WORKSHOP

Planetary Protection Knowledge Gaps for Human Extraterrestrial Missions

March 24-26, 2015 NASA Ames Research Center HEOMD & PPO

85 Attendees: 3 Sub-Group Focus Areas:

1. *Microbial & Human Health Monitoring*
2. *Technology & Ops for Contamination Control*
3. *Natural Transport of Contamination on Mars*

NASA Advisory Council Recommendation

TITLE: Planetary Protection Procedural Requirements Document for Human Extraterrestrial Missions

RECOMMENDATION: The NASA Advisory Council recommends that NASA develop the appropriate implementing document to specify planetary protection procedural requirements for human extraterrestrial missions at a level corresponding to the current COSPAR (Committee on Space Research) planetary protection policy, and update it as new knowledge becomes available.

MAJOR REASONS FOR PROPOSING THE RECOMMENDATION: NASA Policy Directive 8020.7G on “Biological Contamination Control for Outbound and Inbound Planetary Spacecraft” requires the development of detailed documents delineating the standards and procedures implementing compliance with planetary protection standards and procedures for human spaceflight missions. Currently, however, no such documents exist for human missions.

CONSEQUENCES OF NO ACTION ON THE PROPOSED RECOMMENDATION: NASA will be out of compliance with its own policy requirements as it plans the prominent flagship missions of human exploration and with international agreements to which the U.S. is a party.

Current status

Planetary Protection core team determined that we did not have the necessary technical requirements to draft an NPR.

Drafted a NASA Policy Instruction (NPI) – Benefits of NPI

- Agency wide – stays in place until removed-must be followed by the entire Agency
  - OGC has advised that there are various type of policy documents used as policy guidance applicable to all parts of NASA. An advantage of the NPI is it is available in NASA's agency-wide Directives system (NODIS) and is thus easily available.
- Would state that an NPR will be drafted for planetary missions involving humans when the necessary specific requirements are developed, emphasizing reasons why building Planetary Protection studies into programs now is key.
- Can be processed much more quickly than an NPR.
- Would incorporate COSPAR policy.
- NPI does not need specific requirements

Next Steps – 2014 and 2015

- MAY 2014: NPI released and included in NODIS
- MAY 2014: Initial literature survey complete to identify notional studies
- MAY/JUNE 2014: Formulation of a planetary protection workshop and study prioritization task force
- AUG 2014: Hold introductory briefing with Human Spaceflight Architecture Team (HAT) personnel for engagement in studies
- March 2015: Conduct a workshop to identify the current state of knowledge in Planetary Protection & Human Mission Systems
- MAY 2015: Create prioritized list of needed studies to inform requirements
- AUG 2015: Approval of studies for funding no later than FY 2016
- OCT 2015: Iteration of draft requirements in parallel with studies

Overall Workshop Goals

- To identify our knowledge gaps with respect to human missions to Mars and planetary protection by:

1. Gathering and discussing information needed to help move closer to definitive (procedural/implementation) requirements for future human missions NPRs

1. Assessing the types and levels of research underway and/or needed to identify knowledge gaps in areas consistent with fulfilling COSPAR Principles and Guidelines for Human Missions to Mars

1. Building a network of expertise to help address planetary protection challenges for human exploration

5 Guiding Sub-Group Questions

- What *PP R&TD areas are critical for each study area?*
- What work/research is *already underway?*
- Special info needed *for nominal vs. non-nominal situations?*
- *Are existing options for mitigating contamination adaptable* for planetary protection needs on the Martian surface?
- Are there any *significant stumbling blocks ahead* that are evident? (including coordination across PP, science exploration, engineering, operation & medical communities)

Objective: Identify Specific *Research Needed to Contribute towards Meeting COSPAR Planetary Protection Principles & Guidelines for Human Mars Missions*

(Incremental approach– NPIs leading to NPRs)

Study Areas and Themes
Seeking "State of Knowledge" & "Gaps"

