

National Aeronautics and
Space Administration

Headquarters
Washington, DC 20546-0001



Reply to Attn of: Science Mission Directorate/Deputy Associate Administrator for Research

MAY 21 2019

Dr. Margaret Kivelson
Space Studies Board
National Academies of Science, Engineering, and Medicine
500 5th Street, NW
Washington, DC 20001

Dear Dr. Kivelson:

I would like to express my appreciation for the June 2018 delivery of the report "Review and Assessment of Planetary Protection Policy Development Processes." I thank you and the members of the Study Team for their hard work and diligence in preparing such a clear and comprehensive assessment of a complex topic.

The Report recommends a series of eighteen actions that NASA and other Federal departments and agencies should undertake. The analysis and guidance provided in the Report represents valuable input in the development of the next generation of NASA's planetary protection policies and practices. I have reviewed the findings and recommendations of the report, and I am pleased to convey our responses to them. In general, our existing efforts appears, by and large, well-aligned with the report's recommendations within the constraints of available and anticipated funding. Please express my appreciation to the Chair, Mr. Joseph Alexander, the Study Director, Mr. David Smith, and to all of the volunteers and staff who worked to bring this complex and comprehensive project to such a successful conclusion.

In the attachment to this letter, I provide initial acknowledgement and preliminary assessments and responses to the report's recommendations. Please do not hesitate to contact Dr. Michael New, who can be reached at (202) 358-1766 or at michael.h.new@nasa.gov, with any questions.

Sincerely,

A handwritten signature in black ink, appearing to read "T. Zurbuchen", with a long horizontal line extending to the right.

Thomas H. Zurbuchen, PhD
Associate Administrator,
Science Mission Directorate

NASA RESPONSE TO THE NATIONAL ACADEMIES OF SCIENCES, ENGINEERING,
AND MEDICINE *REVIEW AND ASSESSMENT OF PLANETARY PROTECTION POLICY
DEVELOPMENT PROCESSES (2018)*

“Planetary protection involves at least three fundamental activities—policy formulation, policy implementation, and compliance and validation. It encompasses those goals, rationales, policies, processes, and substantive requirements that are intended to ensure that any interplanetary space mission does not compromise the target body for a current or future scientific investigation and does not pose an unacceptable risk to Earth (in the case, for example, of sample return missions).”

NASA agrees with the scope of planetary protection as stated in the above quote from the interim report (2017) and final report (2018) from NASEM.

NASA notes that the historic focus on integrity of scientific investigations will necessarily evolve as technology for human space travel advances and enables the return to the Moon and then to Mars. NASA is actively working with international partners and commercial entities to maximize exploration benefits and minimize environmental impacts of astronauts landing, building habitats, and conducting research on Mars. There is broad agreement about the importance of treading lightly on Mars until the presence or absence of indigenous Martian life can be established with some certainty.

Recommendation 3.1: 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.

Response: *The Office of Planetary Protection was moved from the Science Mission Directorate to the Office of Safety and Mission Assurance in 2017. Concurrently, NASA conducted a widely publicized search for a new Planetary Protection Officer and hired Dr. Lisa Pratt to fill the position in February 2018. Under new leadership, the Office of Planetary Protection reached out to subject matter experts from universities, other Federal agencies, and commercial industries to serve on review panels and participate in workshops as a means to resolve complex technical disagreements with transparency, equity, and reliance on current scientific understanding. The following two examples illustrate conflict resolution using this type of process. In May 2018, five outside experts conducted an aerobiology review of the fluid mechanical particle barrier (FMPB) for the Mars 2020 project and recommended experimental validation to increase confidence in particle exclusion by FMPB which the reviewers regarded as innovative and appropriately modeled. New tests of the FMPB in air rather than water are now being conducted by Mars 2020 project engineers. In November 2018, fourteen outside experts participated in a workshop to refine the probabilistic risk assessment (PRA) for inadvertent introduction of a viable organism into a liquid water environment as a result of the Clipper mission. External input and consensus decisions during the workshop enabled the Clipper PRA to be revised and to successfully demonstrate compliance with less than a 1 in*

10,000 chance of biological contamination of Europa (NPR 8020.12D, requirement 5.4.1). Following the workshop, the revised planetary protection plan for Clipper was approved at NASA Headquarters.

