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MARS SAMPLE RETURN: DESIGN OF THE BIO-CONTAINMENT SYSTEM

Abstract

One of the critical aspects of a future Mars Sample Return (MSR) mission is the actual return configuration of the Mars sample container. All bio-sealing operations are to be performed in Mars orbit, inside the MSR orbiter as part of the orbiting sample handling system (OSHS). After capture of the orbiting sample container, the bio-containment system creates a reliable and safe packaging of the MSR samples before placing them into the Earth Return Capsule (ERC) in line with the planetary protection guidelines.

Two options for the bio-sealing operations have been elaborated in the frame of the MSRO studies. The most demanding requirements are related to planetary protection and high shock resistance up to 900g to survive ballistic impact, combined with typical limitations as small volume, low weight and careful use of power. The first bio-seal is considered the most critical one, as it must ensure sterility by breaking the link with the Mars environment.

In option one, the bio-containment system ensures planetary protection with bio-sealing operations at two levels; Immediately after capture, the first bio-seal is applied by closing the first containment level with a double cover. Shape Memory Alloys are used to generate high forces to create metal knife edge seals with high leak tightness. After sterilization of the sealed interfaces, the double cover is separated leaving two bio-seals, one to enclose the MSR samples and one to seal the 'contaminated' capture mechanism. Two additional bio-seals are then to be applied on the structural bio-container.

The alternative bio-containment system makes use of a temporary barrier, which will be a polymeric bag type of material that can be sealed more easily. The permeability is higher, but it works as a perfect bio-barrier during a short time. Similarly to the first concept, the sealing of the temporary bag needs to be a double bio-seal which allows separation of the MSR samples from the capture mechanism. In this simplified bio-containment system, three more bio-seals, all SMA operated, are applied on the structural bio-container to ensure triple redundancy.

Monitoring of the bio-seals is for both systems based on pressure and temperature monitoring at three levels, allowing control of each individual seal.

This design will be explained in more details.