

# ***Review and Assessment of Planetary Protection Policy Development Processes***

**Committee to Review Planetary Protection Policy  
Development Processes**

**Space Studies Board**

**National Academies of Sciences, Engineering,  
and Medicine**

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## **Statement of task (abbreviated)**

- 1. Consider the historical context and the current policy development process. [review history and status]**
- 2. Consider and make recommendations regarding key factors in the current policy development process. [assess current process]**
- 3. Make recommendations about the future policy development process. [advise]**

# ***Review and Assessment of Planetary Protection Policy Development Processes***

## **Committee roster**

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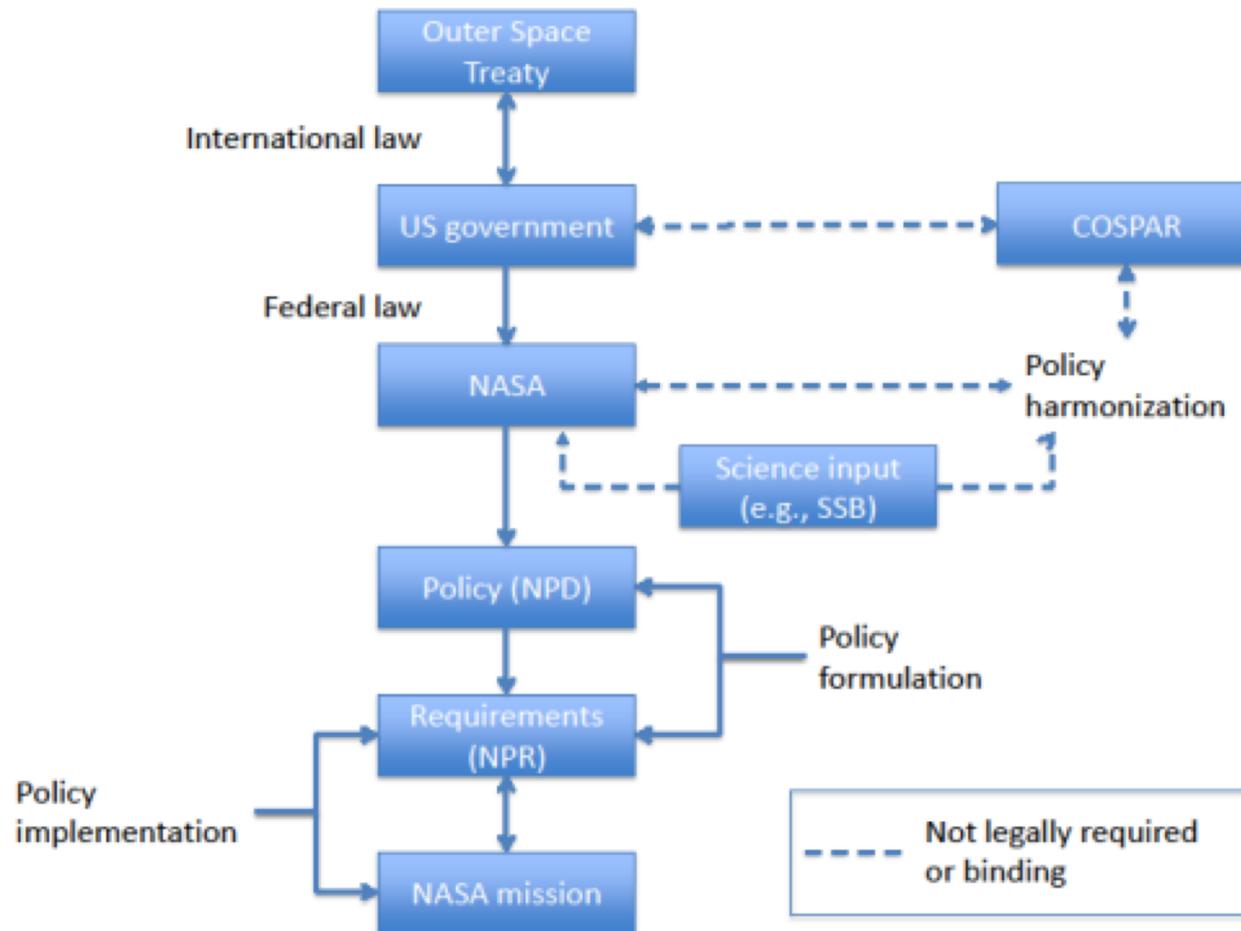
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## **Study motivation and emphasis**

