Planetary Protection for Discovery Phase A Studies

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NASA Planetary Protection Policy: 
 Protect Science, Protect the Earth

NASA Policy Directive 8020.7G:

• “The conduct of scientific investigations of possible extraterrestrial life forms, precursors, and remnants must not be jeopardized.”
  – avoid forward contamination: don’t “discover” life we brought with us

• “In addition, the Earth must be protected from the potential hazard posed by extraterrestrial matter carried by a spacecraft returning from another planet or other extraterrestrial sources.”
  – avoid backward contamination: don’t contaminate the Earth

• “Therefore, for certain space-mission/target-planet combinations, controls on organic and biological contamination carried by spacecraft shall be imposed in accordance with directives implementing this policy.”
  – tailor requirements by target location and mission type: don’t require unnecessary measures
International Obligations

• The Outer Space Treaty of 1967
  – Proposed to the UN in 1966; Signed in January 1967
  – Ratified by the US Senate on April 25th, 1967
  – Article IX of the Treaty states that:
    “...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...”

• The Committee on Space Research of the International Council for Science
  maintains an international consensus policy on planetary protection
  – COSPAR policy represents an international scientific consensus, based on advice
    from national scientific members, including the US Space Studies Board
  – COSPAR is consultative with the UN (through UN COPUOS and the Office of Outer
    Space Affairs) on measures to avoid contamination and protect the Earth under the
    Treaty
  – NASA and ESA policies specify that international robotic missions with agency
    participation must follow COSPAR policy, providing a consensus basis for
    requirements
  – COSPAR policy requires an inventory of microbial diversity carried on spacecraft
NASA Requirements: Planetary Protection Mission Constraints

- Depend on the nature of the mission and on the target planet

- Assignment of categories for each specific mission/body is to “take into account current scientific knowledge” via recommendations from advisory groups (SSB, PPS).

- Examples of specific measures include:
  - Documentation of spacecraft trajectories and spacecraft material archiving
  - Spacecraft organic inventory and restrictions
  - Constraints on spacecraft operating procedures
  - Reduction of spacecraft biological contamination
  - Restrictions on the handling of returned samples

W. Peet, 1967
### Planetary Protection Mission Categories

<table>
<thead>
<tr>
<th>PLANET PRIORITIES</th>
<th>MISSION TYPE</th>
<th>MISSION CATEGORY</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Any</td>
<td>I</td>
</tr>
<tr>
<td><strong>Not of direct interest for understanding the process of chemical evolution. No protection of such planets is warranted.</strong></td>
<td></td>
<td></td>
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<tr>
<td>B</td>
<td>Any</td>
<td>II</td>
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<tr>
<td><strong>Of significant interest relative to the process of chemical evolution, but only a remote chance that contamination by spacecraft could compromise future investigations. Documentation is required.</strong></td>
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<tr>
<td>C</td>
<td>Flyby, Orbiter</td>
<td>III</td>
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<tr>
<td><strong>Of significant interest relative to the process of chemical evolution and/or the origin of life and for which scientific opinion provides a significant chance of contamination which could compromise future investigations. Substantial documentation and mitigation is required.</strong></td>
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</tr>
<tr>
<td>All</td>
<td>Any Solar System Body</td>
<td>V</td>
</tr>
<tr>
<td><strong>Earth-Return “restricted” or “unrestricted”</strong></td>
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Planetary Protection Documentation Schedule

Mission Categorization
- Communicate with PPO in pre-Phase A
- Formal request to PPO during Phase A (discuss implementation by SRR)
- Categorization letter received by KDP B

Planetary Protection Plan (II-V)
- Drafted during Phase B (consult with PPO)
- Released by PDR (included in review)
- Approved by KDP C

Pre-launch Planetary Protection Report
- due 90 days prior to Launch; (Launch Certification at FRR for Cat. III-Vr)

Post-launch Planetary Protection Report
- due 60 days post Launch

Extended Mission Planetary Protection Plan
- Approved prior to end of original Phase E (KDP F)

End-of-Mission Report
- due 60 days after End of Mission
Categorizations are Determined

• On a mission-by-mission basis

• Based on recommendations from the Planetary Protection Subcommittee of the NASA Advisory Council

• Considering advice from the Space Studies Board of the National Research Council
Category II Requirements for Non-Habitable Objects

Documentation:

• Planetary Protection Plan (what the project will do)
• Pre-Launch Planetary Protection Report (what was done so far)
• Post-Launch Planetary Protection Report (is the spacecraft working?)
• (Extended Mission Plan, if relevant)
• End-of-Mission Report (where did it go, where is it now)
• Microbial Inventory is a possible future requirement on Venus missions

Standard spacecraft assembly procedures (cleanrooms, etc.)
Additional Considerations

- All missions crossing Mars orbit must document a $1 \times 10^{-4}$ probability that launch vehicle hardware could impact Mars for a period of 50 years after launch.
- End-of-mission scenarios that account for the disposition of a radioisotope power source may choose to demonstrate orbital lifetime beyond the effective lifetime of the heat source, a burn-up/break-up analysis demonstrating that the heat source would not create a biological contamination concern, or directed disposal of the spacecraft into an object that is not of concern for biological contamination.

*Missions must address the potential for creating an habitable environment, or facilitating transport to such locations, if a heat source is present.*
Science class should not end in tragedy....
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