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NASA Interim Directive

Effective Date: July 9, 2020
Expiration Date: July 9, 2022

Subject: Biological Planetary Protection for Human Missions to Mars

Responsible Office: Office of Safety and Mission Assurance

Table of Contents

Preface

P.1 Purpose

a. This directive defines NASA's obligation to avoid harmful forward and backward biological contamination under 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 (the "Outer Space Treaty"), October 19, 1967.

b. This directive specifically addresses the control of forward biological contamination of Mars and backward biological contamination of the Earth-Moon system associated with human presence in space vehicles intended to land, orbit, flyby, and return from Mars.

c. The 1967 Outer Space Treaty provides in relevant part: "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." NASA recognizes that the 1967 Outer Space Treaty (OST) sets forth legal requirements on U.S. governmental and non-governmental entities to prevent such forward and backward harmful biological contamination.

P.2 Applicability

a. This NASA Interim Directive (NID) is applicable to NASA Headquarters and NASA Centers, including Component Facilities and Technical and Service Support Centers. This language applies to the Jet Propulsion Laboratory (a Federally-Funded Research and Development Center), other contractors and subcontractors, recipients of grants, cooperative agreements or agreements concluded under provisions of the Space Act, and other agreements, including international agreements, to the extent specified or referenced in the applicable contracts, grants, or agreements.

b. The provisions of this NID cover human spaceflight missions with NASA involvement, which may intentionally or unintentionally carry terrestrial organisms and organic constituents to the planets or other solar system bodies, including missions employing spacecraft where hardware elements are intended to return to Earth and/or the Earth-Moon System from missions to Mars. Specifically, this includes NASA-controlled missions, commercial missions sponsored by NASA, joint missions that NASA participates in, and NASA support of non-NASA missions to the extent specified or referenced in the applicable contracts, grants, or agreements.

c. In this directive, the term "should" denotes a good practice and is recommended, but not required, and "will" denotes expected outcome.

d. In this directive, all document citations are assumed to be the latest version unless otherwise noted.

P.3 Authority

a. The National Aeronautics and Space Act, 51 U.S.C. § 20113(a).

b. Space Policy Directive 1 (2017): Reinvigorating America's Human Space Exploration Program.

c. NPD 1000.0, Governance and Strategic Management Handbook.

d. NPD 8020.7, Biological Contamination Control for Outbound and Inbound Planetary Spacecraft.

P.4 Applicable Documents

a. Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies (the "Outer Space Treaty"), October 19, 1967, Article IX.

P.5 Measurement/Verification

a. Compliance with this directive is continuously monitored by the Project Safety and Mission Assurance Technical Authority and by the NASA Office of Safety and Mission Assurance. Compliance may also be verified as part of selected life-cycle reviews and by assessments, reviews, and audits of the processes defined within this directive.

b. To ensure compliance with this NID, the Office of Planetary Protection (OPP) evaluates planetary protection related activities and developments by NASA programs, including calls for mission concept studies and proposals.

P.6 Cancellation

NPI 8020.7, NASA Policy on Planetary Protection Requirements for Human Extraterrestrial Missions.

Chapter 1. Mitigating Backward and Forward Harmful Biological Contamination from Human Missions to Mars

1.1 Overview

1.1.1 Biological planetary protection is the practice of protecting solar system bodies from contamination by Earth life to enable scientific exploration and protecting Earth from possible harmful biological contamination that may be returned from other solar system bodies. The Office of Planetary Protection supports NASA's responsible exploration of the solar system to enable science, exploration/discovery, and commercial activities.

1.1.2 NASA's existing relevant policies and planetary protection requirements ensure the search for extraterrestrial life can be conducted in a safe and verifiable manner. Specifically, the primary objectives are to:

a. Control forward contamination of other worlds by terrestrial organisms and organic constituents carried by spacecraft in order to support the integrity of the search and study of extraterrestrial life, if it exists.

b. Preclude backward contamination of Earth by extraterrestrial life and bioactive molecules, such as prions, in returned samples from habitable worlds.