NASA agrees with the need for biological contamination policy and requirements to be applied to Government-sponsored and private sector missions during robotic exploration of Mars and during all mission stages of restricted return of samples to Earth. Over the past year, the Office of Planetary Protection has closely partnered with the advanced architecture team for Mars sample return at the Jet Propulsion Laboratory (JPL). The primary topics of shared concern are sterilization of the exterior sample canister prior to departure from Mars orbit and technical criteria for a sample receiving facility. Of particular relevance to Recommendation 3.1, a sterilization working group has been established with eleven outside members representing health-product companies, industrial processors, Federal health agencies, and university groups with expertise in sterilization, biophysics, and epidemiology. A first meeting of the sterilization working group was held in January 2019. External members of the working group were generous in sharing their knowledge and volunteered to prepare a meeting report for rapid submission to a journal. The NASA and external members of the working group started work on identification of a suite of terrestrial organism, biological agents, and complex molecules to use in challenges tests for advanced sterilization methods at industrial research facilities. There are substantial benefits to NASA and its commercial partners in conducting challenge tests as analogues for sterilization and denaturing of extraterrestrial organic materials. A second meeting of the sterilization working group will be held in May 2019 and will include a representative from the European Space Agency (ESA)

Recommendation 3.2: NASA should assess the completeness of planetary protection policies and initiate a process to formally define the planetary protection requirements that are missing. NASA should ensure that all future headquarters planetary protection requirements imposed on spaceflight missions follow NASA standard project management and systems engineering protocols for review, approval, and flow-down of requirements and, when disagreements occur, ensure that NASA’s conflict resolution process is followed. For future new situations such as private-sector missions to other bodies or human exploration of Mars, the policies and their potential impacts should be evaluated and examined well in advance of a mission start.

***Response:** NASA agrees that current policies and requirements for planetary protection have not kept pace with the genomic revolution in biology and advances in computerization of spacecraft operations. Over the past 30 years, revision of requirements were additive with little or no elimination of antiquated protocols. As part of the move to OSMA, comprehensive review and rewriting of NASA’s planetary protection requirements has been initiated with the intent of increasing flexibility and encouraging innovation while continuing to maintain rigorous standards for biological cleanliness of spacecraft based on international guidelines. Shifting away from a culture of change aversion to a culture of resourceful problem solving is yielding immediate benefits for the Clipper mission in the form of streamlining bioburden sampling handling and sharing best practices so it will be possible to directly compare and calibrate cleanliness data among the Clipper planetary protection laboratories at JPL, Goddard Space Flight Center (GSFC), and the Applied Physics Laboratory (APL). A web-based bioburden*

assessment tool (BAT) developed at GSFC is undergoing beta testing using raw spore data from the InSight mission and will be available for use by the Clipper project in late 2019. The Office of Planetary Protection has a new consulting contract with Idaho National Labs to incorporate Bayesian statistical tools into the web-based BAT so biological cleanliness can be reported and assessed at any point during assembly and launch preparation with variance for spore concentrations.

In anticipation of increasing commercial partnerships and private missions to the Moon and other destinations, and in response to a recommendation from this NASEM report and the NASA Advisory Council, the opportunities and challenges for planetary protection will be assessed by a new Independent Review Board being organized by Dr. Thomas Zurbuchen, Associate Administrator for the Science Mission Directorate. Members of the task force are currently being invited from commercial groups, research institutes, and universities. A first meeting of the new task force is anticipated in June 2019, and it is targeted to complete its work by the end of September 2019, consistent with the recommendation that these policies and their potential impacts should be evaluated and examined well in advance of a mission start.

