National Aeronautics and Space Administration

NASA Office of Planetary Protection Update and Status

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NASEM CoPP, Space Week 2025

April 2, 2025

Overview

- Policy Status
- Priority Mars Architecture Key Decisions
- Mission Update
- Directed Technology and Research Developments

Policy Status

OPP Document Tree

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

NPD 8700.1F
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
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, 2025

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 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-20240016475
NASA Planetary Protection Handbook
Effective Date: January 24, 2025

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

NEW!!

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

= Document being updated

NASA NID 8715.129 Conversion Strategy Update

- NID 8715.129 (“Mars NID”) Biological Planetary Protection for Human Missions to Mars
  - *Effective Date: July 9, 2020*
  - *Expiration Date: Sept 30, 2025*
- Working now with internal stakeholders to develop a path forward:
  - *Finalizing survey to NASA Centers and stakeholders* **Completed; March 2025**
  - *Next steps*
    - *Evaluate survey comments and develop plan* ← **In Progress; March – May**
    - *Establish working group of internal stakeholders*
- Solution space includes – canceling existing NID, folding key objectives into NPR 8715.24 (2026 expiration), critical design considerations into the NASA Human Rating Standard and capturing guidance and assumptions in Moon to Mars Architecture Concept Review White Papers.

Crewed Mars Policy Planetary Protection Background

NASA Conference Publication 10086

Planetary Protection Issues and Future Mars Missions

Edited by D. L. DeVincenzi, Ames Research Center, Moffett Field, California; H. P. Klein, Santa Clara University, Santa Clara, California; J. R. Bagby, Missouri State Dept. of Health, Jefferson City, Missouri

Proceedings of a workshop held at NASA Ames Research Center, Moffett Field, California, March 7-9, 1990

NASA/CP—2005-213461

Planetary Protection Issues in the Human Exploration of Mars

Final Report May 9, 2005

Editors: M. E. Criswell, M. S. Race, J. D. Rummel, A. Baker

NASA/TM—2006-213485

Life Support and Habitation and Planetary Protection Workshop

Final Report

An Analysis of the Precursor Measurements of Mars Needed to Reduce the Risk of the First Human Mission to Mars

David W. Beaty (Mars Program Office-JPL/Caltech), Kelly Snook (JSC/NASA HQ), Carlton Allen (JSC), Dean Eppler (SAIC), Bill Farrell (GSFC), Jennifer Heldmann (ARC), Phil Metzger (KSC), Lewis Peach (USRA), Sandy Wagner (JSC), and Cary Zeitlin (Lawrence Berkeley), on behalf of the Mars Human Precursor Science Steering Group (MHP SSG)

June 2, 2005

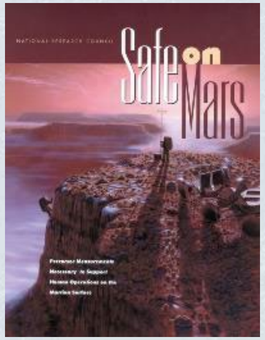
COSPAR PLANETARY PROTECTION POLICY

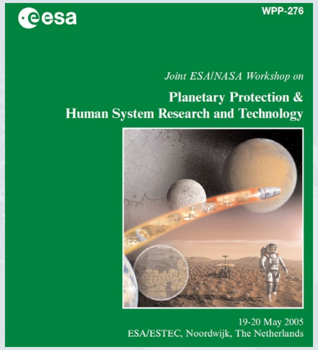
(20 October 2002; As Amended to 24 March 2011)

APPROVED BY THE BUREAU AND COUNCIL, WORLD SPACE COUNCIL, HOUSTON, TEXAS, USA

(Prepared by the COSPAR/IAU Workshop on Planetary Protection, 4/02, with updates 10/02; 1/08, 4/09, 12/09, 3/11)

1990 — 1992 — 2001 — 2002 — 2005 — 2008 — 2011





ScienceDirect — Advances in Space Research

Planetary protection and humans on Mars: NASA/ESA workshop results

Margaret S. Race, Gerhard Kminek, John D. Rummel, Participants of the NASA/ESA planetary protection Workshop

*Workshop reports captured based on date of workshop NOT publication date

COSPAR Policy Trace Crew to Mars – 2005 to Present

NASA/TM—2006-213485

Life Support and Habitation and Planetary Protection Workshop
Final Report

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Prepared for the Life Support and Habitation and Planetary Protection Workshop
Held at the Center for Advanced Space Studies
Houston, Texas, April 27-29, 2005
Sponsored by NASA Headquarters

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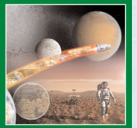
esa WPP-276

Joint ESA/NASA Workshop on
Planetary Protection & Human System Research and Technology



19-20 May 2005
ESA/ESTEC, Noordwijk, The Netherlands

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ADVANCES IN SPACE RESEARCH (a COSPAR publication)
www.elsevier.com/locate/asr

Planetary protection and humans on Mars: NASA/ESA workshop results

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Received 7 June 2007; received in revised form 28 February 2008; accepted 6 March 2008

COSPAR PLANETARY PROTECTION POLICY

(20 October 2002; As Amended to 24 March 2011)

APPROVED BY THE BUREAU AND COUNCIL, WORLD SPACE COUNCIL, HOUSTON, TEXAS, USA
(Prepared by the COSPAR/IAU Workshop on Planetary Protection, 4/02, with updates 10/02; 1/08, 4/09, 12/09, 3/11)

Policy text derived NASA 2005 consensus points into NASA/ESA Workshop 2005. Published as a peer-reviewed paper captured in Race et. al 2008

Policy draft accepted by COSPAR in March 2011

COSPAR BUSINESS

Editorial to the New Restructured and Edited COSPAR Policy on Planetary Protection

The COSPAR Panel on Planetary Protection established a subcommittee in 2023 to propose a new version of the COSPAR Policy on Planetary Protection. Upon endorsement of the new version of the Policy by Panel members on 1 March 2024, the text was submitted to the COSPAR Bureau for validation and was approved by the Bureau on 20 March 2024. Below follows a brief explanation to the new version of the Policy, which is published hereafter in the *Space Research Today* journal.

