National Aeronautics and Space Administration

EXPECTATIONS FOR BACKWARD PLANETARY PROTECTION DURING MARS SAMPLE RETURN

MEPAG Meeting 38: Virtual Format
April 15, 2020

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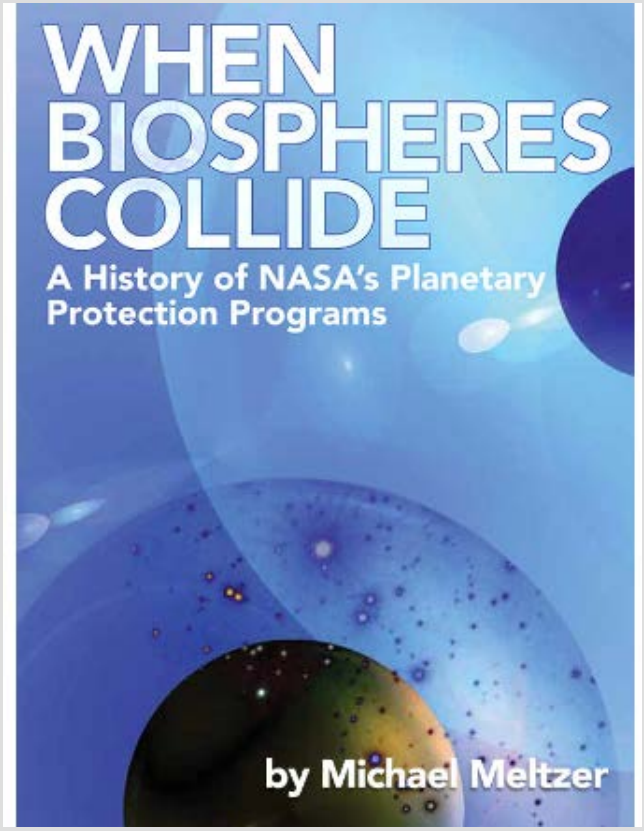
Artist's concept of NASA's Mars 2020 rover using its drill to core a rock sample on Mars

60 Years of International Effort

- 1956: International Astronautical Federation meets to discuss lunar and planetary contamination
- 1957: successful launch of Sputnik 1
- 1958: US National Academy Science establishes Space Studies Board (SSB)
- 1958: Formation of NASA
- 1963: NASA's first Planetary Quarantine Officer on loan from the Public Health Service
- 1967: The Outer Space Treaty



Meeting the Intent of the Outer Space Treaty

NASA and ESA conduct exploration of other planetary bodies "...*so as to avoid their harmful contamination and also adverse changes in the environment of the Earth resulting from the introduction of extraterrestrial matter...*"

NASA and ESA independently develop policies, requirements, and standards that are derived from COSPAR guidelines for best practices in forward and backward planetary protection.

National Aeronautics and Space Administration
Planetary Protection Independent Review Board

= Currently being updated/created

NPD = NASA Policy Directive

NPR = NASA Procedural Requirements

NID = NASA Interim Directive

NPI = NASA Policy Instructions

Outer Space Treaty

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COSPAR Guidelines

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NPD 8020.7G
Biological Contamination Control for Outbound and Inbound Planetary Spacecraft (Revalidated 05/17/13 w/change 1)
Expiration Date: November 19, 2020

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NPR 8020.12D
Planetary Protection Provisions for Robotic Extraterrestrial Missions
Expiration Date: December 20, 2020
Status: Revision E currently in work and planned to be routed for review in 2020

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NID 8020.109A
Planetary Protection Provisions for Robotic Extraterrestrial Missions
Expiration Date: September 1, 2020

