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Engineering Planetary Protection – Conclusions from the ExoMars Rover Phase A Study

R.Wall, L. Waugh, R. Slade, M. F. Smith, C. Draper
EADS Astrium Ltd., Gunnels Wood Road, Stevenage, SG1 2AS, U.K.
ronan.wall@astrium.eads.net / Fax: +4414 3877 8911

How COSPAR Planetary Protection requirements are translating to engineering principles and implementation strategies for Europe's first Mars Rover.

The ExoMars Rover represents a challenging engineering project on many levels, not least ensuring that Planetary Protection requirements can be met. The ExoMars Descent Module and Rover with its Pasteur payload are classified as COSPAR Planetary Protection Category IVc in light of the exobiological science that it will perform and nature of the landing site. The application of this demanding category to the Mission will mean that, for example, the AIV procedures for ExoMars will be far more complex than any performed thus far in Europe, with consequences for the overall system design.

Meeting the overall levels of sterility requires innovative planning including looking at such diverse possibilities as post-sterilization ultra-clean assembly, glovebox integration, full biosuit integration (in excess of that utilised for Beagle 2).

The science mission operations for the ExoMars Rover and the topic of 'special regions' is critical in determining the appropriate sterilization strategies. Key will be the understanding of the nature, location and accessibility of the 'special regions' and the probability of their accidental contamination for different mission scenarios. Given the stated exobiology objectives of the Pasteur science payload, the limited range of the Rover and the accuracy of an unguided ballistic entry, it expected that all elements of the DM and Rover systems will land in a 'special region' and therefore the stringent requirements of category IVc will apply to the whole vehicle.

Three bio-burden management strategies: ‘aseptic modular integration’ and ‘terminal sterilization’ and a hybrid approach, have been considered and will be discussed.

The baseline design for the Rover incorporates a highly modular approach with modules that can be made tolerant to Dry-heat Sterilization (with the exception of the battery and Pasteur). The challenges in developing an overall Assembly, Integration and Verification approach for ExoMars will be discussed in light of the sensitivity of the Pasteur payload elements to Dry-Heat. The practical accommodation issues of ‘late fit’ items will be discussed.

The PP impact of the potential inclusion of an RHU heat source will be highlighted and concerns about the integrity of the RHU containment after a non-nominal landing scenario will be discussed.

Although not a Planetary Protection requirement, organic cross-contamination is also a major driver in the design of instruments and subsystems to ensure that the organic-sensitive experiments remain accurate and unbiased, and will be described during the presentation.