4.6 Crewed Missions to Mars

The intent of planetary protection is the same whether a mission to Mars is conducted robotically or with human explorers. Accordingly, planetary protection goals should not be relaxed to accommodate a human mission to Mars. Rather, they become even more directly relevant to such missions - even if specific implementation guidelines should differ [Ref. Spry et al. 2024]. General principles include:

- Safeguarding the Earth from potential back contamination is the highest planetary protection priority in Mars exploration.
- The greater capability of human explorers can contribute to the astrobiological exploration of Mars only if human associated contamination is controlled and understood.
- For a landed mission conducting surface operations, it will not be possible for all human-associated processes and mission operations to be conducted within entirely closed systems.
- Crewmembers exploring Mars, or their support systems, will inevitably be exposed to Martian materials.

Space Research Today N° 220 July 2024 18

6.6 Crewed Mars Missions

Implementation guidelines for human missions to Mars include:

- Human missions will carry microbial populations that will vary in both kind and quantity, and it will not be practicable to specify all aspects of an allowable microbial population or potential contaminants at launch. Once any baseline conditions for launch are established and met, continued monitoring and evaluation of microbes carried by human missions will be required to address both forward and backward contamination concerns.
- A quarantine capability for both the entire crew and for individual crewmembers should be provided during and after the mission, in case potential contact with a Martian life-form occurs.
- A comprehensive planetary protection protocol for human missions should be developed that encompasses both forward and backward contamination concerns and addresses the combined human and robotic aspects of the mission, including subsurface exploration, sample handling, and the return of the samples and crew to Earth.
- Neither robotic systems nor human activities should contaminate "Special Regions" on Mars, as defined by this COSPAR PP Policy.
- Any uncharacterized Martian site should be evaluated by robotic precursors prior to crew access. Information may be obtained by either precursor robotic missions or a robotic component on a human mission.
- Any pristine samples or sampling components from any uncharacterized sites or Special Regions on Mars should be treated according to current planetary protection Category V, restricted Earth return, with the proper handling and testing protocols.
- An onboard crewmember should be given primary responsibility for the implementation of planetary protection provisions affecting the crew during the mission.
- Planetary protection guidelines for initial human missions should be based on a conservative approach consistent with a lack of knowledge of Martian environments and possible life, as well as the performance of human support systems in those environments. Planetary protection guidelines for later missions should not be relaxed without scientific review, justification, and consensus.

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SAME text kept during administrative policy update 2024

COSPAR 4.6 – Crewed Missions to Mars

ADDED - Updated Reference

4.6 Crewed Missions to Mars

The intent of planetary protection is the same whether a mission to Mars is conducted robotically or with human explorers. Accordingly, planetary protection goals should not be relaxed to accommodate a human mission to Mars. Rather, they become even more directly relevant to such missions - even if specific implementation guidelines should differ [Ref. Spry et al. 2024]. General principles include:

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*

Space Research Today N° 220 July 2024 18

Exact Language

§1.1 Overview
"workshop starting assumptions"

M.S. Race et al. / Advances in Space Research 42 (2008) 1128–1138 1129

monitoring and control systems). In order to initiate communication, understanding and working relations between the ALS, EVA, and planetary protection communities in NASA and ESA, a special workshop "The Mars Planetary Protection and Human Systems Research and Technology Joint NASA/ESA workshop" was held May 19–20, 2005 at the European Space Research and Technology Centre (ESTEC), Noordwijk, Netherlands to focus on mission-specific planetary protection issues during future human missions to Mars. The top-level workshop goal was to determine how planetary protection requirements will be implemented during human missions, and what standards of contamination control will apply to human explorers.

Deliberations at the workshop built upon the findings of a number of earlier reports and studies on planetary protection and human missions (Criswell et al., 2005; Hogan et al., 2006; Beaty et al., 2005). Two important principles guided the workshop deliberations: (1) planetary protection requirements will not be relaxed solely in order to accommodate human missions,[2] given that one major advantage of a human presence on Mars is to aid in the scientific search for evidence of life, and (2) the Mars robotic precursor program will attempt to determine the presence or absence of human-affective biohazards on the Martian surface. This determination is required to establish what the US National Research Council referred to as "Zones of Minimal Biological Risk" in their 'Safe on Mars' report (NRC, 2002).[3] Workshop discussion also built on the following set of starting assumptions:

- Safeguarding the Earth from potential backward contamination is the highest planetary protection priority in Mars exploration.
- The greater capabilities of human explorers can contribute to the astrobiological exploration of Mars only if human-associated contamination is controlled and understood.
- It will not be possible for all human-associated processes and mission operations to be conducted within entirely closed systems.
- Crewmembers exploring Mars will inevitably be exposed to Martian materials.

The specific overall goals and objectives of the workshop aimed to:

- Initiate communication, understanding and a working relationship between the ALS, EVA, and planetary protection communities in NASA and ESA.
- Identify knowledge necessary to establish planetary protection requirements with respect to ALS and EVA systems, including the identification of potential contaminants, contamination pathways, and potential off-nominal events typical of such systems.
- Explore operations and technology issues concerning the potential disruption of an extraterrestrial ecology via EVA and/or ALS operations, including interplanetary and planetary surface waste disposal, etc.
- Explore the requirements posed by the astrobiological/geological exploration of Mars, and examine how EVA and ALS systems may affect them.
- Examine how ALS and EVA systems interact with backward-contamination prevention requirements to protect both the human habitat on Mars and the Earth upon crew return.
- Identify future research needs for ALS, EVA, and Mars robotic-missions, and define precursor mission requirements to understand and prepare for human support systems for a Mars mission.

