# NASA's Revised Planetary Protection Policy and Implementation

Dr. Elaine Seasly

NASA Deputy Planetary Protection Officer

NASA Office of Safety and Mission Assurance

Presentation to the 44th COSPAR Scientific Assembly

July 21, 2022

# Contributors

- Dr. J. Nick Benardini, NASA Planetary Protection Officer
- Dr. J. Andy Spry, Senior Scientist SETI Institute, Planetary Protection Consultant
- Amy Baker, Senior Scientist SETI Institute, Planetary Protection Consultant
- Dr. Erin Lalime, NASA Goddard Space Flight Center, Planetary Protection Engineer
- Dr. Lisa Pratt, NASA Planetary Protection Officer (Retired)
- Pedro Rivera, ARES Corporation, Technical Standards Engineer

# Planetary Protection Policy

## The Outer Space Treaty of 1967

***International Responsibility***

### Article VI:

*States Parties to the Treaty shall bear international responsibility for national activities in outer space, including the moon and other celestial bodies, whether such activities are carried on by governmental agencies or by non-governmental entities, and for assuring that national activities are carried out in conformity with the provisions set forth in the present Treaty*

***Planetary Protection***

### 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*

### Committee on Space Research (COSPAR)

- Panel on Planetary Protection forms international consensus guidelines
- Defines PP Categories I – V based on target body and mission type

### NASA

- Supports the science-based international consensus process
- Develops new guidelines and provides significant input to COSPAR

# NASA's Planetary Protection Policy Documents (current)

**NPD 8020.7G**
*Biological Contamination Control for Outbound and Inbound Planetary Spacecraft (Revalidated 05/17/13 w/change 1)*
**Expiration Date:** June 19, 2022

***NASA Policy Directives (NPDs)***
- Documents Agency policy statements
- Describe what is required by NASA management to achieve NASA's vision, mission, and external mandates

**NPR 8715.24**
Replaced NPR 8020.12D/NID 8020.109A
*Planetary Protection Provisions for Robotic Extraterrestrial Missions*
**Effective Date September 24, 2021**
**Expiration Date: September 24, 2026**

***NASA Procedural Requirements (NPRs)***
- Provide detailed procedural requirements to implement policy
- Guide how policy directives are implemented in the context of specific missions

**NID 8715.129 ("Mars NID")**
*Biological Planetary Protection for Human Missions to Mars*
**Expiration Date:** July 9, 2023

***NASA Interim Directives (NIDs)***
- Documents an immediate, short-term statement of the Agency's policies, requirements, and identifies responsibilities for implementation
- Temporarily modify policy directives or implementation requirements

**NASA-STD-8719.R**
*Implementing Planetary Protection Requirements for Space Flight*
**Expiration Date:** TBD
**Status:** Estimated Release ~6/22

***NASA Standards***
- Provide technical requirements
- Each NASA Technical Standard is assigned to a Technical Discipline

**NASA-HDBK-6022**
*Handbook for the Microbial Examination of Space Hardware*
**Expiration Date:** N/A
**Status:** Revision planned. Last draft revision released Aug 17, 2010

***NASA Handbooks***
- Companion documents to NPRs and NASA Standards
- Provide supporting material such as guidelines, lessons learned, procedures, and recommendations

All published documents found in NODIS: https://nodis3.gsfc.nasa.gov/ or the OPP website: https://sma.nasa.gov/sma-disciplines/planetary-protection

= New Documents

# NASA's Planetary Protection Policy Documents (current)

**NPD 8020.7G**
*Biological Contamination Control for Outbound and Inbound Planetary Spacecraft (Revalidated 05/17/13 w/change 1)*
**Expiration Date:** June 19, 2022

***NASA Policy Directives (NPDs)***
- Documents Agency policy statements
- Describe what is required by NASA management to achieve NASA's vision, mission, and external mandates