1.1.3 NASA's programmatic authorities provide resources to achieve and assure compliance with applicable planetary protection requirements. The Office of Planetary Protection (OPP) will coordinate with relevant programmatic authorities to establish appropriate resource levels.

1.2 Guidance for Biological Planetary Protection for Human Missions to Mars

1.2.1 NASA has been a key participant and advocate for the development of internationally accepted protocols to prevent backward and forward contamination, including the guidelines for "Human Missions to Mars" in the Committee on Space Research (COSPAR) planetary protection policy.

1.2.2 Specifically, NASA concurs with the general COSPAR planetary protection policy paradigm that:

a. "Safeguarding the Earth from potential back[ward] contamination is the highest planetary protection priority in Mars exploration."

b. "The greater capability that human explorers can contribute to the astrobiological exploration of Mars is only valid if human-associated contamination is controlled and understood."

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

d. "[Humans] exploring Mars, and/or their support systems, will inevitably be exposed to martian materials."

1.3 NASA Policy on Biological Planetary Protection for Human Missions to Mars

1.3.1 NASA will develop risk-informed decision making implementation strategies for human missions to Mars, which account for and balance the needs of human space exploration, science, commercial activities, and safety. Specifically, NASA will develop guidelines and utilize data and experience gained via ground-based tests, the International Space Station (ISS), Artemis, and other missions.

1.3.2 If there is a gap between current knowledge/capability and the desired outcome as described in 1.3.1, NASA will undertake a program of activities to close the knowledge/capability gap.

1.3.3 NASA will adopt the following research structure, leveraging information from the NASA Planetary Protection Knowledge Gaps for Human Extraterrestrial Missions Workshop Report, Race et al. (2015), developing as needed:

a. Capabilities to monitor biological processes associated with the human presence in space exploration and to evaluate changes over time;

b. Technologies for mitigating contamination release or intrusion, potentially including closed-loop systems; cleaning/re-cleaning capabilities; quarantine, support systems, and biological waste disposal that minimize impact of humans on the environment of Mars; and

c. An understanding of environmental processes on Mars that would contribute to transport and sterilization of terrestrial organisms released by human activity.

1.3.4 NASA will determine if it is necessary to conduct a precursor in situ experiment at a location close to the human mission landing or operating sites to characterize any organic constituents that are present, noting that the measurement should be on airborne materials and on materials from the surface and down to a depth to which astronauts may be exposed, and to establish a baseline scientific understanding.

> *Note: This is recommended in part because of the Mars Science Laboratory finding of complex organic constituents in the surface and the shallow subsurface, and also because it was recommended in the National Research Council 2002 Safe on Mars report.*

1.3.5 NASA will continue to leverage the ISS as a testbed in preparation for human missions to Mars. Specifically, increased frequency of biological monitoring of crew, hardware, and environmental control and life-support system (ECLSS), processes inside and outside of the ISS will allow for the development of critical baseline data.

1.3.6 NASA will make public the data from such programs, for use by any academic, industrial, or private sector entities contemplating participation in a human mission to Mars.

Appendix A. References

A.1 Actions Normally Requiring an EIS, 14 CFR § 1216.306.

A.2 PD/NSC-25, Scientific or Technological Experiments with Possible Large-Scale Adverse Environmental Effects and Launch of Nuclear Systems into Space, as amended May 8, 1996.

A.3 NPD 8900.5, NASA Health and Medical Policy for Human Space Exploration.

A.4 COSPAR Planetary Protection Policy, Kminek et al. (2017) Space Research Today 200 p.12.

A.5 Planetary Protection Knowledge Gaps for Human Extraterrestrial Missions Workshop Report, Race et al. (2015) NASA Washington DC downloadable from https://sma.nasa.gov/docs/default-source/sma-disciplines-and-programs/planetary-protection/2015-report.pdf?sfvrsn=b2fcfff8_6.

A.6 Safe on Mars: Precursor Measurements Necessary to Support Human Operations on the Martian Surface, Hauck et al. (2002) National Academy Press Washington DC downloadable from http://www.nap.edu/catalog/10360.html.