1.2. Workshop format, subgroups and tasks

The workshop participants included 39 individuals selected for their combined expertise and experiences in areas relevant to ALS, EVA, Operations, and planetary protection.[4] The workshop began with a series of tutorial presentations providing overview information on planetary protection and the detailed findings of two previous planetary protection workshops focused on human missions (Hogan et al., 2006; Criswell et al., 2005). Subsequently, participants were assigned to one of three independent subgroups: (1) Extravehicular Activities (EVA), (2) Advanced Life Support (ALS), and (3) Operations and Support (Ops), each with an overall charge of determining how planetary protection requirements will be implemented during human missions to Mars (contrasting initial human missions versus later human missions, if appropriate) and understanding the impact of planetary protection requirements on the design of various human support systems. Each subgroup was asked to debate the following four broad questions during their deliberations:

1. What is the overall approach to contamination control, including: Forward & backward contamination levels in different areas (e.g., zones of contamination control), and Quarantine requirements (for crew and samples)?
2. What is the approach to waste & consumables management, focusing on: Different mission phases; (e.g., transit, planetary surface) and Different types of wastes & consumables, and their levels of contaminants and dispersion properties?
3. What are the off-nominal events that could potentially lead to contamination of Mars or the terrestrial bio-

[2] It is assumed that any changes in planetary protection policy will be supported by appropriate science findings and justification, rather than made to accommodate human missions *per se*.

[3] Zones of minimum biological risk are *not* the same as the COSPAR "special regions."

[4] A list of participants and their affiliations is provided in the Acknowledgement section at the end of the paper.

***Wording verbatim to workshop report**

COSPAR 6.6 Crewed Mars Missions sans quarantine

6.6 Crewed Mars Missions

Implementation guidelines for human missions to Mars include:

^ • Human missions will carry microbial populations that will vary in both kind and quantity, and it will not be practicable to specify all aspects of an allowable microbial population or potential contaminants at launch. Once any baseline conditions for launch are established and met, continued monitoring and evaluation of microbes carried by human missions will be required to address both forward and backward contamination concerns.

• A quarantine capability for both the entire crew and for individual crewmembers should be provided during and after the mission, in case potential contact with a Martian life-form occurs.

* • A comprehensive planetary protection protocol for human missions should be developed that encompasses both forward and backward contamination concerns and addresses the combined human and robotic aspects of the mission, including subsurface exploration, sample handling, and the return of the samples and crew to Earth.

* • Neither robotic systems nor human activities should contaminate "Special Regions" on Mars, as defined by this COSPAR PP Policy.

* • Any uncharacterized Martian site should be evaluated by robotic precursors prior to crew access. Information may be obtained by either precursor robotic missions or a robotic component on a human mission.

* • Any pristine samples or sampling components from any uncharacterized sites or Special Regions on Mars should be treated according to current planetary protection Category V, restricted Earth return, with the proper handling and testing protocols.

* • An onboard crewmember should be given primary responsibility for the implementation of planetary protection provisions affecting the crew during the mission.

* • Planetary protection guidelines for initial human missions should be based on a conservative approach consistent with a lack of knowledge of Martian environments and possible life, as well as the performance of human support systems in those environments. Planetary protection guidelines for later missions should not be relaxed without scientific review, justification, and consensus.

§3.1 Policy #2
Rephrased - *"working conclusion"*

§3.1 Policy #4
"working conclusion"

§3.2 Special regions #3
"working conclusion"

§3.3 Operations and crew #1
"working conclusion"

§3.3 Operations and crew #2
"working conclusion"

§3.3 Operations and crew #3
"working conclusion"

§3.1 Policy #3
"working conclusion"

associated with a human landing, and the plausible limits of zones of non-contamination that can be preserved nearby.

- Define the spatial dispersion of dust and human-associated contaminants on Mars by wind and other means.
- Determine the survivability of Earth organisms and their component molecules in the ambient Mars environment, and in the conditions of the martian near-subsurface.
- Examine future ALS designs and concepts with respect to planetary protection needs, especially with respect to organic and microbial contamination, to assess the potential effects of human activities in pressurized habitats and human-carrying rovers.
- Examine future EVA designs (thermal control, gas control, material leakage) with respect to planetary protection needs, especially with respect to organic and microbial contamination, to assess the potential effects of human activities on the martian surface away from pressurized habitats and human-carrying rovers.
- Develop EMC technology required for life detection and potential pathogen detection within the habitat or EVA system, with a focus on sensitivity and specificity of tests needed to identify potential microbes of unknown origin.
- Develop field-deployable systems to monitor human-associated biological contamination released into the martian environment (autonomous/automatic, rapid, reusable, and/or low-consumable recharge).
- Determine how to conduct human-associated robotic operations on Mars to be consistent with planetary protection concerns, both for those robotic resources deployed independently during precursor missions and for those deployed in conjunction with human landings.
- Define and develop planetary protection protocols for use on human missions. Develop and test methodologies for implementation of those protocols using Earth-based simulations (laboratory and field), lunar experience, and an improving knowledge of the martian environment based on precursor missions. Define and implement a training plan for the crew and other personnel involved with the mission.
- Ensure that human factors research and design for human Mars missions will address biosafety considerations associated with planetary protection.
- Provide robust and field-deployable systems to securely contain materials (wastes, propellants, etc.; for TBD durations) that may contaminate the martian environment.
- Provide for containment of Mars samples within human-occupied spaces, and for those returned to Earth.
- Develop mitigation techniques to deal with human-associated contaminants released on Mars, and with contamination of human-occupied spaces by martian materials.