- Study Area #1: Human Health & Microbial Monitoring
  - Monitoring growth and survivability of human & habitat associated microbial populations in space environments
  - Minimal mass/volume and low consumable/waste product biological assay techniques
  - Microbiome research and ability to detect extraterrestrial perturbations
  - Crew quarantine measures for preventing back contamination
  - Crew health and habitat microbiome impacts from Mars material
- Study Area #2: Technology & Operations for Contamination Control
  - Cleaning, sterilization, and re-contamination prevention technologies for in-situ application
  - ECLS loop closure and mitigation of spacecraft effluents
  - Technologies for contamination control of human surface mobility systems and spacesuits
  - Contamination control and localized special region prevention for support systems (ISRU, Power, etc.)
  - Human surface exploration operational strategies for mitigating contamination
  - Sample containment and breaking-the-chain (BTC) of contact technologies
- Study Area #3: Mars Environmental Effect Characterization
  - Transport mechanisms on the Mars surface
  - Potential sterilization effects of the Mars environment
  - Environmental clean-up of inadvertent release of unsterilized terrestrial material

Workshop & Collaborative Outcomes To Date

- Publication of Workshop Report Anticipated, Summer 2015
  - Draft Summaries Already Completed for All 3 Study Areas
  - Final Report To be Posted on Planetary Protection Website
    - http://planetaryprotection.nasa.gov

- Already: Successful Interdisciplinary Collaborations - HEOMD & PPO

① EVA SWAB TESTING ON ISS

- Development of Prototype Tool – How To Swab & Contain in Space
- In November- Piggy Back on Spacesuit Testing
- Later- To Test & Use on ISS Vents during EVA's (inside/outside vents)

② MINI-DNA SEQUENCING - Microbial Dispersal Studies (away from Habs & Rovers)

Arctic Field Tests Anticipated in Summer 2015

Later: Demo Low-cost DNA Sequencing for use on ISS and Space?

Titles for the three Advances in Space Research papers

An overview/summary of a Literature Review on Planetary Protection and Human Missions

A summary of the recent Planetary Protection Knowledge Gaps Workshop

An overview of Systems Engineering & Planetary Protection in relation to future human exploration.

Workshop agenda – Day 1

WORKSHOP DAY 1: Tuesday, March 24, 2015

Agenda Topic	Start Time	Duration	Speaker/Facilitator	Room	Misc. Notes
Check-in - lunch ordering available	**8:00**	**0:30**	**--**	**Main Entrance**	
Opening/Welcome	**8:30**	**0:10**	**Cassie Conley**	**171**	
Statement of Workshop Goals & Scope	**8:40**	**0:10**	**James Johnson**	**171**	
NASA, Mars, Human Spaceflight and Planetary Protection	**8:50**	**1:30**	**Bette Siegel**	**171**	
NASA's Evolvable Mars Campaign Overview	8:50	0:30	Doug Craig/Dr. Jitendra Joshi	171	
Current Planetary Protection Policy & Human Spaceflight	9:20	0:30	Cassie Conley	171	
NASA's Suggested Studies & Status	9:50	0:30	James Johnson	171	
BREAK	10:20	0:15	--	--	
Review of Previous Workshops	**10:35**	**1:00**	**John Rummel**	**171**	
The Development of Planetary Protection Requirements for Human Mars Missions: A History	10:35	0:30	Rummel, J. D.	171	25 min present/5 min Q&A
Summary of the 2005 Life Support and Habitation and Planetary Protection Workshop	11:05	0:30	Hogan, J. A.	171	25 min present/5 min Q&A
Study Area #1 Keynote Speaker	**11:35**	**0:30**	**TBD**	**171**	
LUNCH BREAK	12:05	1:30	--	--	
Study Area #1 Abstract Briefings	**13:35**	**2:00**	**Steve Davison**	**171**	
Planetary Protection for Human Exploration Missions: A Flight Surgeon's Perspective	13:35	0:20	Law, J.	171	15 min present/5 min Q&A
Capabilities for Planetary Protection: Safeguarding the Crew and Engineering Systems for Human Missions to Mars	13:55	0:20	Venkateswaran, K.	171	15 min present/5 min Q&A
Microbial Biocontamination Control in Manned Space Habitats	14:15	0:20	Leys, N.	171	15 min present/5 min Q&A
NASA's International Space Station: A Testbed for Planetary Protection Protocol Development	14:35	0:20	Bell, M. S.	171	15 min present/5 min Q&A
Phobos and Deimos: Planetary Protection Knowledge Gaps for Human Missions	14:55	0:20	Lee, P.	171	15 min present/5 min Q&A
Overview of Microbial Monitoring Technologies Considered for Use Inside Long Duration Spaceflights and Planetary Habitats	15:15	0:20	Roman, M. C.	171	15 min present/5 min Q&A
BREAK	15:35	0:15	--	--	
Study Area #1 Abstract Briefings (Continued)	**15:50**	**0:40**	**Steve Davison**	**171**	
Current Trends of High-Throughput Methods for Planetary Protection Requirements Associated with a Human Mission	15:50	0:20	Karouia, F.	171	15 min present/5 min Q&A
Near Real-Time Quantitation of Viable Microorganisms for Planetary Protection and Crew Health	16:10	0:20	Wainwright, N. R.	171	15 min present/5 min Q&A
Closing Comments/Adjourn	**16:30**	**0:05**	**James Johnson**	**171**	**Announcements (if any)**

