National Aeronautics and Space Administration

What You Need to Know about Planetary Protection Categorization for Your Mission

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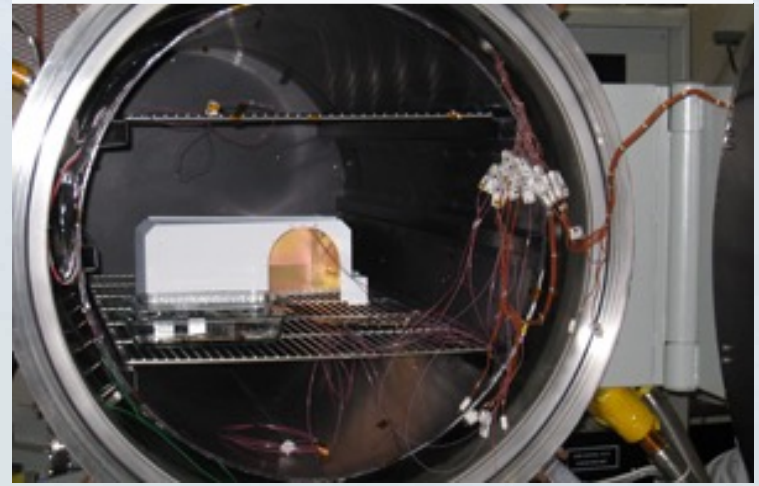
What is PP Mission Categorization and Why is it Needed?

- Not all solar system bodies to be explored have the same level of sensitivity to contamination.
- PP Categorization defines a mission's biological contamination risk in a process which considers the target body, target bodies encountered, hardware, and operations.
- Based on this contamination risk, a range of technical requirements are then implemented and documented to control risk to an acceptable level.
- Common PP practices include:
  - *cleanroom assembly,*
  - *hardware cleaning and bakeouts,*
  - *trajectory biasing,*
  - *inadvertent impact avoidance,*
  - *organic inventory documentation,*
  - *sample containment, etc.*