Recommendation 3.3: NASA should ensure that in assessing changes to COSPAR planetary protection policies and requirements there is a process to engage the full breadth of NASA stakeholders, including the spaceflight mission and science communities. This process should be at least as disciplined as the process NASA uses to review, concur, and approve changes to its own policies.

***Response:** NASA participates in COSPAR scientific assemblies which are open to all interested parties and are convened every two years. The COSPAR planetary protection panel holds a public meeting during the assembly and actively seeks input on changes in policy from diverse stakeholders. At the 2018 meeting in Pasadena, Dr. Lisa Pratt explicitly asked the panel to be more responsive to the concerns and issues raised by commercial and private space industries. NASA has changed their designated representative on the COSPAR Planetary Protection Panel from the Planetary Protection Officer to the NASA Chief Scientist in order to ensure broad agency awareness and input to international guidelines. The COSPAR Panel also has been largely reconstituted with new international space agency and science community representatives. As a result of this change, Dr. Jim Green participated on the COSPAR panel in January 2019 when assessments were presented to the panel from a NASEM/ESA study and an independent JAXA study of requirements for sample return from Martian moons. The COSPAR Panel held an open session and then a closed-door session on this topic and subsequently gave a consensus recommendation to the COSPAR Bureau for unrestricted sample return from Phobos or Deimos. The change in designated representation on the COSPAR Planetary Protection Panel for NASA provides Agency-wide engagement in policy decisions. In addition, the COSPAR Planetary Protection Panel is now chaired by Dr. Athena Coustenis, a well-known astrobiologist from Europe. The Planetary Protection Officer from ESA is one of two Panel Vice-Chairs. The Vice-Chair role is primarily to provide previous committee procedures and background information and is not expected to cause an imbalance of influence.*

Recommendation 3.4: NASA should expeditiously complete the transition of the OPP to OSMA and clarify the remaining issues concerning roles, responsibilities, resources, and locations of OPP functions. The Chief of the Office of Safety and Mission Assurance should complete the Science Mission Directorate’s move toward instituting a formal method for imposing planetary protection requirements that are in accordance with standard NASA systems engineering practices.

Response: NASA has completed transfer of the Office of Planetary Protection to OSMA. In addition to hiring a new Planetary Protection Officer in 2018, NASA hired a program scientist for planetary protection research in 2018 and a Deputy Planetary Protection Officer in 2019. With full staffing in place, the ROSES 2017 research proposals have been selected. Additional information on the status of planetary protection research is provided in the response to recommendation 3.8. The ROSES 2018 research call has been refocused on knowledge gaps for Mars sample return and a Europa lander.

NASA requirements for planetary protection are currently outlined in NPR 8020.12D and NID 8020.109A which are difficult to read and apply due to intermingling of roles, requirements, and technical standards. A new NASA procedural requirement document is being developed following a template for system-engineering practices used in other areas of OSMA technical authority. A companion NASA technical standard will be developed to ensure up-to-date protocols and clear instructions for implementation.

Recommendation 3.5: NASA should develop an agency-wide strategic plan for managing the planetary protection policy development challenges that sample return and human missions to Mars are creating.

Response: NASA agrees on the importance of Agency-wide strategic planning for technical innovations and policy changes in preparation for human missions to Mars that comply with “do no harm” language in the Outer Space Treaty. NASA, ESA and JAXA are working collaboratively within the COSPAR framework to identify key technology gaps and to recommend policy changes which will be needed to monitor and control biological contamination during Mars sample return and human missions to Mars. Although COSPAR recommendations are used as guidelines, NASA independently revises and updates procedural requirements for missions in each of the planetary protection categories and NASA technical standards are not identical to ESA or JAXA technical standards.

Recommendation 3.6: NASA should reestablish an independent and appropriate advisory body and process to help guide formulation and implementation of planetary protection 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. The advisory body and process should involve a formal Federal Advisory Committee Act committee and interagency coordination, as well as ad hoc advisory committees, if and as circumstances dictate. This advisory apparatus should be situated and engage within NASA at a level commensurate with the broad cross-cutting scope of its purview and the potentially broad interests that the involved issues may engender.