YOU ARE HERE

**NPR 8715.24**
Replaced NPR 8020.12D/NID 8020.109A
*Planetary Protection Provisions for Robotic Extraterrestrial Missions*
**Effective Date September 24, 2021**
**Expiration Date: September 24, 2026**

***NASA Procedural Requirements (NPRs)***
- Provide detailed procedural requirements to implement policy
- Guide how policy directives are implemented in the context of specific missions

**NID 8715.129 ("Mars NID")**
*Biological Planetary Protection for Human Missions to Mars*
**Expiration Date:** July 9, 2023

***NASA Interim Directives (NIDs)***
- Documents an immediate, short-term statement of the Agency's policies, requirements, and identifies responsibilities for implementation
- Temporarily modify policy directives or implementation requirements

**NASA-STD-8719.R**
*Implementing Planetary Protection Requirements for Space Flight*
**Expiration Date:** TBD
**Status:** Estimated Release ~6/22

***NASA Standards***
- Provide technical requirements
- Each NASA Technical Standard is assigned to a Technical Discipline

**NASA-HDBK-6022**
*Handbook for the Microbial Examination of Space Hardware*
**Expiration Date:** N/A
**Status:** Revision planned. Last draft revision released Aug 17, 2010

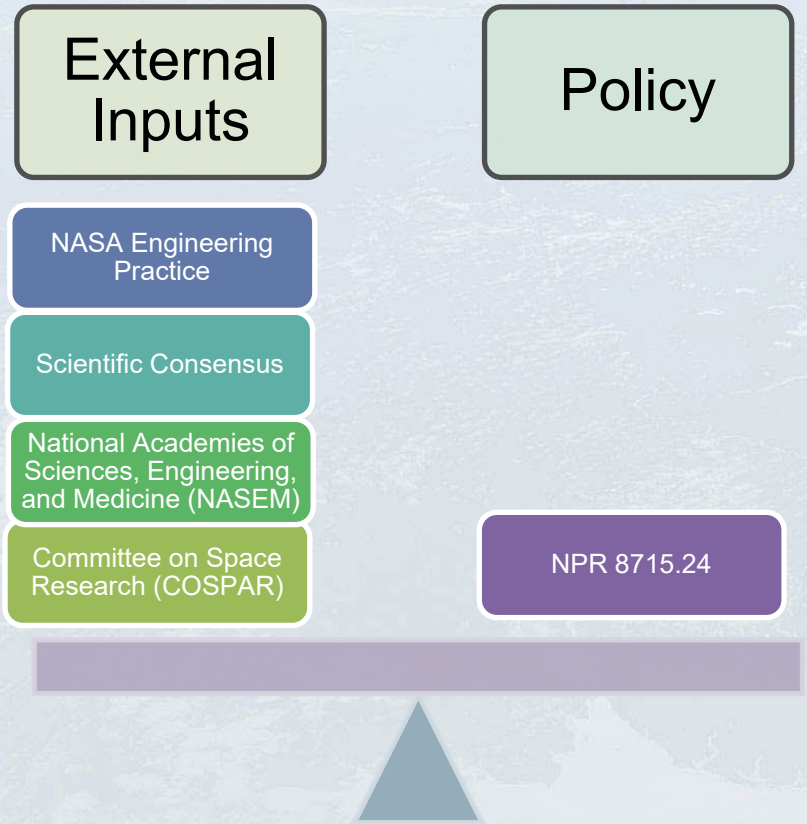
***NASA Handbooks***
- Companion documents to NPRs and NASA Standards
- Provide supporting material such as guidelines, lessons learned, procedures, and recommendations

All published documents found in NODIS: https://nodis3.gsfc.nasa.gov/ or the OPP website: https://sma.nasa.gov/sma-disciplines/planetary-protection

= New Documents

# Purpose of NPR 8715.24 - *Planetary Protection Provisions for Robotic Extraterrestrial Missions*

- Defines NASA roles responsibilities and procedural requirements to implement PP on robotic missions.



