



SSB Meeting(s) of Experts: Terrestrial Organic Contamination Requirements Associated with Sample Caching and Return for Planetary Protection

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International Agreements on Planetary Contamination/Protection



- The Outer Space Treaty of 1967:
 - Proposed to the UN in 1966
 - Signed by the US and Soviet Union in January 1967
 - Ratified by the US Senate on Apr. 25th, 1967



- Article IX:

“...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...”

“Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies.”

(<http://www.state.gov/t/ac/trt/5181.htm>)

Committee on Space Research Planetary Protection Activities



- COSPAR maintains the international consensus standard planetary protection policy supporting compliance with the 1967 UN Space Treaty.
- COSPAR's Planetary Protection Panel was formed to:
 - Develop, maintain, and promulgate planetary protection knowledge, policy, and plans to prevent the harmful effects of such contamination
 - Provide an international forum for exchange of information in this area through symposia, workshops, and topical meetings at COSPAR Assemblies
 - Inform the international community, e.g., the Committee on the Peaceful Uses of Outer Space (COPUOS) of the United Nations, as well as various other bilateral and multilateral organizations, of COSPAR decisions in this area.
- Current Policy approved by COSPAR Bureau and Council at the COSPAR Assembly in 2011



NASA Planetary Protection Policy

(from NPD 8020.7; near-verbatim from COSPAR)



- “The conduct of scientific investigations of possible extraterrestrial life forms, precursors, and remnants must not be jeopardized.”
 - Preserves science opportunities directly related to NASA’s goals, and can support certain ethical considerations; originally recommended to NASA by the NAS in 1958
 - Preserves our investment in space exploration
 - Can preserve future habitability options
- “The Earth must be protected from the potential hazard posed by extraterrestrial matter carried by a spacecraft returning from another planet.”
 - Preserves Earth’s biosphere, upon which we all depend...

NASA Planetary Protection Policy



- The policy and its implementation requirements are embodied in NPD 8020.7G (*NASA Administrator*)
 - Planetary Protection Officer acts on behalf of the Associate Administrator for Science to maintain and enforce the policy
 - NASA obtains recommendations on planetary protection issues (requirements for specific bodies and mission types) from the National Research Council's Space Studies Board
 - Advice on policy implementation to be obtained from the NAC Planetary Protection Subcommittee
- Specific requirements for robotic missions are embodied in NPR 8020.12D (*AA/SMD*)
 - Encompasses all documentation and implementation requirements for forward and back-contamination control

Recommendations on Category V Restricted Earth Return



NASA/CP—2002–211842



A DRAFT TEST PROTOCOL
FOR DETECTING POSSIBLE BIOHAZARDS IN
MARTIAN SAMPLES RETURNED TO EARTH

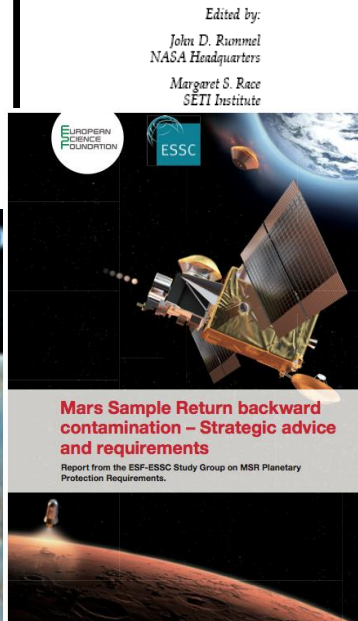
- Previous requirements developed over decades of MSR preparation and adopted by COSPAR
- ESA and NASA are continuing a program of requirements refinement
- Key recommendations driving implementation:

NRC: samples returned from Mars by spacecraft should be contained and treated as though **potentially hazardous** until proven otherwise

ESF: a Mars sample should be applied to Risk Group 4 (WHO) a priori

NRC: No uncontained martian materials ... should be returned to Earth unless sterilized