Hardware Cleaning & Sampling

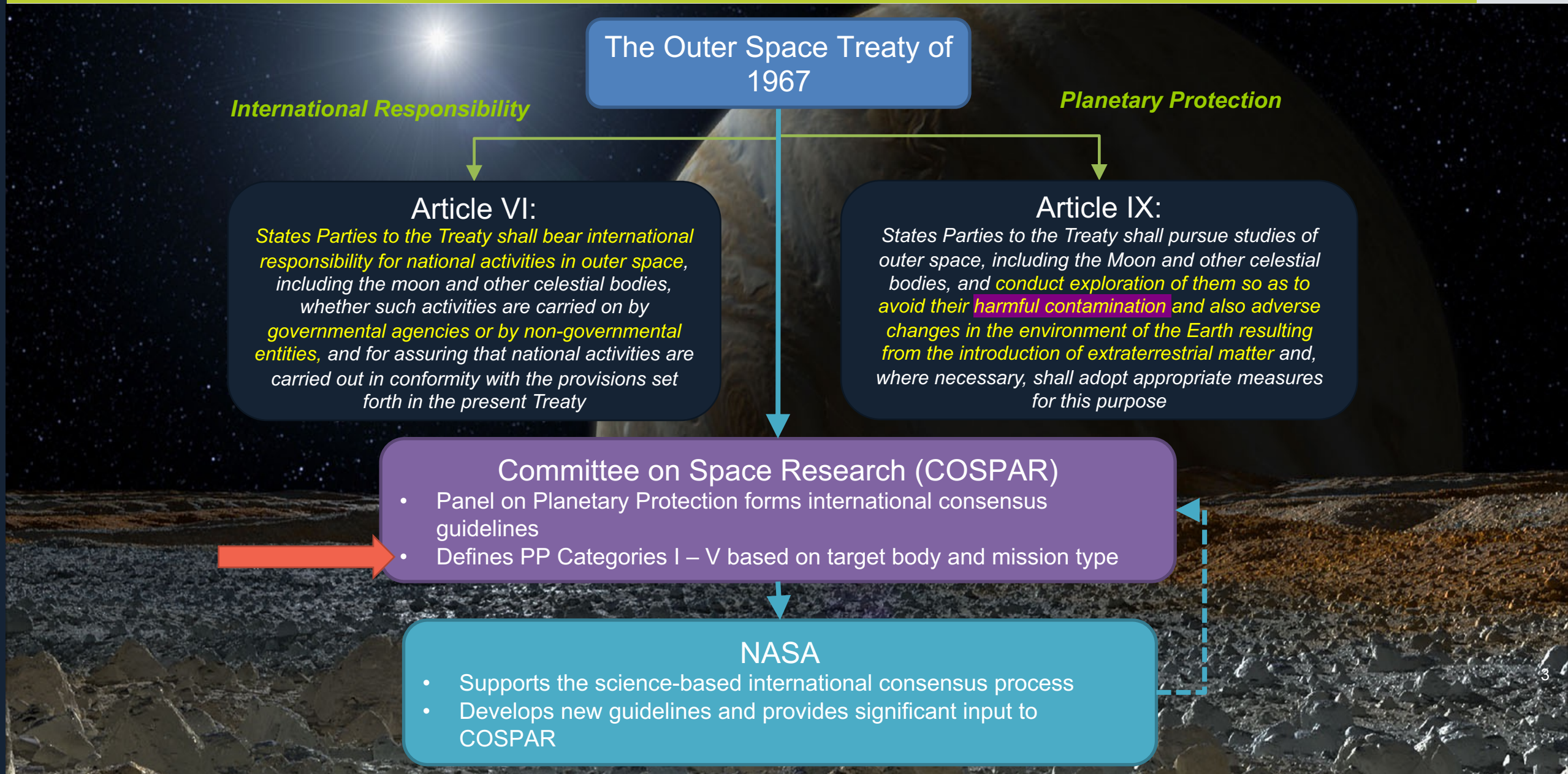
NASA/JPL-Caltech

Hardware Bakeout



NASA/JPL-Caltech

Where do the PP Categories come from?



NASA's Planetary Protection Policy Documents

NPD 8700.1F
Replaced NPD 8020.7G
NASA Policy for Safety and Mission Success
Effective Date July 28, 2022
Expiration Date: July 28, 2028

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

- PP Categories
- Roles involved in PP categorization

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
Effective Date: July 9, 2020
Expiration Date: September 30, 2024

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

- PP categorization requirements
- Biological contamination requirements
- Implementation requirements

NASA-STD-8719.27
Implementing Planetary Protection Requirements for Space Flight
Effective Date August 30,2022

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

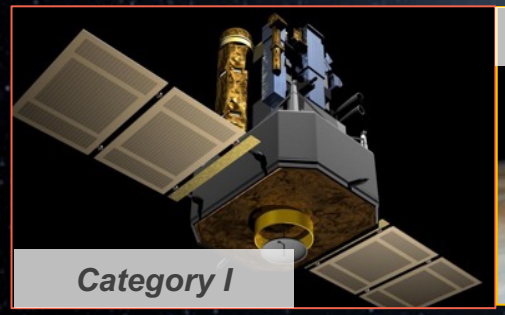
Link to NASA Planetary Protection policy and guidance documents at www.sma.nasa.gov

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

= Documents to be updated

Planetary Protection Mission Categories

COSPAR Panel on Planetary Protection



Category I

Missions to bodies that have no scientific interest for life or origins of life

Category II

Missions pose low risk to bodies of scientific interest *(Earth's Moon: IIa or IIb depending on lunar pole or permanently shadowed region access)*

Category III

Missions present serious risk of contamination to bodies of scientific interest (Flyby, Orbiter) *Mars, Europa, Enceladus*

Category IV

Missions present serious risk of contamination to bodies of scientific interest (Lander, Probe) *Mars, Europa, Enceladus (Mars: IVa, IVb, IVc depending on Special Region access and/or Life Detection)*