- **Changes in the planetary protection landscape:**
  - **Missions to two objects that may be favorable for life are now being developed:**
    - **the first phase of a Mars sample return program and**
    - **a Europa orbiter.**
  - **Nearly all past missions have been government-sponsored, robotic, scientific fly-bys, orbiters, or landers.**
  - **Private-sector entities are now seriously considering solar system missions.**
  - **Human missions to Mars are now being seriously considered.**
  - **International participation is growing.**
- **Primary areas of concern:**
  - **Planetary protection applies to all solar system bodies, however**
  - **Only those objects that may be likely to support life require substantial planetary protection actions.**
  - **For the relatively near term, those bodies are Mars, Jupiter's moon Europa, and Saturn's moon Enceladus.**

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## Overview of U.S. and international policy relationships



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## Key provisions of the Outer Space Treaty

- **Article I**: Outer space, including the Moon and other celestial bodies, shall be free for exploration and use by all States without discrimination of any kind, on a basis of equality and in accordance with international law, and there shall be free access to all areas of celestial bodies.
- **Article II**: Outer space, including the moon and other celestial bodies, is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means.
- **Article VI**: States Parties to the Treaty shall bear international responsibility for national activities in outer space ... whether such activities are carried on by governmental agencies or by non-governmental entities ... The activities of non-governmental entities in outer space ... shall require authorization and continuing supervision by the appropriate State Party to the Treaty.
- **Article IX**: 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.

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## **Major conclusions: Key elements of past success**

**Certain fundamentals of planetary protection policy remain relevant and vital, including:**

- **The Outer Space Treaty as the policy and legal foundation for both government-sponsored and non-government planetary missions;**
- **COSPAR's role in fostering international cooperation on planetary protection guidelines;**
- **Science-based decision making;**
- **Involvement of a wide-range of scientific communities; and**
- **U.S. leadership in planetary protection policy making.**

**POST-VM3 CLARIFICATION from S. Hubbard: "Of all of the countries of the world, there are only two that have not signed the OST and have demonstrated at least some ability to launch payloads that might reach space. Those countries are Iran and North Korea".**

**With respect to the development and implementation of planetary protection policy, the committee emphasizes that the fundamental goal of such policy is to enable, not inhibit, exploration and the search for life.**

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### **Major conclusions: Overview of NASA processes**

**Finding: NASA needs to address aspects of the following issues:**

- **Managing planetary protection policy implementation,**
- **Securing relevant outside expert advice,**
- **Developing a long-range forecast of future solar system exploration missions having planetary protection implications,**
- **Setting planetary protection research and technology investment priorities, and**
- **Identifying the agency's strategy for dealing with major policy issues such as sample-return and human missions to Mars and private sector solar system exploration missions.**

**Recommendation: NASA should develop a planetary protection strategic plan that clearly responds to each of these issues.**

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### **Recommendations for NASA: Managing Policy Implementation**

- **Assess completeness of PP policies; formally define requirements that are missing; follow NASA standard project management and systems engineering protocols for review, approval, and flow-down of requirements; follow NASA's conflict resolution process; and evaluate policies for new mission situations well in advance of a mission start.**
- **Ensure that there is a process to engage the full breadth of NASA stakeholders in assessing changes to COSPAR PP policies and requirements and that the process is as disciplined as what NASA uses to review, concur, and approve changes to its own policies.**
- **Complete the transition of the OPP to OSMA and clarify the remaining issues concerning roles, responsibilities, resources, and locations of OPP functions.**
- **Evaluate the ESA PP implementation process and consider incorporating elements that are effective and appropriate.**

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### **Recommendations for NASA: Securing Relevant Outside Expert Advice**

- **Reestablish an independent and appropriate advisory body and process to help guide formulation and implementation of planetary protection policy adequate to serve the best interests of the public, the NASA program, and the variety of new entrants that may become active in deep space operations in the years ahead.**
- **Engage the full range of relevant scientific disciplines in the formulation of NASA's planetary protection policies. This requires that scientific leaders outside of the standard planetary protection community in NASA participate in revisions to NASA and COSPAR planetary protection policies and requirements.**

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### **Recommendations for NASA: Planning for Future Missions**

