Evolution of Planetary Protection Requirements for Missions to Mars

COSPAR Panel on Planetary Protection
Meeting, 20 October 2021

Probabilistic Approach in the 70s

Probabilistic approach to **limit the risk of contaminating** a planet to $<1x10^{-3}$ during the period of biological exploration.

Agreement reached at COSPAR level for sub-allocations:

- $4.4x10^{-4}$ → US
- $4.4x10^{-4}$ → USSR
- $1.2x10^{-4}$ → Other nations

US sub-allocation for Viking Project: $2x10^{-4}$

Viking Project sub-allocation for the two missions:

- $0.65x10^{-4}$ → Viking 1
- $1.35x10^{-4}$ → Viking 2

Credit: NASA

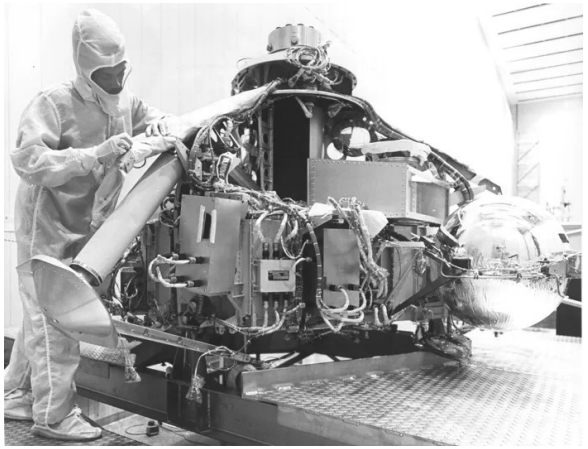
Probabilistic Approach in the 70s

→ **Extensive research program** required to establish further sub-allocations to flight hardware and mission phases and to translate the requirements so that they can be used by engineers.

→ **Moving target** beyond the stage where requirements for a mission are agreed.

→ A good portion of the requirement implementation and verification was **not under the direct control** of the **project manager**.

Difficult to use this approach in a typical flight project environment with the cost, schedule and risk constraints and w/o extensive R&D program ahead of starting the flight project.



Credit: NASA

Transition to the New Approach†

Transition started at the begin of the 80s and was completed in 1994.

COSPAR Decision No. 7/84 to change approach leading to a simplification of the compliance procedures:

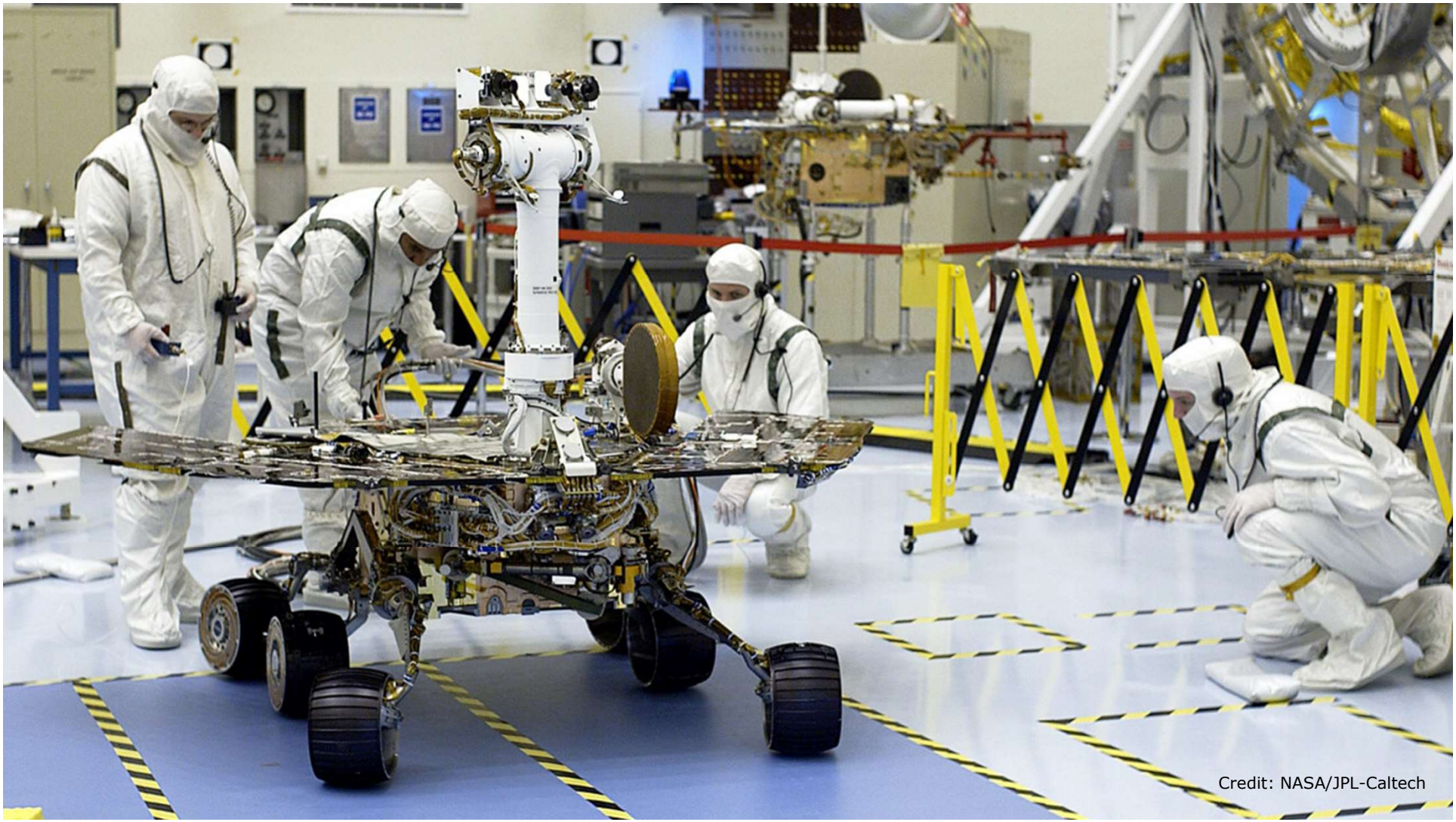
- The inherent weakness of the probabilistic approach is the uncertainty of the input parameters in the mathematical modelling
- D.L. DeVincenzi *et al., Adv. Space Res.,* Vol. 3 (1983)
- Planetary Protection Workshop in July 1984