Category V

Sample return missions where the biological integrity of Earth itself is critical *Unrestricted V(u) or Restricted V(r)*

PP Categorization for Ongoing NASA Missions

- **Solar / Lagrange Point Missions**
  - *Solar Cruiser – Cat I*
  - *SunRISE – Cat I*
  - *Global Lyman-alpha Imagers of the Dynamic Exosphere (GLIDE) Category I*
  - *IMAP – Cat I (L1)*
  - *Solar Parker Solar Probe – Cat II (Venus flyby)*
- **Lunar Missions**
  - *ARTEMIS (THEMIS follow-on) – Cat II*
  - *Lunar Reconnaissance Orbiter – Cat II extended mission until 2025*
  - *CAPSTONE – Cat II (in partnership with NZ)*
  - *Artemis I – Cat IIa*
  - *Artemis I Secondary Payloads (ArgoMoon, BioSentinel, CubeSat for Solar Particles (CuSP), EQUULEUS, Lunar IceCube, Lunar Polar Hydrogen Mapper (LunaH-Map), LunIR, Near-Earth Asteroid Scout, OMOTENASHI, and Team MILES) – Cat II*
  - *Lunar Trailblazer – Cat II*
  - *Gateway – Cat II outbound, Cat I in NRHO operation, unrestricted Earth return*
  - *HLS – Category IIa or IIb depending on destination, with unrestricted Earth Return*
- **Mars Missions**
  - *Mars Odyssey - Cat.III orbiter in extended mission until 2025*
  - *Mars Reconnaissance Orbiter - Cat.III orbiter in extended mission until 2025*
  - *MAVEN - Cat.III orbiter in extended mission until 2025*
  - *Mars Science Laboratory/Curiosity Rover - Cat.IVa in extended mission until 2025*
  - *InSight - Cat.IVa lander*
- **Mars Missions (continued)**
  - *Mars 2020/Perseverance - Cat.IVb (subsystem sterilization) mission, w/ restricted Mars sample return*
  - *MMX – P-Sampler – Cat III, unrestricted Earth return (in partnership with JAXA)*
  - *The Escape and Plasma Acceleration and Dynamics Explorers (EscaPADE), Category III*
  - *Mars Sample Return Campaign –*
    - *Earth Return Orbiter Cat III (in partnership with ESA),*
    - *Sample Return Lander Cat IVb with Cat V(r) restricted Earth Return*
- **Asteroid Missions**
  - *OSIRIS-Rex – Cat II with Cat V(u) unrestricted sample return (2023) in extended mission until 2031 (OSIRIS –APEX [APophis EXplorer])*
  - *Lucy – Cat II*
  - *DART – Cat II*
  - *Psyche – Cat III (Mars flyby)*
  - *JANUS – Cat II*
- **Jovian Missions**
  - *JUNO – Cat III (recategorized from Cat II due to Europa, Ganymede, Io flyby)*
  - *Europa Clipper – Cat III*
- **Saturian Missions**
  - *Dragonfly – Cat II*
- **Other**
  - *New Horizons – Cat II (Pluto system)*

(Missions not yet launched)

Several Factors Need to be Considered for PP Categorization

1. What is the target body?

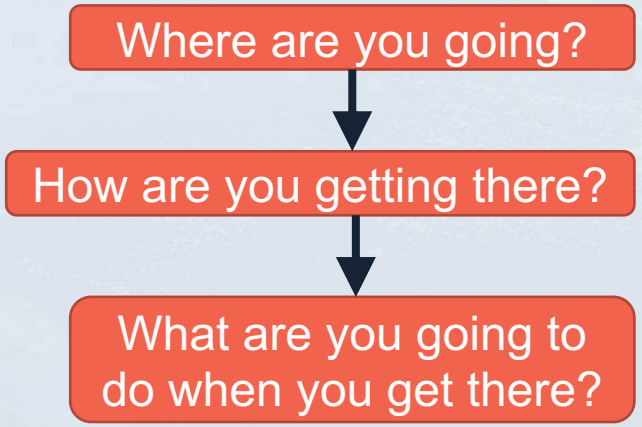
2. What are the main characteristics of the trajectory, including flybys?

