

PLANETARY PROTECTION CONSIDERATIONS FOR MARS SAMPLE RETURN. Catharine A. Conley²,
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Introduction: Regarding planetary protection for Mars Sample Return missions, there are three distinct aspects that must be addressed. The highest priority for any sample return mission must be to protect the Earth from harmful contamination by a returned sample, as dictated by international law, specified in the Outer Space Treaty of 1967. Secondly, the sample must be protected from the environment of Earth, because contamination by terrestrial materials could irretrievably damage the potential for specific scientific investigations to be performed on the returned samples. Finally, the target location from which the samples are collected must be protected from contamination by materials or organisms carried on the spacecraft performing mission activities, which might interfere with future scientific investigation of that target body.

The sources for requirements addressing each of these aspects of planetary protection for Mars Sample Return are the international policy on planetary protection that is maintained by the Committee on Space Research (COSPAR) of the International Council for Science (ICSU), and the individual policies of the national or international space agencies that will perform a sample return mission.

Policy for MSR missions: The planetary protection policies of both COSPAR and NASA assign any mission to return samples from Mars to Category V, Restricted Earth Return. On this category of mission, both COSPAR and NASA policy impose the most stringent restrictions for planetary protection purposes, as described in NASA Requirements Document 8020.12 (The COSPAR policy uses slightly different wording with the same intent):

“the highest degree of concern is expressed by the prohibition of destructive impact upon return, the need for containment throughout the return phase of all returned hardware which directly contacted the target body and/or any unsterilized material from the body, and the need for containment of any unsterilized sample collected and returned to Earth. After the flight mission there is a need to conduct, under strict containment and using the most effective techniques, timely analyses of the unsterilized sample collected and returned to Earth. If any sign of a non-terrestrial replicating entity is found, the returned sample must remain contained unless treated by an effective sterilizing procedure. Category V concerns are reflected in requirements that encompass those for Category IV plus the continued monitoring of related project activities, studies, and research.”

NASA Requirements for MSR missions: In addition to abundant documentation and reporting, specific requirements are imposed by NPD 8020.12 on NASA-led missions to Mars that are assigned to Category V, Restricted Earth Return, as follows:

- a) Unless specifically exempted, the outbound leg of the mission shall meet Category IVb requirements. This provision is intended to avoid "false positive" indications in a life-detection and hazard-determination protocol or in the search for life in the sample after it is returned. A "false positive" could prevent distribution of the sample from containment and could lead to unnecessary increased rigor in the requirements for all subsequent Mars missions.
- b) Unless the sample to be returned is subjected to an accepted and approved sterilization process, the sample container must be sealed after sample acquisition. A redundant, fail-safe containment procedure with a method for verification of its operation before Earth-return shall be required. For unsterilized samples, the integrity of the flight containment system shall be maintained until the sample is transferred to containment in an appropriate receiving facility.
- c) The mission and the spacecraft design must provide a method to "break the chain of contact" with Mars. No uncontained hardware that contacted Mars, directly or indirectly, shall be returned to Earth. Isolation of such hardware from the Mars environment shall be provided during sample container loading into the containment system, launch from Mars, and any in-flight transfer operations required by the mission.
- d) Reviews and approval of the continuation of the flight mission shall be required at three stages: 1) prior to launch from Earth; 2) prior to leaving Mars for return to Earth; and 3) prior to commitment to Earth entry.
- e) For unsterilized samples returned to Earth, a program of life detection and biohazard testing or a proven sterilization process shall be undertaken as an absolute precondition for the controlled distribution of any portion of the sample.

Beyond the overarching requirements given in official NASA documents, a considerable amount of work has been done to define more clearly the planetary protection requirements for individual Mars Sample Return missions. This includes both advice from the Planetary Protection Officer to project planning efforts and reports from the Space Studies Board and other advisory bodies, as well as results from a number of workshops that have been held by NASA and the international community to consider specific aspects of Mars Sample Return.