US NRC Report (Biological Contamination of Mars, 1992) recommended an update to the requirements for Mars planetary protection consistent with the current knowledge

COSPAR Decision No. 1/94 adopting a new approach for planetary protection requirements:

- Planetary Protection Workshop in May 1994
- D.L. DeVincenzi *et al.* in F3.5.2 (COSPAR 1994), published in *Adv. Space Res.,* Vol. 18 (1996)
- Developed and used already by the NASA Pathfinder mission

†Credit: P. Stabekis


Credit: NASA/JPL-Caltech

Mars Special Regions

Introduction of Mars Special Regions into COSPAR Planetary Protection Policy, 2002

- Mars Special Regions discussed in the COSPAR Planetary Protection Panel, Warsaw, July 2000

Review & Update of Mars Special Regions, 2008

- NRC Preventing the Forward Contamination of Mars, 2006
- MEPAG Mars Special Regions Science Analysis Group, SR-SAG, 2006
- COSPAR Colloquium on Mars Special Regions, Rome, Sept. 2007

Review & Update of Mars Special Regions, 2017

- MEPAG Mars Special Regions Science Analysis Group 2, SR-SAG2, 2013-2014
- COSPAR Workshop on Mars Special Regions, Montreal, April 2014
- NRC-ESF Committee to review SR-SAG2, 2014-2015 (NAP Report, 2015)
- COSPAR Planetary Protection Colloquium, Bern, Sept. 2015

The reviews & updates were presented and discussed at least once at the NASA Planetary Protection Sub-Committee and the ESA Planetary Protection Working Group.

Are we ready for the next step?

COSPAR/NASA/ESA workshop series to refine planetary protection requirements for human missions to Mars (2016, 2018 and 2019 at LPI and 2020 virtual) identified two (out of four) high priority knowledge gaps that would also apply to robotic missions:

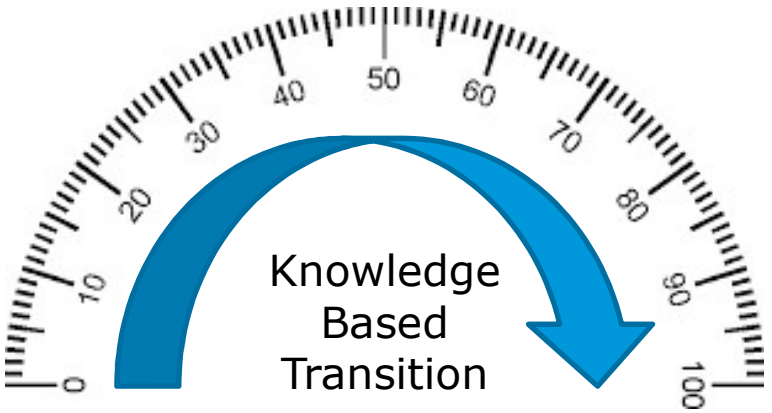
- Natural transport of (terrestrial biological) contamination on Mars.
- Synergistic biocidal effects of the martian environment on the survival and growth of spacecraft (robotic and human) associated microbiome.

An **informed partitioning of the martian surface** and the establishment of quantitative planetary protection requirements (reflecting this partitoning) are only possible based on an increased understanding of the natural transport of biological contamination and their fate on Mars. This requires new targeted measurements on Mars and ground-based research.

Are we ready for the next step?

"The current state of research is not yet adequate to determine whether there are regions on Mars where human explorers or commercial missions might land with minimal planetary protection implications", NRC-SSB, 2020

Are we ready for the next step?



Contaminate-ometer
Credit: A. Spry, SETI Institute