***Response:** NASA uses review panels, workshops, and taskforces to re-engage with subject-matter experts across a broad spectrum of scientific and engineering disciplines relevant to planetary protection. It remains to be determined, however, if a FACA-chartered committee is the most effective mechanism for supporting and assessing missions with complex planetary protection requirements.*

Recommendation 3.7: NASA should engage the full range of relevant scientific disciplines in the formulation of its 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.

***Response:** As noted in the response to Recommendation 3.1, the Office of Planetary Protection is reaching out to external experts from commercial industries, space research institutes, , and academic institutions. A relatively small proportion of the recently invited, external participants in reviews and working groups related to planetary protection are individuals with prior direct involvement with the Office of Planetary Protection. The sterilization working group, in particular, was energized by the observations and recommendations from external scientists who are national and international experts in sterilization of consumer health products and medical devices. A number of unexpected research collaborations emerged from the first meeting of the sterilization working group.*

As noted in the response to Recommendation 3.2, a new Independent Review Board is being formed by the Science Mission Directorate to address concerns about policies and requirements for implementation of planetary protection by commercial and private space missions.

Recommendation 3.8: NASA should 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.

***Response:** NASA agrees with the need to appropriately invest in research to innovate planetary protection for likely future missions to Mars, Jupiter’s moon Europa, and Saturn’s moon Enceladus. SMD Planetary Science Division (PSD) has hired a new program officer to support relevant planetary protection research activities. The new PSD program officer for planetary protection research has collaborated with the Planetary Protection Officer to compose a ROSES 2018 call focused on mission needs. For ROSES-17, the total amount awarded over the lifetime of the five (5) awards is \$2,176,640. In anticipation of a twice yearly cadence for selection, ROSES-18 anticipates awarding three (3) awards with a total lifetime amount of \$1.5M.*

In December 2018, a brainstorming session to identify technology needs and gaps for planetary protection was jointly hosted by the Planetary Exploration Science Technology Office at the Glenn Research Center, the Chief Technologist for the Engineering and Science Directorate at JPL, and the Office of Planetary Protection. There were 20 participating scientists and engineers representing relevant missions and programs at JPL, GSFC, Langley Research Center, Applied Physics Lab, and Johnson Space Center. This was the first time many

of the participants had an opportunity to discuss in detail their needs and key technology gaps. Ideas captured in the brainstorming session were used in developing the ROSES 2018 call and as input to the NASA Technology Taxonomy.

Recommendation 3.9: NASA should evaluate the ESA process for planetary protection implementation and strongly consider incorporating the elements of that process that are effective and appropriate.

Response: NASA will review ESA’s implementation of planetary protection as well as JAXA’s and other countries as appropriate and identify potential best practices for incorporation. NASA and ESA are working collaboratively on development of probabilistic requirements for backward planetary protection as part of the evolving campaign architecture for Mars Sample Return.

Recommendation 3.10: 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 are all using the same values. Specification of this period is vital to the calculations of probability of contaminating a potential habitat on another world.

Response: NASA has adopted a 1,000-year period of biological exploration for incorporation into the Clipper probabilistic risk assessment based on recommendations from Planetary Protection Outer Solar System (PPOSS) which is an international forum funded by the European Union’s Horizon 2020 research and innovation program. This activity was led by the European Science Foundation with representation from the U.S. National Academies of Science, Engineering, and Medicine; NASA; and ESA. There were open discussions of the rationale for a 1000-year period at the PPOSS 2017 meeting in London, UK and the PPOSS 2018 meeting in Florence, Italy. NASA will continue to assess the policy implication of establishing periods of biological contamination rather than establishing knowledge levels necessary to determine if restricted sample return is warranted or if quarantine of astronauts is prudent.