## Forward Planetary Protection

- Control risk of **harmful contamination** to other bodies to protect science

## Backward Planetary Protection

- Prevent **harmful contamination** to Earth's environment from extraterrestrial samples

**P.1 Purpose**

a. This directive defines NASA roles and responsibilities and the procedural requirements, informed by Committee on Space Research (COSPAR) Planetary Protection Policy and Guidelines (hereafter referred to as COSPAR policy and guidelines) and National Academies of Sciences, Engineering, and Medicine (NASEM) advice, to:

(1) Control the risk of harmful contamination to other bodies in the solar system, protecting the integrity of the search for and study of processes of chemical evolution or origin of life.

(2) Prevent potentially harmful consequences for humans and the Earth's environment due to the return of extraterrestrial samples from destinations or operations categorized as restricted Earth return.

# Overview of NPR 8715.24 - *Planetary Protection Provisions for Robotic Extraterrestrial Missions*

## Chapter 1. Introduction

1.1 Overview

1.2 Utilization of Current Scientific Consensus Throughout the Project

1.3 PP Considerations for Participation in Partnered Missions

1.4 Delegation of Responsibilities

1.5 Request for Relief

## Chapter 2. Roles and Responsibilities

2.1 Mission Directorate Associate Administrator

2.2 NASA Project Manager

2.3 Chief, Safety and Mission Assurance

2.4 Planetary Protection Officer

2.5 Project-Level SMA Technical Authority

## Chapter 3. Planetary Protection Procedural Requirements

3.1 Categorization and Planning

3.2 Verification, Assurance, and Pre-Launch Report Activities

3.3 Post-Launch/End of Mission

3.4 Restricted Sample Return and Containment

**Chapter 1:**

- Introduces risk-informed decision making
- Addresses how current scientific consensus is considered for missions
- Addresses missions with NASA partners / resources
- Baselines PP Relief using NASA General Safety Program Requirements

**Chapter 2:**

- Defines the key roles and responsibilities for executing PP
  - Previously, only the PPO role was defined
  - COSPAR Interfacing
- Merges PP into the regular mission and project management structure

**Chapter 3:**

- Provides the process for obtaining mission PP categorization
- Addresses PP documentation, review, and concurrence throughout the project lifecycle
- Defines independent verification/assurance activities as well as anomaly investigations
- Addresses sample return break-the-chain, containment and process.

# Expanded Roles and Responsibilities

## Programmatic

### Mission Directorate Associate Administrator (MDAA)

NEW

- Provides PP Mission Categorization
- Provides resources for PP compliance
- Negotiates missions-specific process for partnered missions (consults with interagency, commercial and international partners)
- Supports R&TD to close knowledge gaps and develop PP requirements to enable future missions.

### NASA Project Manager

NEW

- Submits PP Category Request to MDAA
- Identifies Agency PP requirements and standards
- Establishes planned implementation approach
- Coordinates verification and assurance activities with PPO
- Documenting implementation activities
- Coordinates extended mission activities and requirements

## Safety & Mission Assurance (SMA) Technical Authority (TA)

### Chief, SMA

- Concurrence on PP category proposals
- Consults with Chief HMO and Engineer on restricted Earth-return
- Monitors and tracks PP requirements
- Oversees extended mission activities
- Advises MDAA on partnered missions
- Office of PP established

NEW

### Planetary Protection Officer

- Represent NASA in external activities
- Maintain policy
- Concurrence on PP category proposals
- Advise projects on PP approach
- Oversee and verify PP implementation
- Independent verification
- Coordinate with MDAA on R&TD
- Advises MDAA on partnered missions

### Project-Level SMA TA

NEW

- Advises project to notify PPO
- Assures formulation and execution of implementation is sound
- Facilitates independent verification
- Coordinates with project to identify events of conditions for further investigation

# Documentation Concurrence Authority

Allows flexibility to demonstrate compliance with PP requirements with a reduced document set.