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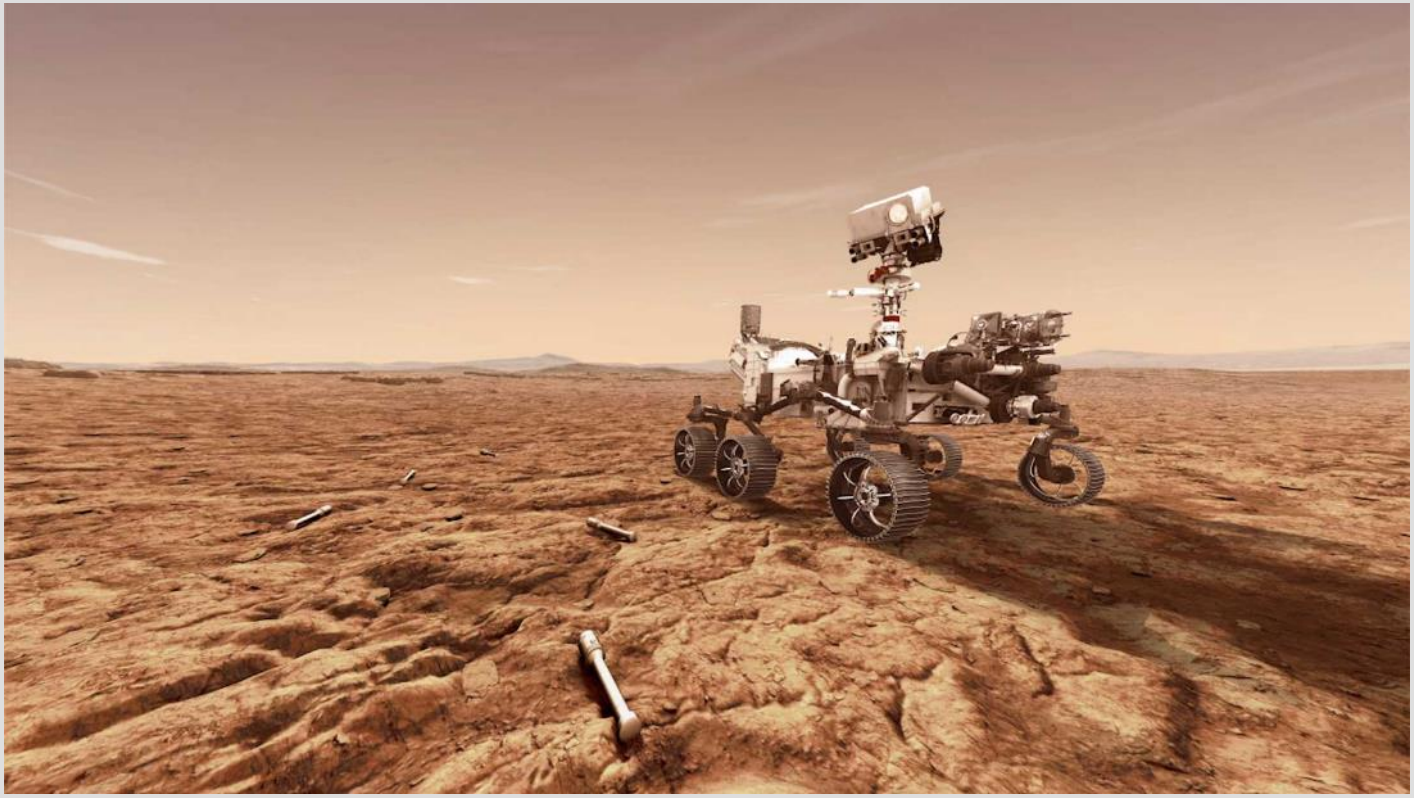
NASA-STD-87XX.X_
Implementing Planetary Protection Requirements for Space Flight
Expiration Date: TBD
Status: Revisions currently in work and planned to be routed for review in 2020

NASA-HDBK-6022
Handbook for the Microbial Examination of Space Hardware
Expiration Date: N/A
Status: Needs revision. Last revision released March 24, 2010

NPI 8020.7
NASA Policy on Planetary Protection Requirements for Human Extraterrestrial Missions
Expiration Date: None.
Status: Last date in NODIS is May 28, 2014

Containment of the Mars 2020 Samples



An extraordinary campaign to bring carefully characterized, drilled, and sealed samples of sedimentary and igneous rocks from Mars to Earth for scientific study.

https://www.jpl.nasa.gov/missions/mars-sample-return-msr/

Lethality of Hardy Terrestrial Organisms Recovered from Spacecraft

Experimental D-values of Bacillus ATCC 2966 Spores	
Temperature ^{o}C	Time for One Decimal Reduction
115	3.35 Days
125	18.8 Hours
150	66.4 Minutes
170	9.76 Minutes
200	20.5 Seconds

A 90% reduction in growth population is one D-value (decimal reduction)

NASA has deep expertise in bioburden control for forward planetary protection but we need outside expertise in evolutionary biology and sterility assurance to determine probabilities and procedures for assurance of backward planetary protection.

Sterilization Working Group: Questions relevant to MSR

- Can we utilize terrestrial microorganisms, viruses, and prions as analogs for assessing sterilization of extraterrestrial biological entities?
- What is the likelihood of sterilizing and/or deactivating biological entities by exposure to solar UV and other space environmental factors during sampling, ascent, and transit to Earth?
- What is the sterilizing effectiveness of various chemical modalities combined with high temperature as currently used for sterility assurance by industry?