3. Overall workshop conclusions

The workshop format provided ample time for plenary presentation and discussion of the various subgroup findings, which in turn led to the following overall workshop conclusions related to planetary protection, which are intended to focus on the broad conceptual approaches and issues, rather than implementation details. The list below reflects what was covered by the various sub-groups, although it is recognized that many other issues related to planetary protection will also need attention before human missions are feasible (e.g., emergency crew transfers, crew return requirements, quarantine details, breaking the chain of contact with Mars prior to Earth entry, microbial identification for habitat and suits, etc.). Overall conclusions by specific areas indicated below:

3.1. Policy

- It does not make sense to have separate planetary protection policies for human and robotic mission. The reasons for protecting Mars and Earth are independent of mission implementation.
- Planetary protection requirements imposed 'at launch' (as done for robotic missions) are not entirely sufficient for human missions. Evaluation of the biological contamination on the spacecraft will be mandatory throughout the mission because of its potential for both forward and backward contamination.
- Planetary protection requirements for early human missions should be based on a conservative approach consistent with our continuing uncertainties about martian life. Planetary protection requirements for later missions should not be relaxed without scientific review, justification, and concurrence.
- There will be a need to develop a comprehensive planetary protection protocol for human missions that encompasses considerations of forward and backward contamination for both robotic and human aspects of the mission, and includes associated sample handling and science activities on both Mars and Earth (similar to the comprehensive protocol developed for robotic sample return missions; e.g., Rummel et al., 2002).

3.2. Special regions

- For outbound spacecraft on human missions, prelaunch cleanroom assembly will be required of all systems regardless of planned landing site.
- For those systems that will land in or be deployed in 'special regions,' appropriate quantitative bioburden reduction requirements will apply.
- Neither robotic systems nor human activities shall contaminate 'special regions' as defined by COSPAR policy.
- Special Regions should be further considered in relation to the potential for local vs. global distribution of biological contamination.

3.3. Operations and crew

- Any uncharacterized martian site must be evaluated by robotic precursors prior to crew access. Information may be obtained by either precursor robotic missions or a robotic component on a human mission.
- Any pristine samples or sampling components from any uncharacterized sites on Mars shall be treated according to current planetary protection Category V, with restricted Earth return and appropriate handling and testing protocols.
- An onboard crewmember should be given primary responsibility for implementation of planetary protection provisions affecting the crew during the mission.
- Human factors (psychological, physiological or other possible impairments) need to be considered along with planetary protection issues for human missions.
- Crew protection and backward contamination requirements may influence ISRU operations. Of particular concerns will be those activities that may create resources or materials that can be transported into the habitat and can be inhaled or consumed by the crew.
- Survival of spacecraft associated terrestrial organisms and their molecular components in the ambient Martian environment
- Near and far-field contamination transport models
- Quantitiative & qualitative life support system process streams (air, water, wastes, etc.) for crew rated systems (e.g., habitat, EVA, suits etc)
- The impact of planetary protection requirements on various types of ISRU operations & systems.

In addition, there is need to develop the following:

- Real-time monitoring system(s) for potential 'unknown' biology within pressurized volume (e.g., spacecraft crew compartments, habitats, suits, etc.)
- Sterilization and decontamination capabilities for generated wastes, spacecraft volumes (habitat, EVA, suits etc.) and associated equipment and samples
- Containment capabilities for generated wastes, spacecraft volumes, associated equipment, samples and crew (quarantine).

Clearly there will be a need for significantly more discus-

^ Rephrased from workshop report
*** Wording verbatim to workshop report**

COSPAR 6.6 Crewed Mars Missions Quarantine

6.6 Crewed Mars Missions

Implementation guidelines for human missions to Mars include:

- Human missions will carry microbial populations that will vary in both kind and quantity, and it will not be practicable to specify all aspects of an allowable microbial population or potential contaminants at launch. Once any baseline conditions for launch are established and met, continued monitoring and evaluation of microbes carried by human missions will be required to address both forward and backward contamination concerns.

^ • A quarantine capability for both the entire crew and for individual crewmembers should be provided during and after the mission, in case potential contact with a Martian life-form occurs.

- A comprehensive planetary protection protocol for human missions should be developed that encompasses both forward and backward contamination concerns and addresses the combined human and robotic aspects of the mission, including subsurface exploration, sample handling, and the return of the samples and crew to Earth.
- Neither robotic systems nor human activities should contaminate "Special Regions" on Mars, as defined by this COSPAR PP Policy.
- Any uncharacterized Martian site should be evaluated by robotic precursors prior to crew access. Information may be obtained by either precursor robotic missions or a robotic component on a human mission.
- Any pristine samples or sampling components from any uncharacterized sites or Special Regions on Mars should be treated according to current planetary protection Category V, restricted Earth return, with the proper handling and testing protocols.
- An onboard crewmember should be given primary responsibility for the implementation of planetary protection provisions affecting the crew during the mission.
- Planetary protection guidelines for initial human missions should be based on a conservative approach consistent with a lack of knowledge of Martian environments and possible life, as well as the performance of human support systems in those environments. Planetary protection guidelines for later missions should not be relaxed without scientific review, justification, and consensus.

^Rephrased from workshop report

§2.3.2 Ops and backward contamination considerations "*subgroup deliberation and findings*"

- System analyses to determine the viability of the surface waste storage concept for various waste processing scenarios.
- Re-examine and modify ALS reference mission designs as necessary to harmonize with planetary protection and science-based requirements.

2.3. Overview of operations and support (Ops) subgroup deliberations

The Ops subgroup used the basic workshop assumptions, conceptual approach and a focus on "'special regions" as they deliberated about the assigned questions. Their findings about forward and backward contamination and their suggestions on R& D topics are summarized below:

2.3.1. Ops and forward contamination considerations

- Human mission planning, including landing site selection, base location, and mission objectives, should follow from precursor robotic information and evaluations made at those sites and/or from information developed from a sample return mission or missions.
- Definition is needed for a system describing and categorizing martian sites of special scientific interest (special regions) and their level of contamination concern. The classification system shall be developed and employed in future planetary protection protocols, as well as in operational plans for later human missions to Mars.
- Additional development and design attention is needed to characterize exploration, sampling, and base activities both to assure effective operation and provide the required level of planetary protection assurance. In particular:
  – The processes associated with EVA egress/ingress must be characterized and optimized.
  – An inventory of microbial populations carried aboard and potentially released by human-associated spacecraft and suits should be established and maintained in support of both planetary protection and crew-health objectives.
  – An inventory of organic materials carried by, or potentially produced by, the mission should be established and maintained.
  – Systems should be provided to allow controlled, aseptic, subsurface sampling operations, so that uncontaminated samples can be returned to the surface, and so that human-associated contaminants are not introduced to the subsurface.
- Quantitative requirements to limit human-associated contamination in different zones shall be derived based on requirements for protection of "special regions' and applied to missions, with the following stipulations:
  – No quantitative bioburden requirements should be applied to landing systems or habitats at launch, other than cleanroom (ISO 8 or better) assembly of Mars-contacting components.
  – Spacecraft, landers, habitats, and rovers shall (to the maximum possible extent) filter material vented as gases, and shall not allow uncontained disposal of solids or fluids.
  – Hardware elements involved with accessing "special regions' shall be subjected to a sterilizing process prior to use.