Workshop – Day 2

Agenda Topic	Start Time	Duration	Speaker/Facilitator	Room	Misc. Notes
Venue opens - lunch ordering available	**8:00**	**0:30**	**--**	**Main Entrance**	
Opening Comments	**8:30**	**0:05**	**James Johnson**	**171**	**Announcements (if any)**
Study Area #1 Abstract Briefings (Continued)	**8:35**	**1:20**	**Steve Davison**	**171**	
Comprehensive and Sensitive Microbial Detection Using A Broad Spectrum Detection Microarray	8:35	0:20	Jaing, C.	171	15 min present/5 min Q&A
Current Progresses of MiDASS: The European Project for an Automated Microbial Identification Instrument	8:55	0:20	Mabilat, C.	171	15 min present/5 min Q&A
The Sloan Foundation Microbiology of the Built Environment Program: What's there? Where does it come from? And what does it mean?	9:15	0:20	Olsiewski, P. J.	171	Cannot present on Day 1. 15 min present/5 min Q&A
Surface Sampling and Detection Investigations at the CDC	9:35	0:20	Rose, L. J.	171	Cannot present on Day 1. 15 min present/5 min Q&A
BREAK	9:55	0:15	--	--	
Study Area #2 Keynote Speaker	**10:10**	**0:30**	**TBD**	**171**	
Study Area #2 Abstract Briefings	**10:40**	**1:20**	**Jitendra Joshi**	**171**	
Environmental Control and Life Support Systems for Mars Missions - Issues and Concerns for Planetary Protection	10:40	0:20	Barta, D. J.	171	15 min present/5 min Q&A
Human Life Support by Microbes in Space	11:00	0:20	Leys, N.	171	15 min present/5 min Q&A
Extravehicular Activity and Planetary Protection	11:20	0:20	Buffington, J. A.	171	15 min present/5 min Q&A
Low-Latency Teleoperations for Mars Planetary Protection	11:40	0:20	Lupisella, M. L.	171	15 min present/5 min Q&A
LUNCH BREAK	12:00	1:30	--	--	
Study Area #2 Abstract Briefings (Continued)	**13:30**	**1:20**	**Jitendra Joshi**	**171**	
Mars Sample Return Feedforward of Potential Planetary Protection Technology/Knowledge to Human Exploration	13:30	0:20	Hays, L. E.	171	15 min present/5 min Q&A
Mars Soil-Based Resource Processing and Planetary Protection	13:50	0:20	Sanders, G. B.	171	15 min present/5 min Q&A
Mitigating Inadvertent Contamination In Subsurface Drilling	14:10	0:20	Glass, B.	171	15 min present/5 min Q&A
Case Study of Human Flora and Spore Contamination	14:30	0:20	Polarine, J. P.	171	15 min present/5 min Q&A
Sample Containment Technology for Mars Sample Return	14:50	0:20	Gershman, B.	171	15 min present/5 min Q&A
BREAK	15:10	0:15	--	--	
Study Area #3 Keynote Speaker (TBD)	**15:25**	**0:30**	**TBD**	**171**	
Study Area #3 Abstract Briefings	**15:55**	**1:00**	**John Rummel**	**171**	
Understanding the Process and Drivers for Developing Human Exploration Planetary Protection Requirements	15:55	0:20	Jones, M. A.	171	15 min present/5 min Q&A
Forward Planetary Protection Issues and Constraints Related to Planning for the Potential Human Exploration of Mars	16:15	0:20	Beaty, D. W.	171	15 min present/5 min Q&A
Ultraviolet Irradiation on the Surface of Mars: Implications for EVA Activities During Future Human Missions	16:35	0:20	Schuerger, A. C.	171	15 min present/5 min Q&A
Closing Comments/Adjourn	**16:55**	**0:05**	**James Johnson**	**171**	**Announcements (if any)**