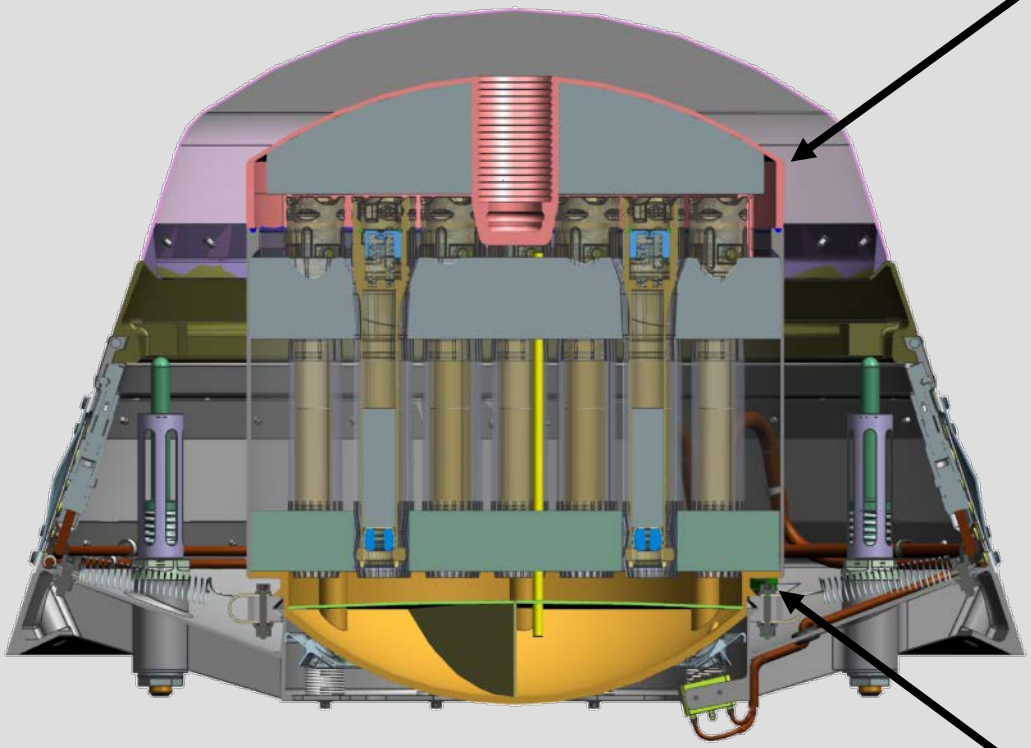
Informal Sterilization Working Group

JPL/NASA partnership with experts from across the health-care industries and relevant federal agencies

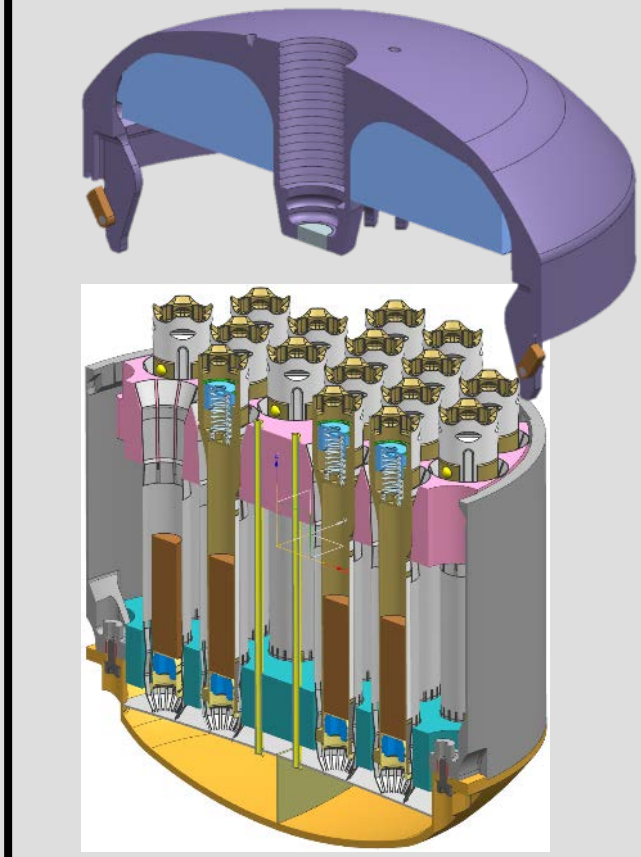
A Few of the Outside Sterilization Experts

- Sr Director, Aseptic Processing & Terminal Sterilization, Johnson & Johnson
- Defense Adv Research Projects Agency, DARPA Biological Technologies
- Deputy Dir. Div. High Consequence Pathogens and Pathology, CDC
- Mevex E-Beam and X-Ray Sterilization
- U.S. Army Edgewood Chemical and Biological Center
- Nelson Labs, vaporized hydrogen peroxide sterilization
- Director Radiation Physics, Sterigenics

Robust, Multi-Layer Containment Starting at Mars



Mars Ascent Payload



Orbital Sample (OS) with tubes containing rock cores

Sample Safety Assessment Protocol (SSAP)

Working Group established by COSPAR

Assess if there are indications of martian life (extant or extinct) in martian samples or on particles adhering to spacecraft hardware and if samples or particles constitute a biological hazard to the terrestrial biosphere, while maintaining the scientific integrity of the overall material from Mars to the maximum extent possible.