- **Adequately fund both the Office of Planetary Protection and the research necessary to determine appropriate requirements for planetary bodies and to enable state-of-the-art planetary protection techniques for monitoring and verifying compliance with these requirements. The appropriate investment in this area should be based on a strategic assessment of the scientific advances and technology needs to implement planetary protection for likely future missions.**

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### **Major conclusions: Mars Sample Return Missions**

**Finding: Planetary protection requirements for the sample containment, verification of containment, return vehicle, and sample receiving facility are not yet in place.**

**Recommendation: NASA's process for developing planetary protection policy for sample return missions should include early consultation with mission developers and managers, mission and receiving facility science teams, and microbiologists and include providing a means to use the best available biological and technological knowledge about back contamination and containment.**

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### **Major conclusions: Human Mars missions**

**Finding: NASA does not currently have an adequate planetary protection policy for human exploration and activities on Mars. In addition, neither NASA nor the Department of State have crafted strategies for productive international dialog on developing policy for**

- **planetary protection for human missions or**
- **the relationship between exploration zones on Mars and the OST's prohibition on national appropriation of parts of celestial bodies.**

**Recommendation: NASA's process for developing a human Mars exploration policy should include**

- **early consultations with mission developers and managers, receiving facility science teams, and microbiologists and technologists,**
- **examination of alternative planetary protection scenarios with access to the necessary research that informs these alternatives, and**
- **plans to engage, via the State Department, with other nations on the policy and legal implications of missions to Mars.**

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### Major conclusions: Period of biological exploration

- **Finding**: As the exploration of the icy moons rises in priority and plans for piloted missions to Mars emerge, it is necessary to reevaluate and clarify the period of biological exploration.
- **Recommendation**: Given the implications with respect to the Outer Space Treaty, NASA and COSPAR should facilitate development of an international strategy for establishing periods of biological exploration. Such a strategy should ensure that individual nation states all are using the same values. Specification of this period is vital to the calculations of probability of contaminating a potential habitat on another world.

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### **Major conclusions: Private sector missions**

- **Planetary protection policy and requirements do not mandate significant actions beyond documentation for the vast majority of ongoing and planned private-sector space activities. The only near-term implications are for missions to Mars.**
- **Planetary protection policies and requirements for forward and back contamination should apply equally to both government-sponsored and private-sector missions to Mars.**

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### **Private sector issues**

**Finding**: A regulatory gap in U.S. federal law poses a problem for U.S. compliance with the OST's obligations regarding private sector enterprises. The OST requires states parties to authorize and continually supervise non-governmental entities, including private sector enterprises, for any space activity that implicates the treaty, including its planetary protection provisions.

**Recommendation**: Congress should promulgate legislation that grants jurisdiction to an appropriate federal regulatory agency to authorize and supervise private-sector space activities that raise planetary protection issues. The legislation should also ensure that the authority granted be exercised in a way that is based upon the most relevant scientific information and best practices on planetary protection.

**Finding**: To date, planetary protection policy development has not involved significant participation from the private sector. The lack of participation creates potential challenges for policy development, because private-sector actors need to be able to understand and embrace appropriate planetary protection.

**Recommendation**: NASA should ensure that its policy-development processes, including new mechanisms (e.g., a revitalized external advisory committee focused on planetary protection) make appropriate efforts to take into account the views of the private sector in the development of planetary protection policy. NASA should support the efforts of COSPAR officials to increase private-sector participation in the COSPAR process on planetary protection.

Backup

# ***Review and Assessment of Planetary Protection Policy Development Processes***

## **Report Outline**

- 1. Introduction**
  - Study scope
  - Interim report
  - Definition of “policy”
  - Ethical issues
  - Readers’ guide to the report
- 2. Historical context**
  - Outer Space Treaty
  - COSPAR
  - National Academies
  - NASA
  - Case studies
- 3. Summary & assessment of the NASA process**
  - Current NASA process
  - Mars 2020 lessons learned
  - Europa Clipper lessons learned
  - Assessment of the NASA process
  - Defining a period of planetary protection
- 4. Summary & assessment of policy development outside NASA**
  - Other U.S. government entities
  - COSPAR
  - Space Studies Board
- 5. Human Mars Exploration**
  - Planetary protection & human missions to Mars
  - Development process for a new policy
  - Future studies
- 6. Private sector and planetary protection**
  - Private sector activities
  - The regulatory gap
  - Private sector participation in policy development
- 7. Elements of a NASA planetary protection strategic plan**
  - Managing implementation
  - Securing outside advice
  - Planning for future missions
  - Sample return & human Mars missions
  - Private sector missions
- 8. Appendices**