2.3.2. Ops and backward contamination considerations

- All operations of a human mission to a new site on Mars shall include isolation of humans from directly contacting martian materials until initial testing (either precursor-mission or on-mission robotic testing) can provide a state-of-the-art verification of the landing site as a "zone of minimum biological risk" (provide for the informed consent of the crew).
- Exploration, sampling, and base activities should be accomplished in a manner to limit inadvertant exposure to the subsurface or to otherwise-untested areas of Mars
- A means for allowing controlled access to those areas shall be provided.
- A site classification system and a biological plausibility map of the martian surface and subsurface, based on remote sensing data and on-mission testing, shall be employed during a mission to limit potential crew exposure to areas on Mars that might support martian life.
- A quarantine capability for both the entire crew and for individual crewmembers shall be provided during and after the mission, in case potential contact with a martian life-form occurs. In particular:
  – As part of normal crew health monitoring and in support of the assessment of possible quarantine measures, basic tests of the medical condition of the crew and their potential response to pathogens or adventitious microbes shall be defined, provided, and employed regularly on the mission.
  – A quarantine capability and appropriate medical testing shall be provided for the crew upon return to the Earth (Moon or Earth-orbit) and if necessary, implemented in conjunction with a health monitoring and stabilization program.
- Samples returned by the crew from uncharacterized or otherwise-untested areas of Mars shall be considered as potentially hazardous, and shall not be released from containment unless they are subjected to a sterilizing process, or until a series of tests determines that they do not present a biohazard.

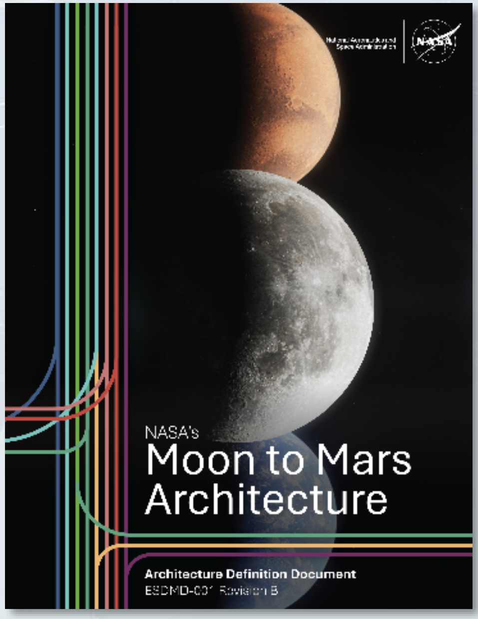
2.3.3. Research & development tasks related to Ops

- Describe the potential impacts on the near-field martian environment of human support activities expected in the operation of a human-occupied martian base (e.g., breathing oxygen, food supply, waste management, etc.) to determine the zone of contamination

Priority Mars Architecture Key Decisions

Mars Decision-10 (MD-10) Forward Contamination PP Risk Posture

Mars Decision-11 (MD-11) Backward Contamination PP Risk Posture



NASA's Architecture Definition Document

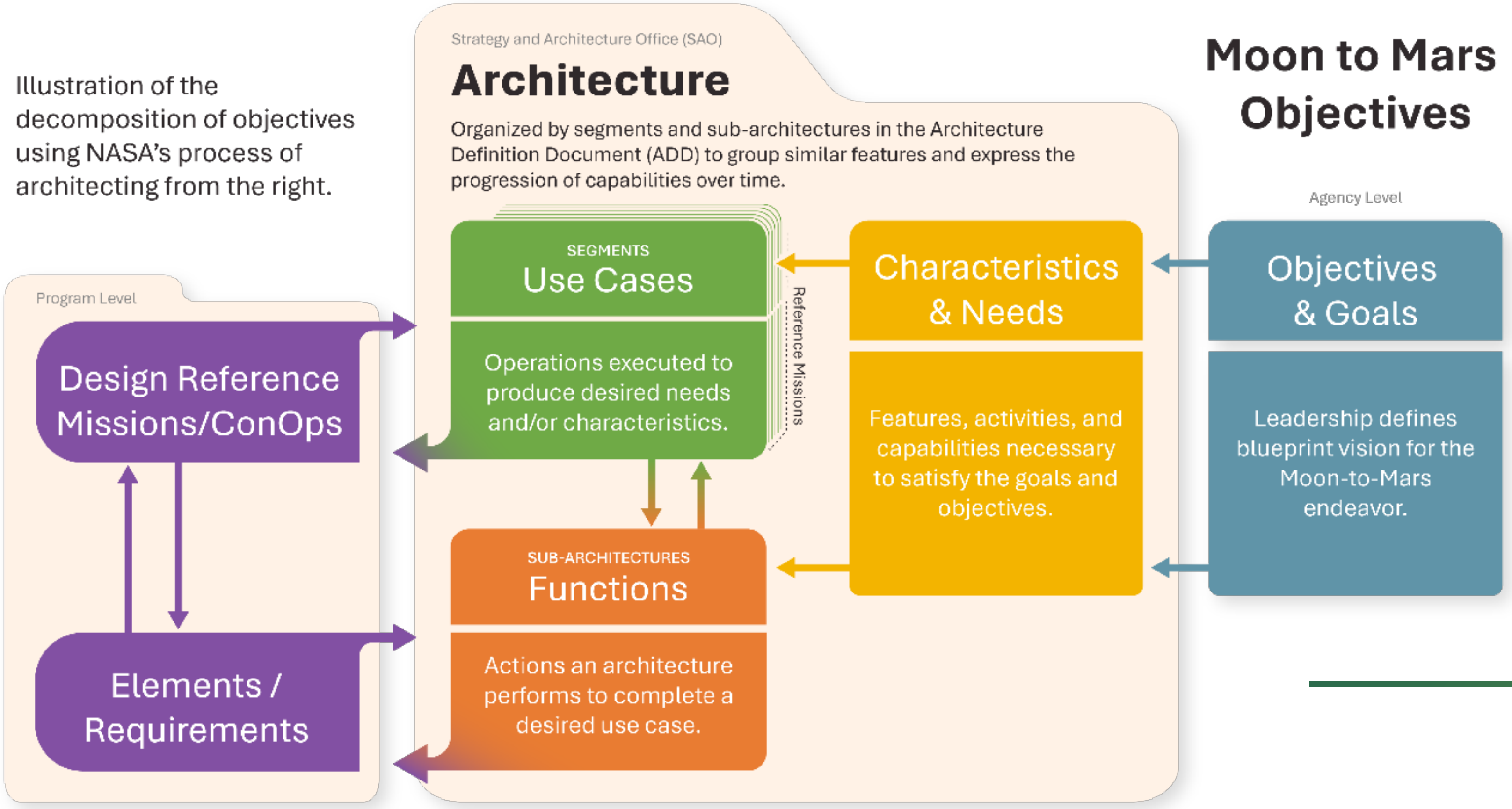
NASA's Moon to Mars Architecture Website
nasa.gov/architecture