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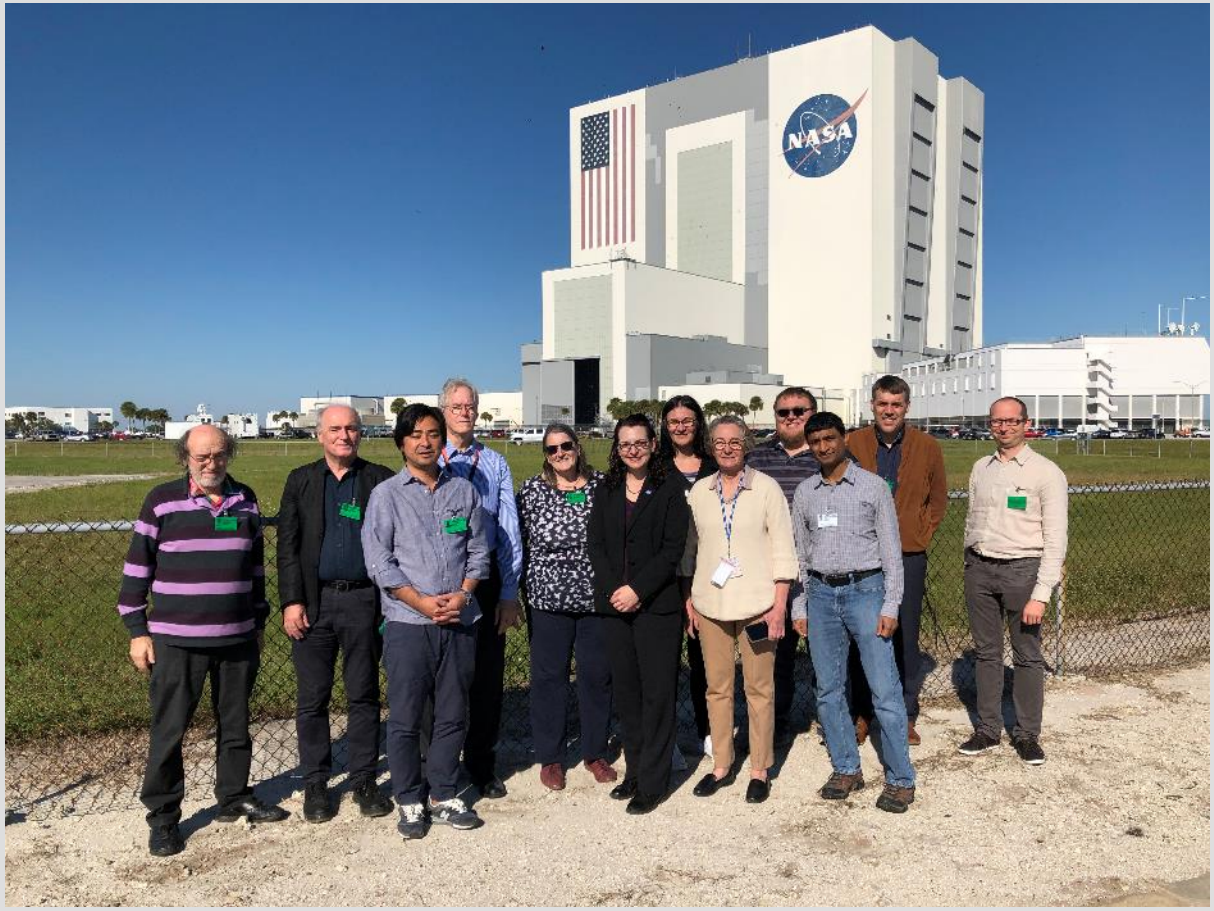
COSPAR Sample Safety Assessment Protocol



NASA/ESA/JAXA and international health experts developing protocols for safe handling of Mars samples in a receiving laboratory.

Sterilization and Molecular Deactivation Advisory Board for MSR

NASA and ESA will work with international experts from industry, academia, and government agencies to design and test combinations of containment, sterilization, and molecular deactivation to meet stringent standards for preventing harm to Earth's environment from potential extraterrestrial biology in the form of microorganisms, virus-like entities, and prion-like molecules.