical evolution

Requirements for lunar missions:

- No technical planetary protection requirements or constraints on mission operation, end-of-life dispositions
- Requirements for documentation (plans, reports)
- Requirements for an organic inventory, i.e. list of materials on the spacecraft, including volatiles released by a propulsion or life support system

Description of Organic Inventory



A spacecraft organic inventory includes a listing of all **organic materials** carried by a spacecraft which are present in a total mass **greater than 1 kg**. A complete 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 include a quantitative and qualitative description of major chemical constituents and the integrated quantity of minor chemical constituents present.

Delivery Mechanisms to the PSR[†]



1. Large impacts may generate their own collisional atmospheres and this transient atmosphere can subsequently condense out on the PSR (Ong *et al.*, 2010; Prem *et al.*, 2015)
2. Ballistic migration of molecules across the surface (Butler, 1997; Crider and Vondrak, 2002; Schörghofer, 2014)

[†]Permanently Shadowed Regions

Review of Category & Requirements



Renewed interest in robotic and human missions to the Moon warranted a **review** of the current categorization and requirements

- ❖ Based on discussions within the Panel, COSPAR initiated a stakeholder consultation
- ❖ Result of the COSPAR stakeholder consultation, as well as inputs received by NASA Lunar Exploration Analysis Group (LEAG) and the US NAS SSB Committee on Planetary Protection (CoPP) will be considered in discussing an update of the COSPAR Planetary Protection Category & Requirements for the Moon

Lunar Questionnaire Status



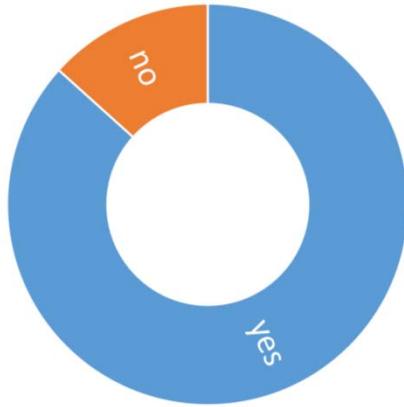
COSPAR consultation of SCs B and F received 90 responses

Questions	Yes	No	Abstain
1. Are the volatiles in the Permanently Shadowed Regions (PSR) on the Moon of significant interest in the study of chemical evolution?	78	12	0
2. Are you concerned that contamination carried by a spacecraft to the Moon could compromise future investigations to study chemical evolution?	73	16	1
3. Are you concerned about the long-term degradation of organic materials?	50	38	2
4. Are you concerned about organic volatiles released by certain types of propellants?	62	28	0
5. Would an organic material list describing the kinds and amounts of organic materials on a spacecraft mitigate your concerns?	63	24	3
6. Would establishment of lunar PSR protected areas with controlled access and avoidance of unnecessary contamination (e.g., obsolete parts of spacecraft like used propulsion stages) mitigate your concerns?	71	17	2
7. Are you concerned about the either controlled or uncontrolled introduction and release of biological materials (living and dead) into the lunar system?	57	32	1

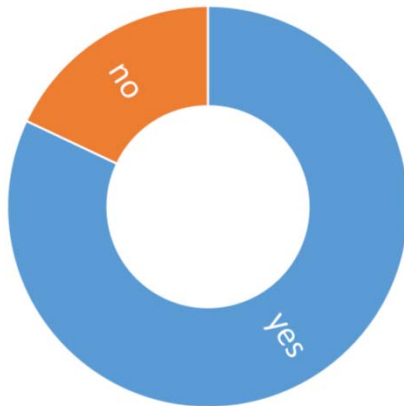
Lunar Questionnaire Status



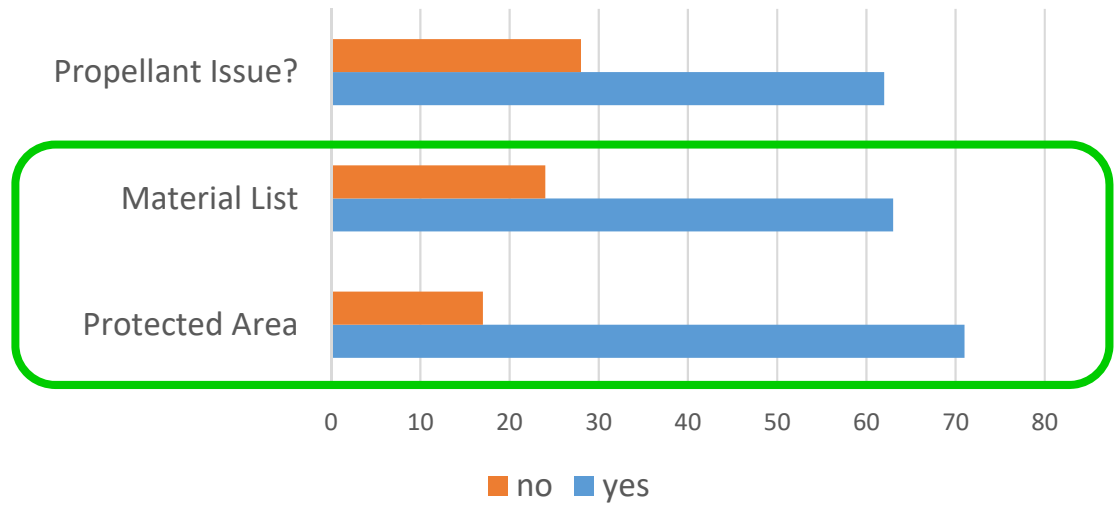
Interested in lunar polar volatiles?



Concerned about contamination?



Mitigation of Issue



Conclusions



- There is still interest in the lunar polar volatiles
- There is concern about contaminating the lunar polar volatiles
 - ❖ Concern about spacecraft propulsion system seems to be dominant

- The result of the COSPAR stakeholder consultation is in line with the current COSPAR Planetary Protection Category & Requirements
 - ❖ There might be a rationale to reduce the documentation of the organic inventory to volatile products of the propulsion & life support system
- COSPAR will take all available inputs into consideration in the review and potential update the regulations for missions to the Moon planned for Q1 2021