Planetary Protection is Not a One Size Fits All Missions Approach: Enabling the Planetary Protection Programmatic and Engineering Process

NASA Contamination, Coatings, Materials, and Planetary Protection Workshop

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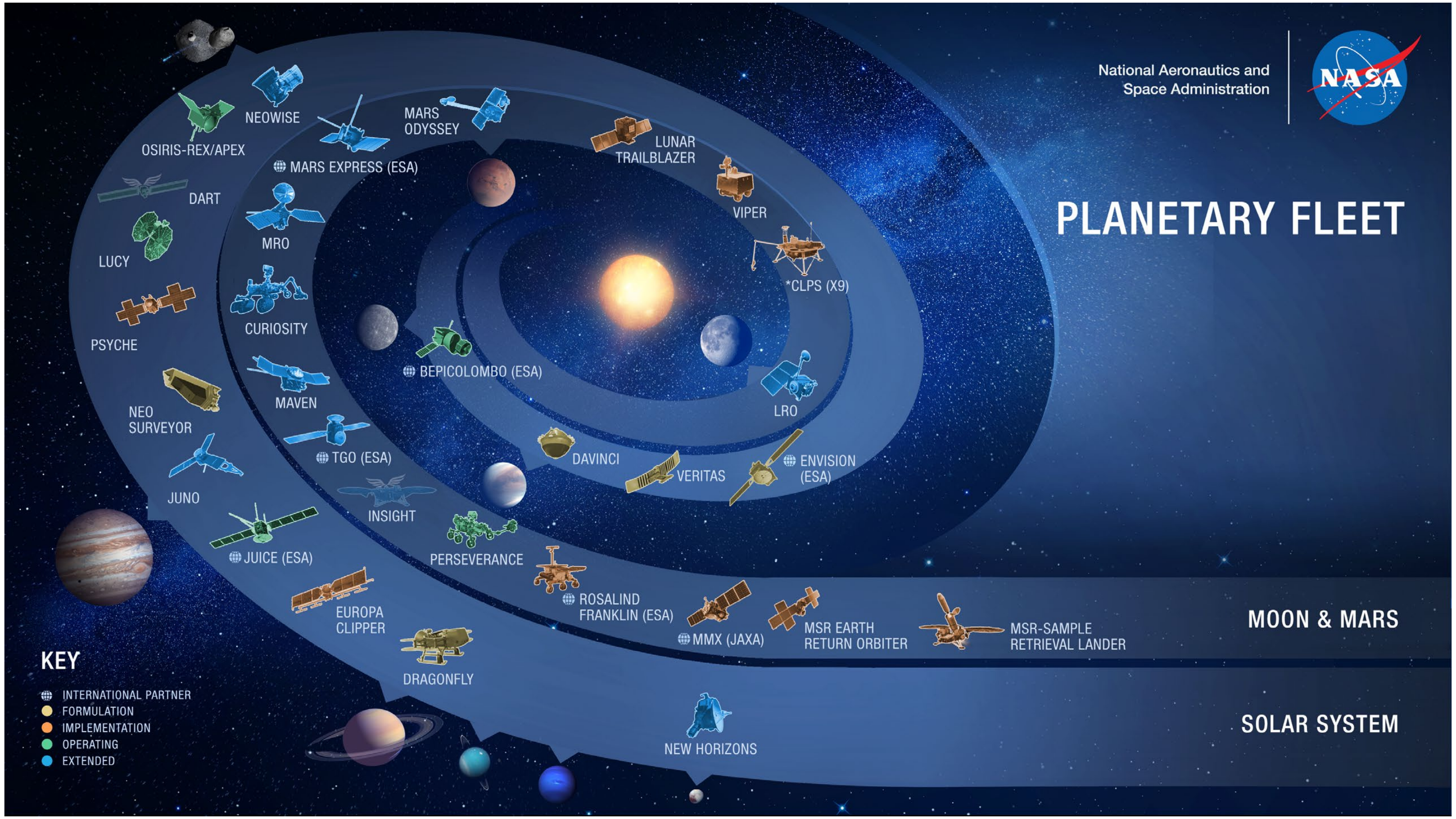
Increased Demand for Planetary Protection Based on Agency Priorities

- Crewed Moon to Mars
- Mars Sample Return
- Outer planets?



Planetary protection policy at NASA allows us to be adapted to enable missions and evolve with design, implementation and operational needs while meeting our international obligations.

