THE DEVELOPMENT OF PLANETARY PROTECTION REQUIREMENTS FOR HUMAN MARS MISSIONS: A HISTORY. J. D. Rummel[1], M. S. Race[2], and G. Kminek[3], [1]East Carolina University, Greenville, NC 27858 USA, rummelj@ecu.edu, [2]SETI Institute, Mountain View, CA 94043, mrace@seti.org, [3]ESA/ESTEC, Noordwijk, The Netherlands, gerhard.kminek@esa.int.

Introduction: Although NASA's preparations for the Apollo lunar missions had only a limited time to consider issues associated with the protection of the Moon from biological contamination and the quarantine of the astronauts returning to Earth, they learned many valuable lessons (both positive and negative) in the process. As such, those efforts represent the baseline of planetary protection preparations for sending humans to Mars. Neither the post-Apollo experience or the Shuttle and other follow-on missions of either the US or Russian human spaceflight programs could add many additional insights to that baseline. Current mission designers have had the intervening four decades for their consideration, and in that time there has been much learned about human-associated microbes, about Mars, and about humans in space that has helped prepare us for a broad spectrum of considerations regarding potential biological contamination in human Mars missions and how to control it.

This paper will review the approaches used in getting this far, and highlight some implications of this history for the future development of planetary protection provisions for human missions to Mars. The role of NASA and ESA's planetary protection offices, and the aegis of COSPAR have been particularly important in this ongoing process.

Shuttle Era Efforts: As the Space Shuttle was developed and eventually flown (1981), NASA was interested in Shuttle-delivered modules as the basis of space activities, and for some those modules were best envisioned as a space station (then TBD). Of significance to the development of planetary protection thinking in this era was the Antaeus Report [1], which identified specific needs for an orbiting space-station associated module that might be dedicated to the quarantine of a Mars sample. The report suggested the use of the smallest available biological test systems that could be emplaced by the Space Shuttle, then under development. The human element was essential for making this concept feasible.

Humans Exploring Space?: With a Presidential announcement of a Moon/Mars destination for NASA (1989), NASA's initial examination of the challenge [2] and other workshops [3] considered the issues of Mars exploration by humans and the planetary protection challenges associated with the then-current thinking about life on Mars. Sometimes the issues were well-considered, and sometimes less well conceived [4]. As it turned out there would be plenty of subsequent chances to continue to hone the effort to understand the challenges and consequences associated with humans and their microbial "load" in an exploration setting.

One of the first attempts to directly involve both human mission planners, developers, and medical personnel in the process of setting planetary protection requirements took place in Pingree Park, Colorado in June 2001 [5]. This workshop began a series of focused discussions among agency and mission-planner that continued in the first half of that decade. An important contribution a short while after was the *Safe on Mars* report of the National Research Council [6], which considered all of the hazards associated with sending humans to Mars, including chemical and biological ones. A consensus effort came together in April 2005 with a comprehensive workshop at the Lunar and Planetary Institute in Houston [7] that involved the life support and habitation personnel from the human space flight community. At that workshop the participants established three principles: 1) avoid forward contamination of Mars or interference with scientific exploration from terrestrially associated microbial contaminants; 2) protect astronauts from harmful contamination from martian life forms; and 3) control back contamination from the spacecraft, astronauts and materials that are returned to Earth. Finally to wrap up the workshops on planetary protection and humans, a joint NASA/ESA workshop was held at ESTEC in The Netherlands in May of 2005 [8]. That workshop included splinter group discussions organized around three main areas with implications for planetary protection on human rated systems:

- Advanced Life Support Systems (ALS);
- Extravehicular Activities (EVA); and
- Operations and Support (OPS).

These splinter-group discussions considered operations and technology concerns, science activities and operations, backward contamination prevention requirements, and the protection of both the human habitat on Mars and the Earth upon crew return. They also identified future research and development needs for ALS, EVA, and Mars robotic missions, including specific precursor mission information necessary to understand and prepare for human support systems and science operations on long duration Mars missions.

COSPAR's Interim Provisions: The results of the various workshops and considerations regarding humans were largely consolidated by the NASA/ESA workshop in 2005. Subsequently, those results were reported to COSPAR in Beijing in 2006, although no action was taken by the Panel on Planetary Protection at that time. The matter was presented and further discussed in 2008 at the COSPAR Assembly in Montréal [10], which resulted in a Panel on Planetary Protection resolution that went forward to the Bureau and COSPAR Council, and was approved by both groups.

As a result, new section was added to the COSPAR Planetary Protection Policy [11] that includes "Principles and Guidelines for Human Missions to Mars," with the following policy statement as a preamble:

> The intent of this planetary protection policy 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 requirements must differ.

Presently: The current planetary protection policy documents do not stipulate detailed requirements for future human missions to Mars, but rather provide principles and guidelines of what will be needed for implementation of any successful mission and provide the basis to move forward to develop agency-level and eventually mission-level requirements. Appropriate agency-level documents are (will?) embodying the new requirements as they come forward. Such requirements are essential complements to future human missions beyond Earth orbit, and can contribute to technology development and science activities on the Moon as well as to planning for human mission to Mars and use of its resources. As long as there is a possibility that Mars may have indigenous life, or that there are places on Mars where Earth organisms might survive and grow (cf., 12], planetary protection provisions will be an essential part of activities and exploration on Mars.

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