NEXT GENERATION MICROBIOLOGY REQUIREMENTS

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As humans continue to explore deep into space, microorganisms will travel with them. The primary means to mitigate the risk of infectious disease are a combination of prudent spacecraft design and rigorous operational controls. The effectiveness of these methods are evaluated by microbiological monitoring of spacecraft, food, water, and the crew that is performed preflight, in-flight, and post-flight. Current NASA requirements associated with microbiological monitoring are based on culture-based methodology where microorganisms are grown on a semi-solid growth medium and enumerated. Subsequent identification of the organisms requires specialized labor and large equipment, which historically has been performed on Earth.

Requirements that rely strictly on culture-based units limit the use of non-culture based monitoring technology. Specifically, the culture-based "measurement criteria" are Colony Forming Units (CFU, representing the growth of one microorganism at a single location on the agar medium) per a given volume, area, or sample size. As the CFU unit by definition is culture-based, these requirements limit alternative technologies for spaceflight applications. As spaceflight missions such as those to Mars extend further into space, culture-based technology will become difficult to implement due to the (a) limited shelf life of the culture media, (b) mass/volume necessary to carry these consumables, and (c) problems associated with the production of biohazardous material in the habitable volume of the spacecraft. In addition, an extensive amount of new knowledge has been obtained during the Space Shuttle, NASA-Mir, and International Space Station Programs, which gave direction for new or modified microbial control requirements for vehicle design and mission operations.

The goal of this task is to develop and recommend a new set of requirements for vehicle design and mission operations, including microbiological monitoring, based upon “lessons learned” and new technology. During 2011, this study focused on evaluating potable water requirements by assembling a forum of internal and external experts from NASA, other federal agencies, and academia. Key findings from this forum included:

- Preventive design and operational strategies should be stringent and the primary focus of NASA’s mitigation efforts, as they are cost effective and can be attained with conventional technology.
- Microbial monitoring hardware should be simple and must be able to measure the viability of microorganisms in a sample. Multiple monitoring technologies can be utilized as long as at the microorganisms being identified can also be confirmed as viable.
- Evidence showing alterations in the crew immune function and microbial virulence complicates risk assessments and creates the need for very conservative requirements.
- One key source of infectious agents will always be the crew, and appropriate preventative measures should be taken preflight.
- Water systems should be thoroughly disinfected (sterilized if possible) preflight and retain a residual biocide throughout the mission.

Future forums will cover requirements for other types of samples, specifically spaceflight food and environmental samples, such as vehicle air and vehicle and cargo surfaces. An interim report on the potable water forum has been delivered to the Human Research Program with a final report on the recommendations for all sample types being delivered in September 2013.