ESF: the probability of release of a potentially hazardous Mars particle shall be less than one in a million



NASA Requirements for Restricted Earth Return

NPR 8020.12D Chapter 2



- 2.3.3 ... extensive set of additional documentation ... shall be required. The associated activities and reviews are intended to ensure that the Earth's biosphere is not adversely affected by the introduction of material from returned samples.
- 2.3.3.2 After the flight mission there is a need to conduct, under strict containment and using approved techniques, timely analyses of the unsterilized sample collected and returned to Earth. If any sign of a non-terrestrial replicating entity is found, the returned sample must remain contained unless treated by an effective sterilizing procedure.
- 2.7.4.1 The Earth Safety Analysis Plan is the primary planning document covering the Earth-return portion of the mission. Its purpose is to demonstrate to the PPO that the project is meeting its planetary protection requirements.
- ESAP to identify Potential Contaminating Sources; Sample Containment Approach; Probability of Contamination Model; Contamination Sources Analysis including analytical techniques; and Analysis Documentation
- 2.8.3.6 The Earth Safety Analysis Review ... may be attended by the SMD AA and members of an Interagency Committee, which will be overseeing activities related to the handling and testing of the returned sample in the Receiving Facility.

NASA Requirements for Mars Sample Return

NPR 8020.12D Section 5.3.5



- 5.3.3.1 Samples returned from Mars by spacecraft shall be contained and treated as though potentially hazardous until demonstrated otherwise.
- 5.3.3.2 Unless specifically exempted, the outbound leg of the mission shall meet PP Category IVb requirements.
- 5.3.3.6 Reviews and approval of the continuation of the flight mission shall be required at three stages: 1) prior to launch from Earth; 2) prior to leaving Mars for return to Earth; and 3) prior to commitment to Earth reentry.
- 5.3.3.10 A sample-receiving facility shall employ appropriately certified personnel and instrumentation to validate and perform the battery of tests described in the NASA life detection and biohazard test protocol...
- 5.3.3.11 An independent science and technical advisory committee shall be constituted with oversight responsibilities for materials returned by a Mars sample return mission.

Terms of Reference for the MoE series



- What is the potential for persistent contamination to be associated with hardware materials selection, hardware design, and hardware cleaning processes (for example, some designs do not allow for ease of cleaning)?
- What is the potential that signatures associated with human-associated contamination (e.g., microbes, biological materials) and/or synthetic organic contamination sources (e.g., lubricants, friable materials) might be shared with potential biosignatures, and, therefore, could confound measurements to be made on Mars samples after return to Earth?
- At what quantitative levels is there concern that the organic signatures identified above will exceed levels that could reduce the confidence in measurements made as part of the biohazard/life detection protocol that will be performed after return?
- What are the concerns related to recontamination of hardware by Earth organic compounds, both particulate and volatile, after launch of the M2020 spacecraft? How can they be quantified? How suitable are the implementation approaches that could be instituted to address them?
- To what extent are the various methods for evaluating Earth (re)contamination (e.g., witness plates, blanks, other options) effective in facilitating differentiation of Earth contamination from genuine Mars organic compounds after return?
- How can understanding levels of background recontamination improve the ability to assess the potential for "false negative" signals to be obtained after return?

MoE1 Agenda: May 28-29th 2014, Beckman Center, Irvine, CA

Planetary Protection



Day 1 - Wednesday, May 28th			
Start	End	Time	Topic
7:00 AM	8:30 AM	1:30	Breakfast in the Beckman Dining Room
8:30 AM	9:15 AM	0:45	Welcome & Introductions
9:15 AM	9:45 AM	0:30	Objectives of the Meeting
9:45 AM	10:15 AM	0:30	Primer: Planetary Protection
10:15 AM	10:30 AM	0:15	Break
10:30 AM	11:30 AM	1:00	Life Detection on Returned Samples
11:30 AM	12:00 PM	0:30	Life Detection on Mars (Viking and ExoMars 2018)
12:00 PM	1:00 PM	1:00	Lunch
1:00 PM	3:00 PM	2:00	Report out from Mars Exploration Program Organic Contamination Panel (OCP)
3:00 PM	3:15 PM	0:15	Break
3:15 PM	5:15 PM	2:00	Discussion and Questions
5:15 PM	5:45 PM	0:30	Interim Perspectives & Plans for Tomorrow
6:00 PM			Dinner



