SPACE EXPLORATION SYMPOSIUM (A3)
Mars Exploration – Part 2 (3B)

Author: Dr. Piergiovanni Magnani
Selex ES, Italy

Mr. Samuel Senese
Selex ES, Italy
Dr. Alessandro Fumagalli
Italy
Mr. Antonio Terribile
Tecnomare S.p.A., Italy
Mr. Alberto Pedrini
Tecnomare S.p.A., Italy
Mr. Dennis Indrigo
Tecnomare S.p.A., Italy
Mr. Michael Guest
SEA, United Kingdom
Dr. Jens Romstedt
European Space Agency (ESA), The Netherlands

BIO-CONTAINMENT OF SAMPLES IN THE FRAME OF THE MARS SAMPLE RETURN MISSION: A MIXED EXPERIMENTAL/ANALYTICAL APPROACH FOR THE VERIFICATION OF BASIC PLANETARY PROTECTION REQUIREMENT

Abstract

The Mars Sample Return (MSR) Mission foreseen in the 2020s envisages the collection of some tens of samples of Martian soil for return to Earth. Once collected, the samples will be stored into a dedicated Container (OS) which is launched into Mars orbit. After being captured by the orbiting Spacecraft, the OS is placed and sealed inside a dedicated Bio-Container and finally transferred into the Earth Reentry Capsule for the return trip. In the frame of a recently performed activity for ESA/ESTEC, the Bio-Container has been designed as a double walled metallic containers with hermetically closing lids equipped with triple gasket system. Another lid with a gasket barrier and self-sterilisation capability is also present with the purpose of breaking the biological chain of contact with Mars. The so conceived Bio-Container has undergone a thorough Bread-boarding and Testing activity including: one full vessel, one full lid, lid closing mechanism, monitoring system and chain breaking lid.

The Bio-Container is therefore one of the key elements to guarantee the very stringent Planetary Protection requirements. The main requirement is summarized as the following: “The bio-container shall ensure that the probability that a single unsterilized particle larger than 10 nm class particles in diameter is released from containment in the terrestrial biosphere is below 10-6”.

The verification of this requirement can be quite difficult due to the very small size of the referred particles and the very low probability figure involved; the verification approach proposed has been based on the following steps:

Helium leak rate characterization by test of calibrated hole and of the gaskets;

particle escape rate characterization from calibrated hole and from gaskets (using nano-particles);

preparation of a mathematical model for the gas (Helium, Argon) leak rate and particle escape rate;

calibration of the mathematical model for gas leak against measured leaks of calibrated hole and gaskets and gaskets characteristics reconstruction;

calibration of the mathematical model for particle leak against measured particle leaks of a calibrated hole;

projection of gas leak and particle escape from the whole Bio-container by utilizing the calibrated leak model across the gaskets.

The proposed paper presents the main issues related to the verification approach used for the main Planetary Protection requirement (related to particle escape) according to the above steps. Furthermore, for completeness, the main achievements in terms of Bio-Container configuration, developed hardware and main tests results are summarized.