Increased Biological Risk = Concurrence from Chief SMA

| Planetary Protection Documentation | Planetary Protection Mission Category | | | | | |
|---|---|---|---|---|---|---|
| | Outbound | | | | Inbound | |
| | I | II | III | IV | V(r) | V(u) |
| Final PP Mission Categorization | Concurrence from PPO | | Concurrence from Chief, SMA based on recommendations from PPO | | | |
| PP Requirements Document | None required | Concurrence from PPO | Concurrence from Chief, SMA based on recommendations from PPO | | | Refer to outbound planetary protection mission category for concurrence authority |
| PP Implementation Plan | | | Concurrence from PPO | | | |
| Pre-Launch PP Report | | | Concurrence from Chief, SMA based on recommendations from PPO | | | |
| Post-Launch PP Report | | | | | | |
| Extended Mission PP Report | | | | | | |
| End of Mission PP Report | | | | | | |

# NASA's Planetary Protection Policy Documents (current)

**NPD 8020.7G**
*Biological Contamination Control for Outbound and Inbound Planetary Spacecraft (Revalidated 05/17/13 w/change 1)*
**Expiration Date:** June 19, 2022

***NASA Policy Directives (NPDs)***
- Documents Agency policy statements
- Describe what is required by NASA management to achieve NASA's vision, mission, and external mandates

**NPR 8715.24**
Replaced NPR 8020.12D/NID 8020.109A
*Planetary Protection Provisions for Robotic Extraterrestrial Missions*
**Effective Date September 24, 2021**
**Expiration Date: September 24, 2026**

***NASA Procedural Requirements (NPRs)***
- Provide detailed procedural requirements to implement policy
- Guide how policy directives are implemented in the context of specific missions

**NID 8715.129 ("Mars NID")**
*Biological Planetary Protection for Human Missions to Mars*
**Expiration Date:** July 9, 2023

***NASA Interim Directives (NIDs)***
- Documents an immediate, short-term statement of the Agency's policies, requirements, and identifies responsibilities for implementation
- Temporarily modify policy directives or implementation requirements

YOU ARE HERE

**NASA-STD-8719.R**
*Implementing Planetary Protection Requirements for Space Flight*
**Expiration Date:** TBD
**Status:** Estimated Release ~6/22

***NASA Standards***
- Provide technical requirements
- Each NASA Technical Standard is assigned to a Technical Discipline

**NASA-HDBK-6022**
*Handbook for the Microbial Examination of Space Hardware*
**Expiration Date:** N/A
**Status:** Revision planned. Last draft revision released Aug 17, 2010

***NASA Handbooks***
- Companion documents to NPRs and NASA Standards
- Provide supporting material such as guidelines, lessons learned, procedures, and recommendations

All published documents found in NODIS: https://nodis3.gsfc.nasa.gov/ or the OPP website: https://sma.nasa.gov/sma-disciplines/planetary-protection

= New Documents

# NASA Standard: *"Implementing Planetary Protection Requirements for Space Flight"*

- Provides the technical requirements to satisfy forward and backward planetary protection

**Forward Planetary Protection**

- Control risk of **harmful contamination** to other bodies to protect science

**Backward Planetary Protection**

- Prevent **harmful contamination** to Earth's environment from extraterrestrial samples

- Provides the required elements to be included in each document throughout the project lifecycle
- Provides requirements for the NASA accepted approach to performing spore assays (NASA Standard Spore Assay) for accounting bioburden

# Strategy to Control Forward Contamination

## PP Hierarchy Strategy 1

**Strategy:** Understand and control harmful contamination of other worlds by terrestrial organisms, organic materials, and organic volatile materials carried or released by spacecraft (referred to as forward contamination) in order to assure integrity in the search for evidence of extraterrestrial life and the study of prebiotic chemistry in the solar system for the appropriate period of biological exploration. (1)