Slide Credit: Julie Grantier, Deputy Manager for Integration Strategy and Architecture Office, NASA-ESDMD-SAO

Architecting from the Right

National Aeronautics and Space Administration

Illustration of the decomposition of objectives using NASA's process of architecting from the right.



Applies rigorous systems engineering approaches to identify the architecture needs, understand relationships and gaps between systems, and underpin analysis to identify the most effective and efficient solutions.

Architecture process provides a transparency in development not previously available

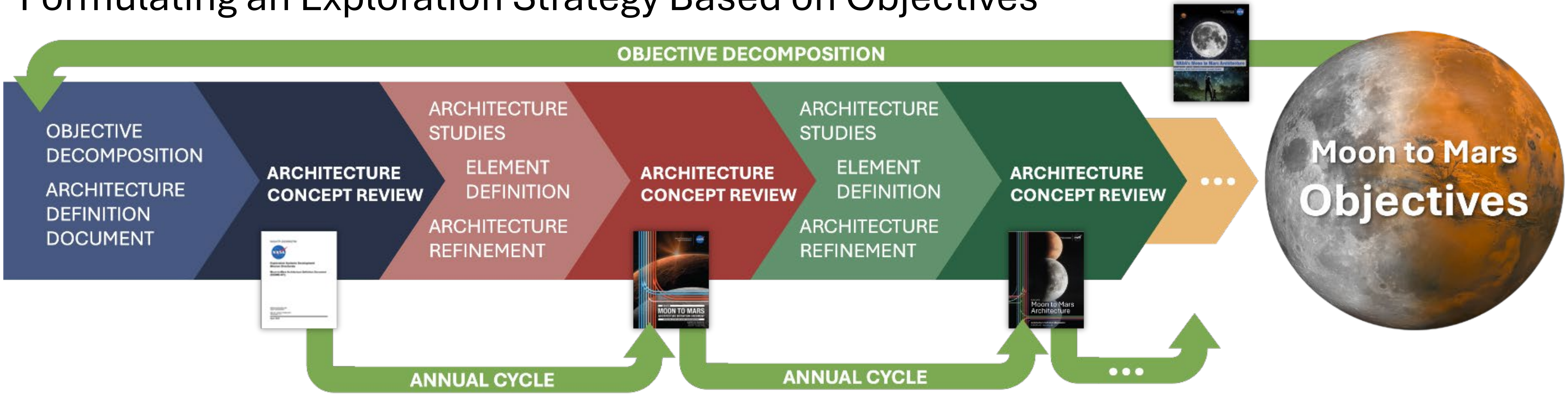
NASA's Moon to Mars Architecture Website

www.nasa.gov/architecture

NASA's Moon to Mars Architecture

National Aeronautics and Space Administration

An Evolutionary Architecture Process:
Formulating an Exploration Strategy Based on Objectives



TRACEABILITY
Decomposition of Blueprint Objectives to executing Architecture elements

ARCHITECTURE FRAMEWORK
Organizational construct to ensure system/element relationships are understood and gaps can be identified

PROCESS & PRODUCTS
Clear communication and review integration paths for stakeholders

Priority Mars Decisions: Planetary Protection Risk Posture

- **Why - MD-10 – Forward PP Risk Posture ?**
  - *"landed Mars missions as Category IV"*
  - *"not possible for all human-associated processes and mission operations to be conducted within entirely closed systems."*
- **Why - MD-11 – Backward PP Risk Posture ?**
  - *"Earth return missions as Planetary Protection Category V, and landed missions to Mars are classified as Restricted Earth Return"*
  - *"…crewmembers exploring Mars, or their support systems, will inevitably be exposed to Mars materials…safeguarding Earth from potential back contamination is the highest planetary protection priority"*
- **Outcome**
  - *"a combination of quantitative and qualitative measures, which may include a minimum acceptable probability value determined based on candidate initial human Mars segment concept(s) of operation. The decision outcome should include comparison of robotic performance alongside other industry risks of comparable and non-comparable magnitudes."*
- **Next Steps**
  - Developing Agency plan to address MD-10 and MD-11. Starting with MD-11 first.

A "risk posture" is an expression of the agreed-upon limits of risk an organization's leadership team is willing to accept in order to achieve one or more of its objectives.