Updates to 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

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: Sept 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

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

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

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

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

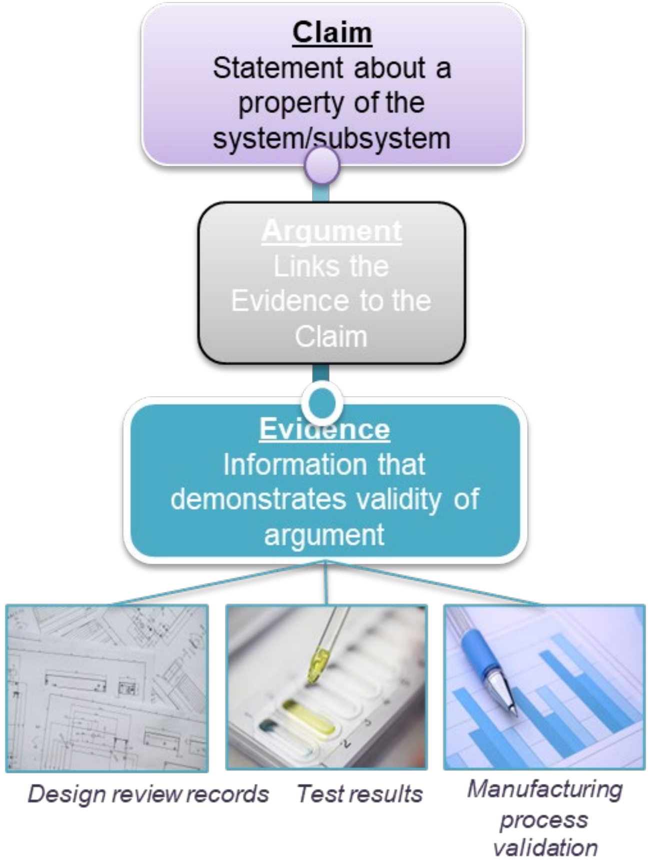
NASA Handbooks
- Companion documents to NPRs and NASA Standards
- Provide supporting material such as guidelines, lessons learned, procedures, and recommendations

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

= Documents to be updated

Performance or Prescriptive Approaches

- Allows for risk informed decision making (opposed to risk-based decision making).
- Develop an assurance case to demonstrate compliance.
- Relatively new approach for NASA but leveraging industry and US interagency established approaches
- **Some of the examples from projects to-date**
  - Implementing the mission to a target level of cleanliness
  - Developing implementation and mitigation strategies around a targeted assurance level



Project can propose performance or prescriptive approaches to requirements.

Programmatic Flexibility for Gate Products and Reviews

NPR 8715.24, "*The actual schedule for delivery of these document is negotiable and is established in the PP requirements document*…Alternative document schedules"

- **Some of the examples from projects to-date**
  - Combined requirements and implementation document
  - Combined post-launch and end of mission reports
  - Additional operational reports to confirm success of flyby or orbital insertion of Mars and Europa
  - Separated primary mission versus secondary payload documentation
  - Combined secondary payload reporting
  - Informal implementation planning reviews
  - Participation as observers during table-top and programmatic PP PDR and CDRs
  - End of mission reporting on mission elements already completed
  - Streamlined reports – brevity! Some reports now 2 pages.

Table 3-2. Planetary Protection Document Schedule

Planetary Protection Documentation	Nominal Document Schedule[1, 2, 3, 4]							
	MCR	SRR	MDR	PDR	CDR	SMSR	PLAR	EOM
PP Mission Categorization[5]	Preliminary	Final						
PP Requirements[6]	Preliminary	Baseline						
PP Implementation Plan			Preliminary	Baseline	Update			
Pre-Launch PP Report						Final Report		
Post-Launch PP Report							Final Report	
Extended Mission PP Report								Prior to extended mission approval
End of Mission PP Report								Final Report

Flexibility in tailored project schedule and gate products – streamline and brevity where it makes sense!

