



The Need for Integrating Planetary Protection Science and Technology Into Lunar Exploration Planning

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What's Planetary Protection (PP)?

Like Environmental Protection for the Solar System

- Based on **Outer Space Treaty of 1967**(OST) and **COSPAR** Policies
- **Avoid Hazardous Cross Contamination** During Exploration ('hitchhiker' organisms)
 - ✓ Protect Planets and Science
 - ✓ Control Forward and Back Contamination
- All US Missions **Must Comply** With OST and PP Policies
- Requirements Depend on Target, Science & Probability for ET Life
- NASA Directives and Requirements Apply



Robotic Missions:

- ✓ PP = Strict, Conservative, Not Optional or Add-on
- ✓ Long Lead Time for Plans, Designs, Technology & Operations
(e.g. Mars Missions: Flybys, Orbiters, Landers, Penetrators etc.)

Human Missions Ditto... Exact Details TBD



How Do PP Regulations Apply To Missions?

PLANET PRIORITIES

		MISSION TYPE	MISSION CATEGORY	REQMTS.
A	Not of direct interest for understanding the process of chemical evolution. No protection of such planets is warranted (e.g., MOON , Most Asteroids)	Any	I	None
B	Of significant interest relative to the process of chemical evolution, but only a remote chance that contamination.... (e.g. Venus, Jupiter, Saturn, Uranus, Neptune, Pluto, KBOs, asteroids)	Any	II	PP Plan Documents
C	Of significant interest relative to the process of chemical evolution and/or the origin of life or for which...a significant chance of contamination which could jeopardize a future biological experiment. e.g. MARS , Europa, others TBD	Flyby, Orbiter	III	**
		Lander, Probe	IV	**
All	Any Solar System Body (All)	Earth-Return	V	Unrestricted (MOON) Restricted **

****** PP Plan, Documentation, Plus Trajectory Biasing, Cleanroom Assembly, Bioload Reduction Of Hardware, Orbital Lifetimes As Necessary



How Will PP Effect Human Lunar Missions?

Lunar Missions: No PP Concerns

Forward Contamination Controls: Category I - No Requirements

Back Contamination Controls: Category V - Unrestricted Earth Return

Even So, Consider PP in Lunar Architecture Planning:

- ✓ **Use Moon as Test Bed to Enable Future Mars Missions**
- ✓ **Help Guide the Designs, Equipment, Protocols, Operations for Long Duration Missions**
 - **ALS, EVA, EMC, Science Activities**
- ✓ **Avoid Pursuing Two Distinct, Expensive Technology Pathways**

Draw from Apollo and Recent Workshops/Studies on PP and Mars Missions

Identified Science, Life Support, Environmental and Technology Issues

- **NASA-ESA PP and Humans on Mars Workshop- Nordwijk, May 2005**
- **NASA LSH and PP Workshop- Houston, April 2005**
- **NASA Workshop PP Issues in Human Mars Exploration, Pingree Park, Summer 2001**
- **Also: MEPAG 2005 JPL - Precursor Info to Reduce Risks of Human Mars Missions**
- **Draft Protocol for Handling and Testing Mars Returned Samples, 2002**



Relevant Findings on PP and Human Missions

- **Must Assume Can't Have Entirely Enclosed Systems For Science And Activities**
- **People *Will* Contaminate And *Be* Contaminated**
 - How Limit Exposure? How Control Contaminants?
 - Forward And Back Contamination
- **Safeguarding Earth Is Highest Priority**
- **PP *Will* Affect Design, Operations And Costs Of Life Support, Environmental And Scientific Systems**
 - Identify Contaminants And Pathways (Nominal)
 - Consider Off-Nominal Events Typical Of Systems
 - Derive Engineering Requirements with PP needs in mind
for ALS, EVA, EMC Systems, Science, Operations



Combined Areas of Importance for PP of Relevance to Lunar Architecture

Forward Contamination

- **Microbial Contamination Inside/Outside Habitat**
 - Understand Survival, Spread, Decay Rates Of Microbes
 - Current Vs. Prior Missions
 - Baseline Levels Of Contaminants Due To Human Presence
 - Track, Understand Microbes & Contaminants Near/Far Outside Habitat
 - Ingress/Egress Associated Contamination, Dusts Etc.
 - EVA & Suit Associated Contaminants (Characterize, Leak Rates, Etc.)
- **Operations**
 - Cleaning, Re-cleaning, Maintenance Of Tools, Suits, Habitat, Etc.
 - Waste Handling, Disposal & Venting From Habitat: Need to Understand, Control
 - Environmental Monitoring And Control (AEMC)
 - EVA, Habitats, Suits, Transit Vehicle Etc. Throughout Mission
 - ALS As Possible Contaminant Sources: Need understand Biological Treatment Technologies, Bioregenerative Systems
 - Habitat Decontamination, Deactivation etc Upon Crew Departure (Microbial Concerns)



Combined Areas of Importance for PP with relevance to Lunar Architecture

Science Activities

- Develop Technologies To Contain/Handle Samples On Planet
- Classification Of Outside Areas
 - Based on Scientific Interest , Contamination Concern, Human Activities
 - Pre-mapping: Include Comm And Nav Systems Considerations
- Improve Subsurface Sampling Technologies And Protocols

ISRU Activities

- Understand Contaminants & Possible Transfers
(e.g., Food, Ice/Water, Life support systems, etc.)

Consider General Human Factors– Long Duration

- Debilitation, Reduced Performance, Unintended Actions
All With PP Implications
- Onboard Crew-Member with Designated PP responsibilities
- Link PP With Ops, Flight And Medical Communities



Conclusions

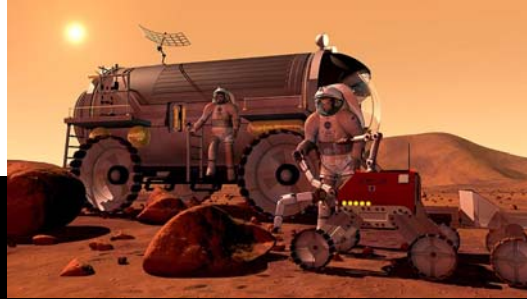
Addressing Scientific, Technical, Operational Aspects Of PP

- **Critical For Mars Human Missions**
- **Important Consideration For Lunar Missions**
 - Enabling Technologies for Future Long Duration Planetary Missions
 - Use Moon As Test Bed
 - Avoid Two Distinct, Expensive Technology Pathways
 - Integrate into Early Planning and Designs

Also Important To Communicate To Public about PP

- PP Policy, Science and Technology As Part In Both Lunar And Mars Missions (Different from Apollo)
- Contribute To Public Understanding And Support For Missions
- Demonstrates Responsible Exploration

QUESTIONS?



Planetary Protection



All of the Planets, All of the Time....



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