**Context:** Understand mission science objectives relative to contamination sensitivity of destination

**Mission Design and Categorization**
Objective: Ensure mission design demonstrates a credible path to implement mission-specific planetary protection requirements for avoiding harmful contamination. (1.A)

**Biological Knowledge and Organic Contamination**
Objective: Inventory and archive relevant organic and biological reference materials to understand potential origination sources and differentiate these sources from future discoveries. (1.B)

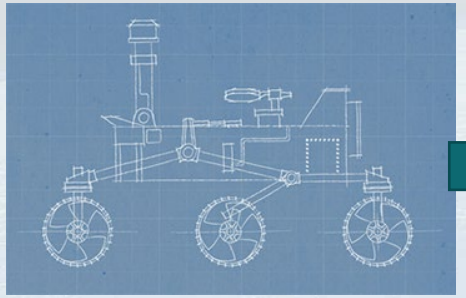
**Robotic Spacecraft Assembly, Test, Transport, Launch, and Operations**
Objective: Demonstrate that management of bioburden during assembly, test, transport, and launch operations is sufficient to meet bioburden allocations. (1.C)

**Avoid Contamination Following Inadvertent Impact**
Objective: Avoid contamination of sensitive solar system bodies by spacecraft and launched elements during flyby, gravity assist, orbital insertion, and orbital operations. (1.D)

**Avoiding Contamination for Robotic Landed Missions**
Objective: Prevent introduction of a viable terrestrial organism into a habitable environment during landing and surface operations, including stationary, mobile, airborne, and subsurface activities. (1.E)

**End-of-Mission Disposition**
Objective: Record biological contamination, organic inventory, and residual fuel remaining at the target, and trajectory/location information to ensure compliance with requirements for end-of-mission disposition. (1.F)

# Control of Forward Contamination



***Mission Design & Categorization***

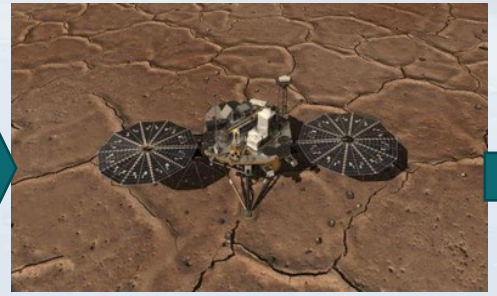
- Information to be included in the PP Mission Categorization Proposal
- Biological and organic contamination knowledge inventory materials

***Robotic Spacecraft Assembly, Test, Transport, Launch, and Operations***

- Controlled manufacturing environments and cleanrooms
- Bioburden Control Approach
- Analytical Approach
- Documentation requirements and communication of data/analysis updates

***Avoiding Contamination following Inadvertent Impact***

- Avoiding inadvertent impact of solar system bodies by spacecraft and launch elements during flyby, gravity assist, or orbital insertion
  - Jovian or Saturnian systems (Cat II)
  - Mars (Cat II-IV)
  - Sensitive Icy Worlds (Cat III or IV)
- Secondary and auxiliary payloads



***Avoiding Contamination for Robotic Landed Missions***

- Prevent occurrence of a biological inoculation event into a potentially habitable environment during landing and surface operations
  - Stationary and mobile activities
- Mars IVa, IVb, IVc requirements
  - Bioburden Control Approach
  - Analytical Approach
- Sensitive Icy World requirements

***End of Mission Disposition***

- Documentation of final disposition of hardware
- Updates to organic, biological, and combustion product inventories
- Information to be included in End of Mission PP Report

# Strategy to Prevent Backward Contamination

## PP Hierarchy Strategy 2

**Strategy:** Prevent harmful biological contamination of the Earth-Moon system by potential extraterrestrial life and bioactive molecules in returned samples and spacecraft from a sensitive solar system body (referred to as backward contamination). (2)

**Context:** Prevent microorganisms and bioactive molecules present at the destination from uncontrolled release into the Earth-Moon System.