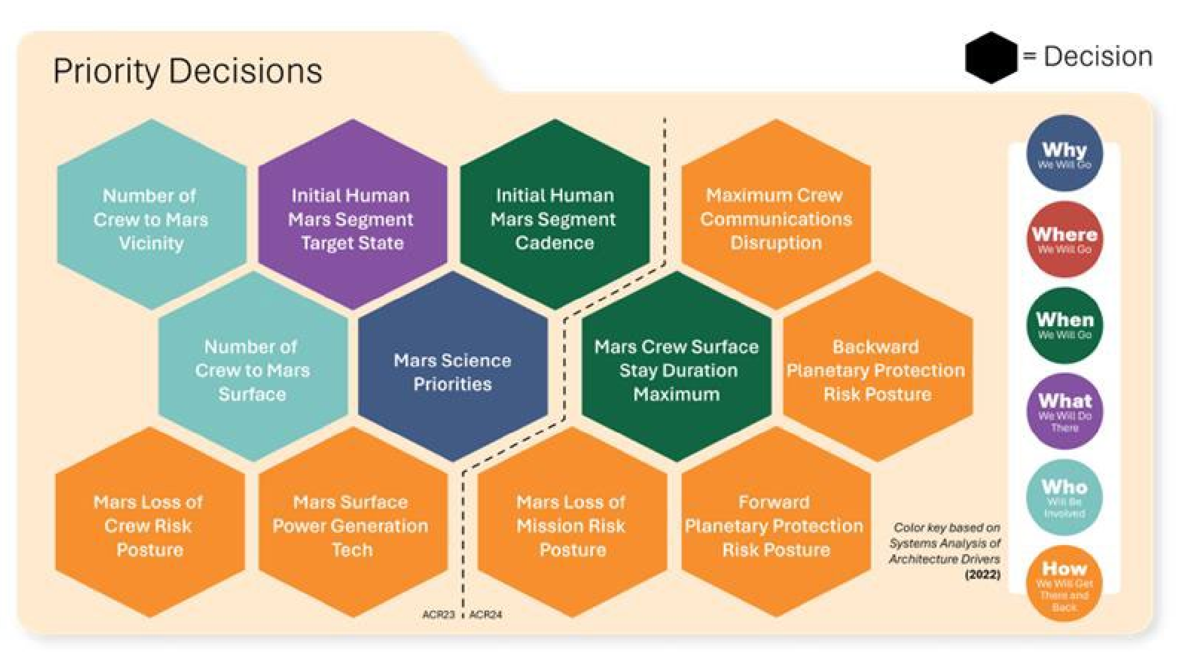


Image Credit: NASA's Architecture Definition Document, ESDMD-001, Rev. B

Mission Update

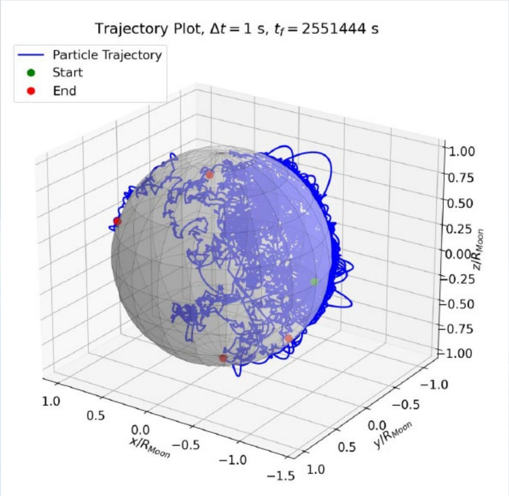
Mission Update

- **Mars Sample Return Update** – Brian Clement will address during the MSR Update presentation.
- **Rosalind Franklin Mission**
  - *Overseeing project's identification of requirements and verifying planned implementation for NASA hardware and launch services.*
- **ESCAPADE**
  - *Verification of project's planned implementation for continued assembly, test and launch operations.*
- **Europa Clipper**
  - *Probability of contamination table-top review completed, and post-launch report review started.*
  - *Peer-reviewed publication on PP implementation planned.*
- **Artemis Commercial Lunar Payload Services**
  - *Missions: Firefly's Aerospace's Blue Ghost Mission 1, Institutive Machines-2, Lunar Trailblazer*
  - *Pre-launch reporting completed through the FAA's payload review process.*
  - *Commercial engagement provided feedback resulting in an update to the pre-launch organics inventory reporting form and streamlined a post-launch / end of mission reporting form for Category II Lunar missions. Will be working to upload the the forms on the OPP website and update the appendices in the handbook.*

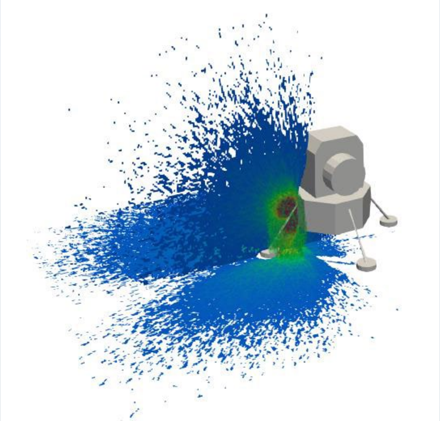
Technology and Research Developments

Directed Technology and Research Developments

- **Metagenomics** – Erin Lalime will address during the metagenomics panel introduction and discussion.
- **Lunar Contamination Modeling**
  - *Lunar lander gas dynamic vacuum venting organic contamination engineering model. Compares 4 different vehicles sizes, vent type (T vs. S vents), vent configurations (upward, sideways and downward venting) and crew size.*
  - *Landing site characterization models for considerations of adsorption or organics and residence times.*
  - *Lunar Descent Engine Thruster Plume induced contamination modeling.*
- **Low-Cost Mars Planetary Protection Guidebook**
  - *Partnered with Mars Exploration Program to initiate the analysis needed for the guidebook.*
  - *Objective – To enable low-cost Mars missions by streamlining planetary protection by providing a series of bounding analysis for mission design and PP compliance.*
  - *Technical Overview*
    1. *Bioburden Management Assessment – will generate a standard spacecraft planetary protection equipment list to evaluate cleanroom manufacturing, microbial reduction, and bioburden assessment needs.*
    2. *Mission Design and Navigation – evaluation of orbital stability and probability of impact given proposed mission design "bus-stops" .*
    3. *Burnup and Break-up Analysis - assessment of entry angle of attack impacts that result in spacecraft breakup and entry heating to evaluate microbial reduction and sterilization impacts.*