Recommendation 4.1: The Administration, most probably through the National Space Council, National Security Council (NSC), and the Office of Science and Technology Policy, should revisit NSC Memorandum 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.

Response: While implementing this recommendation is not the sole purview of NASA, the Agency has initiated discussions with the Office of Science and Technology Policy and other relevant Federal departments and agencies to ensure coordination of regulation for return of samples from Mars to Earth and for transport of Mars samples from a landing site to a receiving facility.

Recommendation 4.2: The Department of State, informed by consultations with the appropriate experts and stakeholders, should embark on active international diplomacy to forge consensus on appropriate policies for planetary protection for a broad range of

future missions to Mars. The goal should be to maintain and develop international consensus on how best to mutually and cooperatively meet all signatories’ obligations under Articles IX and VI of the Outer Space Treaty. Such diplomacy should take into consideration, to the extent possible, the best available science as well as anticipate new missions in space.

Response: While the Department of State is responsible for interpretation of treaties and compliance with international obligations, NASA contributes technical expertise related to planetary protection, as warranted. For example, NASA participates in numerous national and international discussions on how to comply with Articles IX and VI of the Outer Space Treaty during Mars sample return and human missions to Mars. NASA also is engaged in discussions about future orbiting missions designed to collect plumes samples from Europa or Enceladus for return to Earth.

Recommendation 4.3: The SSB and NASA should pursue new mechanisms to anticipate emerging issues in planetary protection, respond more rapidly, and address new dimensions such as private-sector missions and human exploration. Future decadal survey committee’s should give greater prominence to planetary protection issues and play a more proactive role in their identification and possible resolution.

Response: NASA celebrates the innovations and successes of private sector-led space missions, and plans to leverage commercial launches and spacecraft for low Earth orbit as well as missions to the Moon and Lunar gateway. The Moon will be a proving ground for commercial rockets and spacecraft with the technology necessary for safe transport of humans to Mars and back.

NASA will consider adding language to the Planetary Science Decadal Survey Statement of Task to ensure that issues of planetary protection play a more prominent role in the development of its recommendations.

Recommendation 5.1: NASA’s process for developing a human Mars exploration policy should include examination of alternative planetary protection scenarios and should have access to the necessary research that informs these alternatives. It should also include plans to engage with other nations on the policy and legal implications of missions to Mars.

Response: NASA concurs with Recommendation 5.1 and is actively working with ESA, and JAXA using a series of COSPAR/NASA human workshops to identify knowledge gaps in planetary protection which can be addressed by funding new research spanning space biology, astronaut health, and astrobiology. Representatives from multiple commercial and private space companies have been invited to participate in the upcoming May workshop.

Recommendation 6.1: Planetary protection policies and requirements for forward and back contamination should apply equally to both government-sponsored and private-sector missions to Mars.

Response: NASA concurs with recommendation 6.1 and notes the Agency works closely with the relevant regulatory agency reviewing commercial space activities to provide technical expertise related to planetary protection, as warranted.

Recommendation 6.2: Congress should address the regulatory gap by promulgating 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.

Response: NASA notes there are bills pending before Congress addressing authorization and supervision of private sector space activities. NASA will work with the authorizing and supervising agency defined by law to ensure best practices on planetary protection.

Recommendation 6.3: 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.

Response: NASA agrees with Recommendation 6.3 and plans to work through the NASA Chief Scientist, as its representative on the COSPAR planetary protection panel, to increase private-sector participation. It is important to note that several commercial groups were invited to the January 2019 COSPAR meeting in Vienna. Although only one attended, several commercial groups expressed appreciation for being invited.

Recommendation 7.1: NASA, under the direction of the Office of the Administrator, should develop a planetary protection strategic plan that clearly addresses the agency’s approach for

- **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, human missions to Mars, and private-sector involvement in solar system exploration missions.**

Response: NASA agrees with Recommendation 7.1 and notes that Agency-level strategic planning for planetary protection will begin later this fiscal year in alignment with the budgetary process for funding ongoing missions, selected missions, and new starts.