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### **Goals & rationales for planetary protection (from Interim Report)**

#### **Goals:**

- **control of forward contamination**
- **control of back contamination**

#### **Rationales (in priority order):**

- **preserve the integrity of the Earth's biosphere**
- **protect the biological ~~and environmental~~ integrity of other solar system bodies for future science missions**

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## **Defining “policy”**

- **NASA’s definition**: “the philosophies, fundamental values, and general direction of the Agency or Center [that] are used to determine present and future decisions ... because established policies are general in nature, they may need more specific requirements established in procedural requirements for full implementation.” [NPR 1400.1G - NASA Directives and Charters Procedural Requirements]
- **Committee’s view**: Accepts NASA’s definition and notes that policy should be developed as a set of guiding principles that point to a course of action (a plan) that accomplishes goals that are clearly articulated. Policy also should establish clear responsibilities for leadership within the agency for formulating and executing that plan.
- **Policy in this context is not** the detailed implementation requirements or performance standards for particular missions. Those detailed requirements and technical goals should, instead, flow down from the policy in a way that can be validated for compliance and effectiveness.
- **However**, more general requirements that describe how high-level policy will be executed and that reflect the application of broad scientific and technical knowledge to meet planetary protection goals do become an element of policy.

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### **Mars 2020 lessons learned**

- **Notable challenges: (a) being the first phase of a sample return program and (b) being cost-capped and directed to maximize use of inherited MSL systems.**
- **Early discussions and agreement between project team and planetary protection office regarding PP requirements and approach are critical.**
- **All PP requirements from NASA Hq need to reflect standard project management and systems engineering protocols.**
- **Implementation of PP policies need to embrace principles of flexibility, adaptability, and openness.**
- **Requirements development process needs to include independent, outside, expert review.**
- **Existing PP standards need continuous peer review and revision to reflect new science & technology.**
- **Modeling techniques for contamination transport at Mars need further assessment.**
- **Conflict resolution mechanisms need to be understood and utilized as often as necessary.**

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### **Europa Clipper lessons learned**

- **Early definition of requirements is essential to effective project implementation. Early establishment of requirements can minimize the risk and uncertainty of future design changes and thus increased cost for the missions.**
- **Future research into the important parameters for these missions, including reevaluating legacy requirements, will likely reduce the cost of missions while still meeting U.S. obligations under the OST.**
- **Imposition of PP requirements on missions needs to follow standard system engineering protocols to ensure that every appropriate requirement is properly understood and implemented and can be adequately verified.**
- **NASA's conflict resolution process is essential in executing spaceflight missions and its use is required when disagreements between technical authorities and projects occur.**

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## **NASA's Standard Program and Project Management and Systems Engineering Practices**

**All requirements are expected to:**

- **be formally issued in accordance with NASA policies;**
- **be individually clear, correct, and feasible;**
- **not be stated as *how* to satisfy the requirement;**
- **be implementable;**
- **have only one interpretation of meaning;**
- **have one actor-verb-object requirement; and**
- **be able to be validated at the level of the system structure at which they are stated.**

**When requirements are presented in pairs or as a set, they are required to:**

- **have no redundancy,**
- **be consistent with terms used,**
- **not conflict with one another, and**
- **form a set of “design-to” requirements.**

**To support mission success, NASA teams need to:**

- **have full and open discussions,**
- **foster and respect diverse views, and**
- **utilize NASA's dissenting opinion process for resolving serious dissent.**

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### Updating National Security Council Directive - 25

**Finding:** NSC-25 (December 1977) is out of date. Plans to send robotic sample-return and human-crewed missions to Mars in the next few decades will, in all likelihood, create planetary protection challenges that current national processes on developing planetary protection policy are not well-equipped to handle.

**Recommendation:** The Administration, most probably through the National Space Council, National Security Council, and the Office of Science and Technology Policy, should revisit NSC-25 in light of NASA plans for Mars sample-return missions and human-crewed missions to Mars and revise or replace its provisions for engaging relevant federal agencies in developing back contamination protection policies.