Day 2 - Thursday, May 29th			
Start	End	Time	Topic
7:30 AM	8:30 AM	1:00	Breakfast in the Beckman Dining Room
			Summary of Discussion from Yesterday & Preparation for
8:30 AM	9:00 AM	0:30	Small Groups
9:00 AM	10:30 AM	1:30	Small Group Discussion - round 1
10:30 AM	10:45 AM	0:15	Break
10:45 AM	11:15 AM	0:30	Small Group Report Outs
11:15 AM	12:00 PM	0:45	Small Group Discussion - round 2
12:00 PM	1:00 PM	1:00	Lunch
1:00 PM	2:00 PM	1:00	Small Group Discussion - round 2, continued
2:00 PM	2:45 PM	0:45	Small Group Report Outs
2:45 PM	3:00 PM	0:15	Break
3:00 PM	4:30 PM	1:30	Plenary and Conclusions

MoE 2 Agenda : May 11-13th 2015; Keck Center, Woods Hole, MA

Planetary Protection



Day 1- May 11, 2015: Current Status			
Start	End	Time	Topic
7:30 AM	8:30 AM	1:00	Breakfast

8:30 AM
9:15 AM
9:45 AM
10:15 AM
10:30 AM
12:00 PM
1:00 PM
2:00 PM
2:15 PM
3:15 PM
5:15 PM
6:00 PM

Day 2- May 12, 2015			
Start	End	Time	Topic
7:30 AM	8:30 AM	1:00	Breakfast

Day 3- May 13, 2015			
Start	End	Time	Topic
7:30 AM	8:30 AM	1:00	Breakfast
8:30 AM	9:00 AM	0:30	Given what you've heard so far, where is Your Brain today? and Plans for Today
9:00 AM	10:00 AM	1:00	Concerns from Curation Point of View: iMARS
10:00 AM	10:15 AM	0:15	Break
10:15 AM	11:15 AM	1:00	Concerns from Curation Point of View: Sample Return History
11:15 AM	12:00 PM	0:45	Discussion
12:00 PM	1:00 PM	1:00	Lunch
1:00 PM	2:00 PM	1:00	Past Examples of Oversight
2:00 PM	2:15 PM	0:15	Break
2:15 PM	3:15 PM	1:00	Discussion and Plan Forward
3:15 PM	4:15 PM	1:00	Round the Table and Take Home Thoughts

Organic Contamination and Life Detection



Measurement Says: Life is not

Life is Present

Present

No life
is really
present

True Negative

Could change
policy for Mars

False Positive

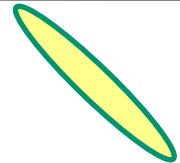
Life is
present

False Negative

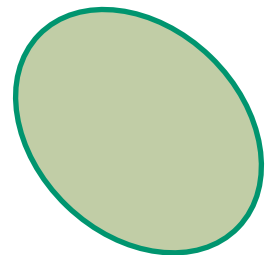
Problematic for
protecting the Earth

Would change
policy for Mars:
a Good Day!

True Positive



Narrow
Ellipse
=
Minimal
False positives
and negatives



Broad
Ellipse
=
Range of
False positives
and negatives

“NASA should sponsor research on nonliving contaminants of spacecraft ... and their potential to confound scientific investigations or the interpretation of scientific measurements, especially those that involve the search for life.”