3. What is the mission architecture at the target body (i.e., orbiting, landing, relocating, etc.)

4. What is the instrument payload? Are secondary or auxiliary payloads included?

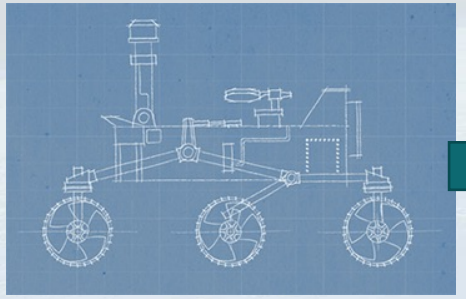
5. What is the end-of-mission plan for hardware, such as shutdown in place or transfer to new location? Include additional locations that could result from an unsuccessful disposal maneuver or relocation by natural processes such as wind and seasonal thawing.

- Interaction with the **most sensitive solar system body** for any of these factors **drives categorization.**
  - *Example: A mission targeting an asteroid (Category I target) will perform a flyby of Mars (Category III). The mission will be designated as a PP Category III mission due to the Mars flyby.*



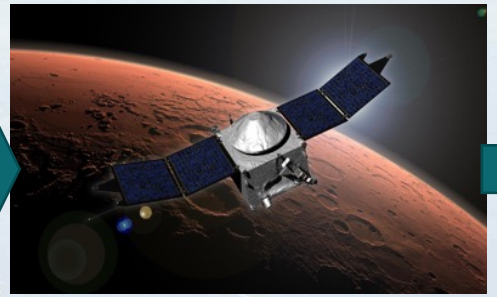
Forward & Backward Planetary Protection Applied to Missions

Control of Forward Contamination to Solar System Bodies (Categories I – IV)

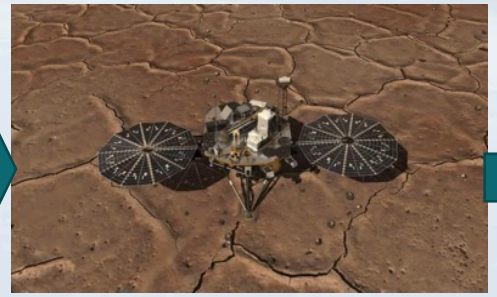


Mission Design & Categorization

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



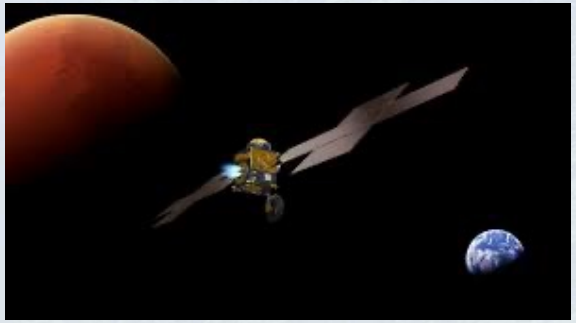
Avoiding Contamination following Inadvertent Impact



Avoiding Contamination for Robotic Landed Missions

End of Mission Disposition

Prevention of Backward Contamination to the Earth-Moon System (Category V)

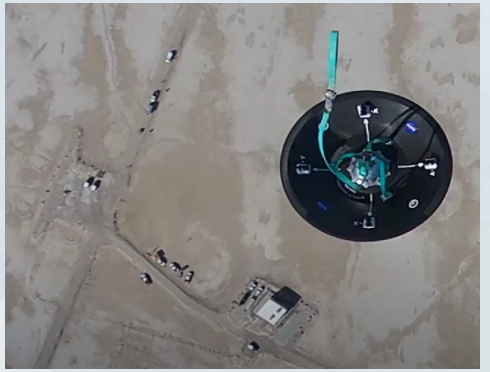


Earth-Return Mission Categorization

Category V(u) & V(r)

Contamination Avoidance Prior to Earth Entry

Category V(r)



Contamination Avoidance during Earth Containment

Category V(r)

Sample Safety Assessment

Category V(r)

Documentation Concurrence Authority

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						

Level of documentation detail depends on mission complexity and contamination risk.