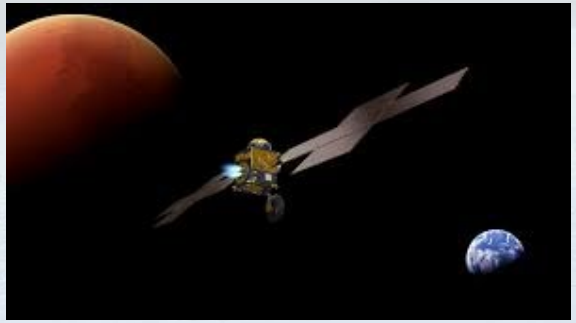
**Earth-Return Mission Categorization**
Objective: Ensure mission design demonstrates a credible path to implement mission-specific planetary protection requirements for avoiding harmful contamination as Unrestricted Earth-return (V(u)) or Restricted Earth-return (V(r)) missions. (2.A)

**Contamination Avoidance Prior to Earth Entry**
Objective: Avoidance of harmful contamination of the Earth-Moon System by release of one or more unsterilized particles of extraterrestrial material during all V(r) mission phases prior to Earth Entry. (2.B)

**Contamination Avoidance during Earth Containment**
Objective: Avoidance of harmful contamination of the Earth by release of one or more unsterilized particles of extraterrestrial material from V(r) missions during all mission phases on Earth. (2.C)

**Sample Safety Assessment**
Objective: Perform a complete sample safety assessment or accepted sterilization process on V(r) mission samples prior to release from containment. (2.D)

# Prevention of Backward Contamination

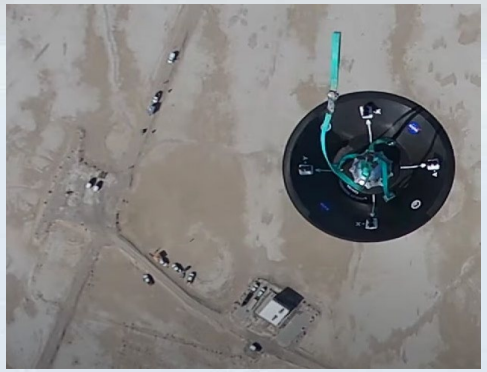


***Earth-Return Mission Categorization***

- Inbound categorization for Earth-return missions
  - Robotic restricted Earth-return V(r)
  - Unrestricted Earth-return V(u)
- Notional timeline for sample receiving facility (SRF) for V(r) missions.
- No further PP considerations for the return phase of V(u) missions

***Contamination Avoidance Prior to Earth Entry***

- **PP Requirements Document:**
  - Reports and reviews to support decision making process for Earth-return, Earth-entry, and sample release from containment
- **PP Implementation Plan:**
  - Approach to demonstrate avoidance of contamination of the Earth-Moon System
- Data and analyses used to demonstrate compliance with requirements prior to samples returning to Earth
- Containment facility readiness prior to samples returning to Earth