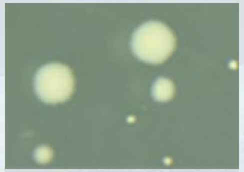
"Free Molecular Monte Carlo Model for Lunar Contaminant Transport and Deposition in Permanently Shadowed Regions" – Raphael Alves Hailer



Example of gas venting near a landed vehicle, **simulated** ***with SPARTA -Paula Gutierrez-Cascales***

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


OSIRIS REx Sample Return Doesn't Pose a Risk to Earth's Biosphere


Bioburden Accounting Tool Release

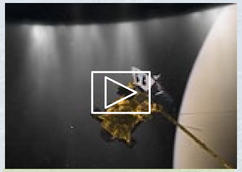
Organic Inventory Workshop

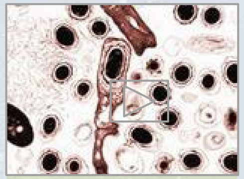

PP Crewed Knowledge Gaps

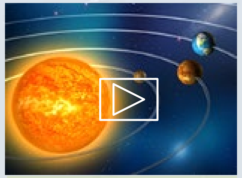

COSPAR PP Policy Update

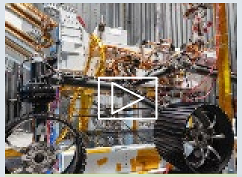

Updated Handbook Release

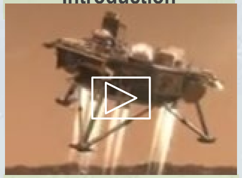
Videos


Planetary Protection: An Introduction

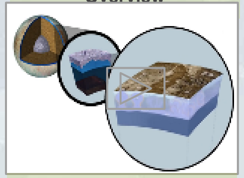

Just How Small is a Spore?

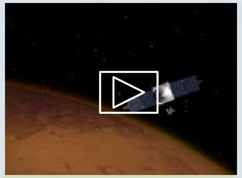

Forward and Backward PP Overview


Behind the Spacecraft Perseverance


Mission Design and PP Categorization


Probability of Impact


Ocean Worlds


End of Mission Disposition

Missions & Studies

Mission Reports

NASEM Study Reports

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

Questions?

Feel free to reach out as well!

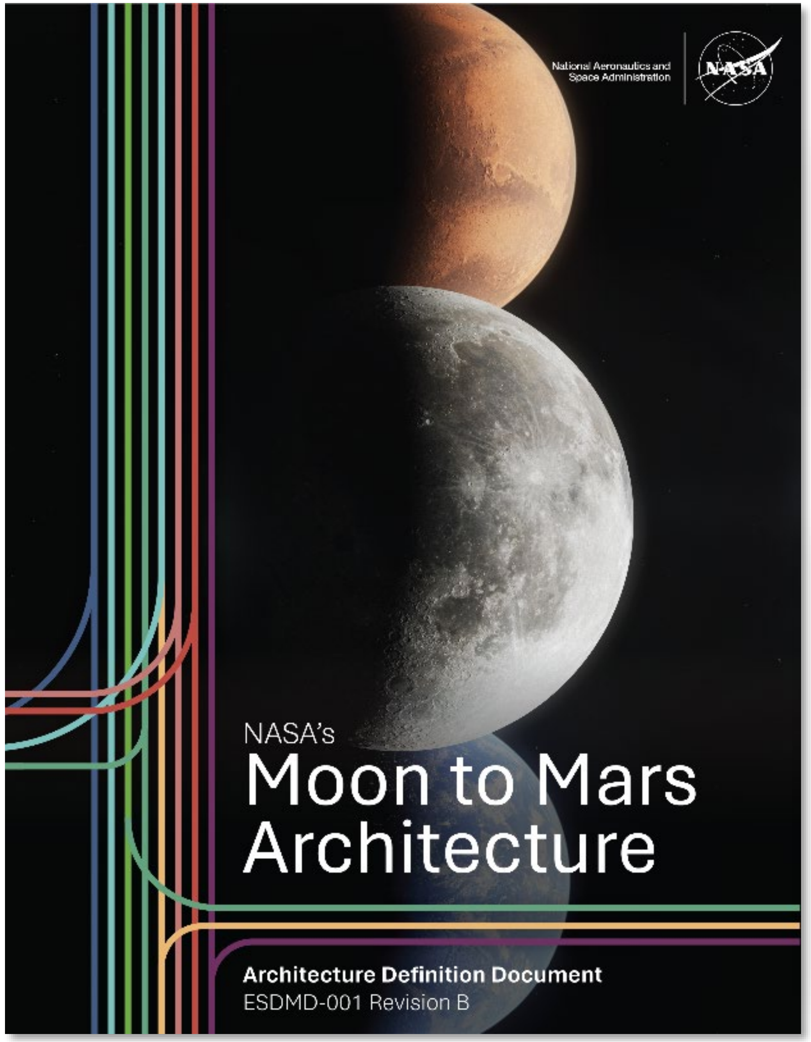
J. Nick Benardini – NASA Planetary Protection Officer – James.N.Benardini@nasa.gov

Erin Lalime – NASA Deputy Planetary Protection Officer (Acting) - Erin.Lalime@nasa.gov

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

Architecture Products

National Aeronautics and Space Administration



NASA's Architecture Definition Document

Executive Overview

Architecture White Papers

NASA documents its roadmap for deep space exploration in the Architecture Definition Document. The agency updates the document yearly and publishes it alongside other public-facing products including white papers on relevant topics and an executive overview of the architecture.

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Revision B Published **December 13**

NASA's Moon to Mars Architecture Website

nasa.gov/architecture