Workshop day 3

Agenda Topic	Start Time	Duration	Speaker/Facilitator	Room	Misc. Notes
Venue opens - lunch ordering available	**8:00**	**0:30**	**--**	**Main Entrance**	
Opening Comments	**8:30**	**0:05**	**James Johnson**	**171**	**Announcements (if any)**
Study Area #3 Abstract Briefings (Continued)	**8:35**	**1:20**	**John Rummel**	**171**	
Geodermatophilus Sp. Strain MN04-01 Survives High Doeses of Simulated Present-Day Martian UV Radiation	8:35	0:20	Paulino-Lima, I. G.	171	15 min present/5 min Q&A
Predicting the Response of Terrestrial Contamination on Mars with Balloon Experiments in Earth's Stratosphere	8:55	0:20	Smith, D. J.	171	15 min present/5 min Q&A
Low Dispersal of Human-Associated Microbes on to Pristine Snow during an Arctic Traverse on Sea Ice by the Moon-1 Planetary Surface Rover	9:15	0:20	Schuerger, A. C.	171	15 min present/5 min Q&A
Near Space Biological Research Using Weather Balloons	9:35	0:20	Harrison, S. M.	171	15 min present/5 min Q&A
BREAK	9:55	0:15	--	--	
NOTE ON BREAKOUT SESSIONS: The goal of these sessions is to identify, based on all abstract briefings given, the most significant planetary protection knowledge gaps pertaining to the future human exploration of Mars. Expect working, facilitated discussions. Attendance of these sessions is strongly encouraged of all participants.					
Breakout Session Ground Rules & Assumptions	**10:10**	**0:20**	**James Johnson**	**171**	
Study Area #1 Breakout Session Commenses	**10:30**	**1:20**	**Steve Davison**	**105/106**	**Note separate room.**
Study Area #2 Breakout Session Commenses	**10:30**	**1:20**	**Jitendra Joshi**	**120**	**Note separate room.**
Study Area #3 Breakout Session Commenses	**10:30**	**1:20**	**Andy Spry**	**112**	**Note separate room.**
LUNCH BREAK	11:50	1:30	--	--	
Study Area #1 Breakout Session Wrap-up	**13:20**	**1:00**	**Steve Davison**	**105/106**	**Note separate room.**
Study Area #2 Breakout Session Wrap-up	**13:20**	**1:00**	**Jitendra Joshi**	**120**	**Note separate room.**
Study Area #3 Breakout Session Wrap-up	**13:20**	**1:00**	**Andy Spry**	**112**	**Note separate room.**
RE-GROUP	14:20	0:15	--	--	
Study Area #1 Outbriefing *(20 min + 10 min Q&A)*	**14:35**	**0:30**	**Steve Davison**	**171**	
Study Area #2 Outbriefing *(20 min + 10 min Q&A)*	**15:05**	**0:30**	**Jitendra Joshi**	**171**	
Study Area #3 Outbriefing *(20 min + 10 min Q&A)*	**15:35**	**0:30**	**Andy Spry**	**171**	
Workshop Conclusion	**16:05**	**0:25**		**171**	
Discussion of Next Steps	16:05	0:15	James Johnson	171	
Wrap-up/Closing Comments	16:20	0:10	Cassie Conley	171	
Adjourn	**16:30**			**171**	

TA 1
LAUNCH PROPULSION SYSTEMS
TA 2
IN-SPACE PROPULSION TECHNOLOGIES
TA 3
SPACE POWER AND ENERGY STORAGE
TA 4
ROBOTICS AND AUTONOMOUS SYSTEMS
TA 5
COMMUNICATIONS, NAVIGATION, AND ORBITAL DEBRIS TRACKING AND CHARACTERIZATION SYSTEMS
TA 6
HUMAN HEALTH, LIFE SUPPORT, AND HABITATION SYSTEMS
TA 7
HUMAN EXPLORATION DESTINATION SYSTEMS
TA 8
SCIENCE INSTRUMENTS, OBSERVATORIES, AND SENSOR SYSTEMS
TA 9
ENTRY, DESCENT, AND LANDING SYSTEMS
TA 10
NANOTECHNOLOGY
TA 11
MODELING, SIMULATION, INFORMATION TECHNOLOGY, AND PROCESSING
TA 12
MATERIALS, STRUCTURES, MECHANICAL SYSTEMS, AND MANUFACTURING
TA 13
GROUND AND LAUNCH SYSTEMS
TA 14
THERMAL MANAGEMENT SYSTEMS
TA 15
AERONAUTICS