***Contamination Avoidance during Earth Containment***

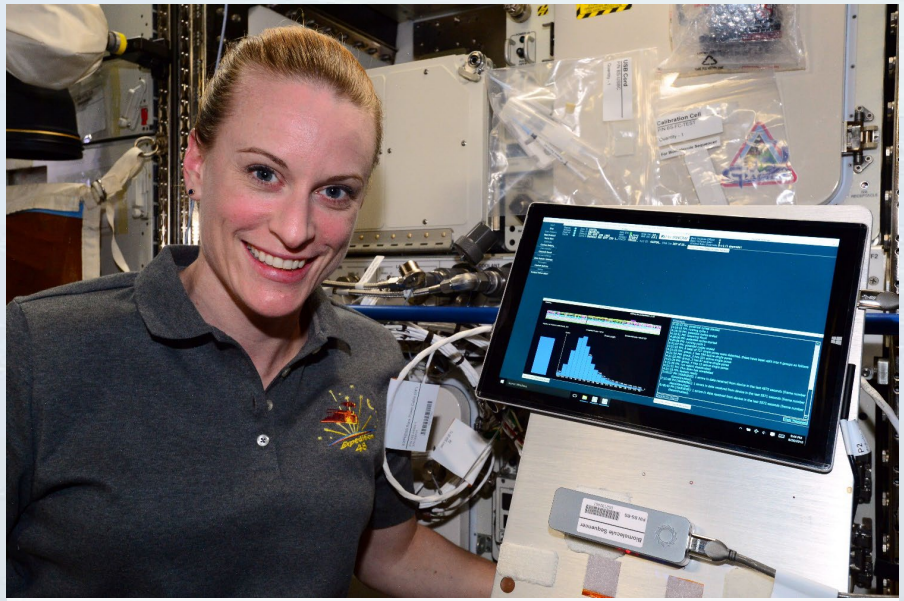
- Demonstrate avoidance of harmful contamination of the Earth by release of unsterilized extraterrestrial material:
  - At landing site
  - During transport
  - During storage, curation, and sample safety assessment activities

***Sample Safety Assessment***

- Sample sterilization to inactivate terrestrial bioactive molecules
- Strategies to avoid “false positives” and “false negatives” in life detection investigations or sample safety assessments
- **Sample Pre-Release Report:**
  - Approach to demonstrate avoidance of contamination of Earth
  - Feeds into the decision-making process for releasing samples out of containment

# NASA's Future Planetary Protection Policy Efforts

- Planetary Protection Handbook
  - *Will document additional background, guidelines, lessons learned and the "how to" processes to support mission developers*
  - *Updated with new methods such as membrane filtration for bioburden assays and metagenomics*
  - *Increased focus of Quality Assurance and Quality Control (QA/QC) processes*
- Planetary Protection for Crewed Missions
  - *Future NASA Procedural Requirements (NPR) document to address PP for crewed lunar and Mars missions*
    - *Will replace current interim directive (NID 8715.129)*
  - *NASA PP Standard currently addressing robotic and crewed missions with updates planned as knowledge gaps are closed*



***NASA Astronaut Kate Rubins sequenced DNA in space for the first time ever for the Biomolecule Sequencer investigation, using the MinION sequencing device.***

## Thank You!

NASA has and will continue to update its planetary protection policy and implementation approach in response to advances in scientific understanding of solar system targets, upcoming mission opportunities for exploration and sample return, and the private sector's emerging capability to plan missions to Earth's Moon and Mars.

# Abstract

NASA has updated its planetary protection policy and implementation approach in response to advances in scientific understanding of solar system targets, upcoming mission opportunities for exploration and sample return, and the private sector's emerging capability to plan missions to Earth's Moon and Mars. In September 2021, the NASA Procedural Requirements NPR 8715.24, entitled "Planetary Protection Provisions for Robotic Extraterrestrial Missions" was released which repositions planetary protection in existing NASA mission and program management structures, introduces risk-informed decision making, expands on key roles and responsibilities for both programmatic and the Office of Safety and Mission Assurance, updates the categorization process and streamlines the planetary protection documentation approval and schedule. NASA is working on a more detailed technical standard to accompany NPR 8715.24 which will include the detailed technical requirements to address organic contamination, inadvertent impact avoidance, biological control and management, end of mission disposal and restricted Earth-Return sample safety and assurance. This report to the COSPAR community will describe the current NASA planetary protection policy and its alignment with the revised COSPAR planetary protection policy. NASA's plans for updating the supporting "Handbook for Implementing Planetary Protection Technical Requirements" and future policies for addressing planetary protection of crewed missions will also be presented.