Expansion to Leverage International Consensus Standards

- Let’s not reinvent the wheel!
- Application of best available science and scientific consensus
- Leveraging consensus standards for implementation – over >30 identified in NASA-STD-8719.27!
- **Some of the examples from projects to-date**
  - ISO 14644-5:2004 – cleanroom operations
  - ECSS, multiple – microbiological assay, dry heat microbial reduction, vapor hydrogen peroxide
  - Standard Methods for the Examination of Water and Wastewater, 2018, 9022 QA/QC – laboratory setup and best practices

NASA / ESA Derived Dry Heat Microbial Reduction D-Values as per ECSS-Q-ST-70-57C; 30 Aug 2013

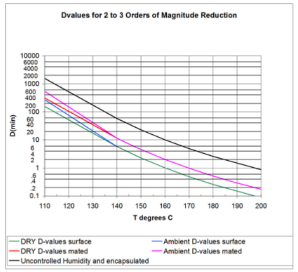


Figure D-1: D-values for 2 to 3 orders of magnitude reduction

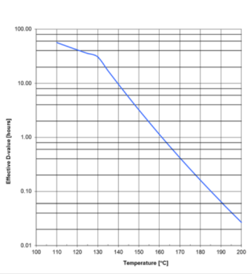
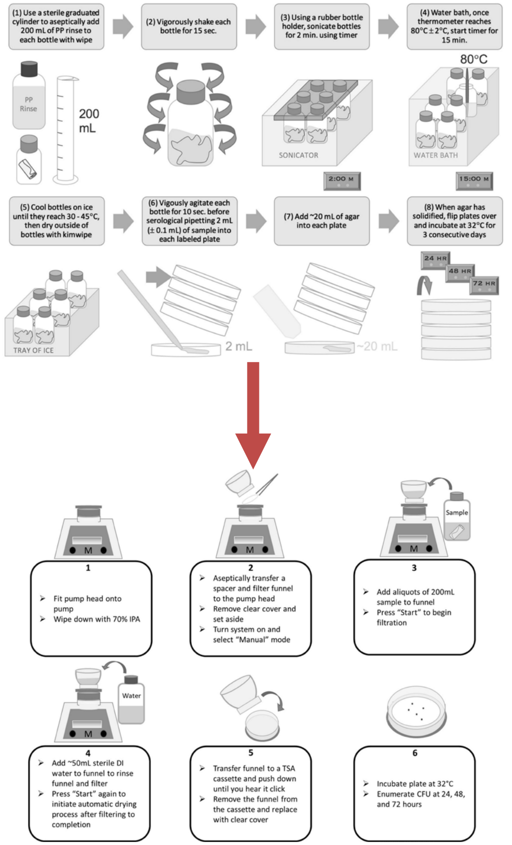


Figure E-1: Effective D-values for 4 to 6 orders of magnitude surface reduction

Don’t reinvent the wheel if it has form, fit and function for your specific project and use case!

Alternative Approaches

- Alternative approaches that align with scientific consensus should be proposed by the project.
- Project should evaluate and proposal project specific use case. As needed, this may require additional comparative analyses, test plan verification and validation to demonstrate fit and form, acceptance testing, etc.
- **Some of the examples from projects to-date**
  - Membrane filtration
  - Inadvertent contamination of Mars or Moon
    - Do what is needed for your project!
      - Statistically intense mission design approach involving launch dispersions, 100,000 monte carlo runs, b-plane keyhole analysis, etc.
      - Not in the neighborhood and don't have the energy capable of getting us there.



Pour plating vs. membrane filtration from Stott *et. al* 2022.

Welcome scientifically sound alternatives approaches to PP!

Summary

- NASA PP codifies and expands approaches for missions to enable mission unique solutions.
  - Flexibility for gate products and reviews aligning with project schedule and content
  - Ability to leverage international consensus standard to implement PP
  - Option to adopt alternative approaches that are scientifically sound
- Mission specific questions? Don’t rack your head too much. Feel free to reach out!

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

Thank You!

Questions?

Abstract

Missions have a wide range of variables that change their management and engineering structure (*e.g.,* competed vs directed missions, multiple NASA centers, international partnerships, increased commercial collaborations, etc.). Why would an identical planetary protection approach and structure for each mission make sense in this evolving landscape? Missions do not fit in a one-size-fits-all approach, likewise their planetary protection process should not be a one-size-fits-all approach. During the significant update to NPR 8715.24 and NASA-STD-8719.27 planetary protection policies, the programmatic execution and engineering implementation processes were changed to provide clarification, streamlining, and expansion to include alternative approaches. From a programmatic perspective, these changes include the flexibility in timing and combination of gate products in addition to providing varying levels of technical depth commensurate and appropriate with the mission categorization. From a technical perspective, these changes include the ability to A) leverage either a performance-based and/or a prescriptive-based approach, B) identify applicable international consensus standards for verification, and C) propose alternative methods that adhere to sound scientific and engineering consensus. This presentation will directly highlight the culture shift in planetary protection, areas of flexibility available to the technical community for mission program and engineering execution, and feature some of the specific mission scenarios that have already leveraged such processes.