Who is Involved in the PP Mission Categorization Process? *(NPR 8715.24)*

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 of missions requiring planetary protection mission categorization
- Assures formulation and execution of implementation is sound
- Facilitates independent verification

PPO Categorization Letter

Closing Thoughts & Resources

- Categories can change or be updated through the international science community and COSPAR.
  - *Example: COSPAR introduced Categories IIa and IIb for Earth's moon in 2021 to relax reporting requirements for the majority of missions to the lunar surface.*
- OPP has resources available to support missions.
  - *Policies, technical standard, upcoming revised PP Handbook, NASA SATERN course*
- **Feel free to reach out to OPP for any questions/clarification.**
  - *Seriously, this can get confusing. We're here to help.*

COSPAR updates its Planetary Protection Policy for missions to the Moon's surface

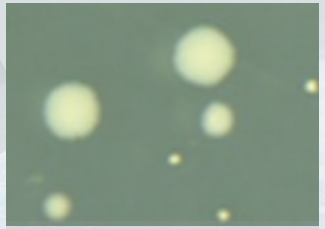
15 July 2021

PLANETARY PROTECTION OVERVIEW
(COURSE SMA-STL-WBT-300)

Course available now in SATERN

Resources Available Through The OPP Website

Articles

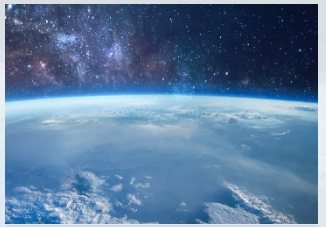


What Are Spores?

How to Build a Clean Spacecraft

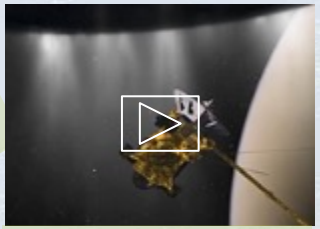
Cleanroom Gowning or How to Dress in the Cleanroom

Ground Support Equipment

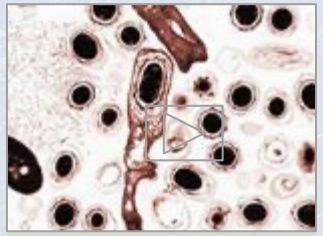


Protecting the Planet: Planetary Protection vs. Planetary Defense

Videos



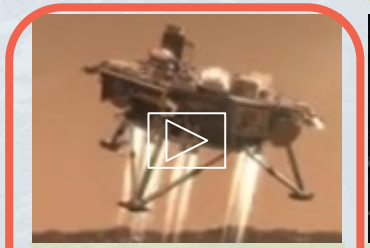
Planetary Protection: An Introduction



Just How Small is a Spore?

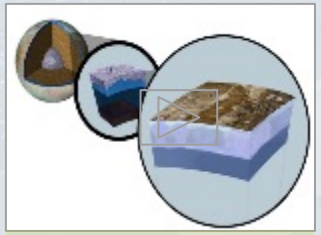
Forward and Backward PP Overview

Behind the Spacecraft Perseverance

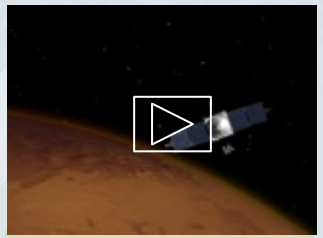


Mission Design and PP Categorization

Probability of Impact



Ocean Worlds



End of Mission Disposition

https://sma.nasa.gov/sma-disciplines/planetary-protection/explore