Jet Propulsion Laboratory
California Institute of Technology

PLANETARY PROTECTION
CENTER OF EXCELLENCE

MISSION FLIGHT SUPPORT

The Jet Propulsion Laboratory takes great precautions during missions to avoid the possible introduction and proliferation of Earth microbes from spacecraft on any planetary body with the potential for past or current biological activity. To prevent either forward or backward contamination, the essence of planetary protection, spacecraft hardware must be cleaned and/or sterilized as well as evaluated for the presence of microorganisms. Additionally, the flight hardware must be maintained in cleanroom environments to control for biological and environmental contamination such as dust particles and moisture. Special air filtering, personnel garments and routine cleaning, provide and maintain a specified level of cleanliness. To meet NASA's planetary protection requirements, JPL has a 1,800 ft^2 lab designed primarily for flight project support housing state-of-the-art microbiology equipment. Planetary protection mission implementation involves routine sampling of spacecraft hardware to verify cleanliness. The samples are processed in this lab using the NASA Standard Assay and other techniques.

Contamination must be prevented in order to preserve the integrity of exploring the solar system.

How does JPL Plan for Planetary Protection?

NASA's Planetary Protection (PP) policy calls for the imposition of controls on biological contamination for certain combinations of mission type and target body. There are five categories for target body/mission type combinations. The assignment of categories and the PP requirements for specific missions is determined by the NASA Planetary Protection Officer based on multidisciplinary scientific advice. This includes, but is not limited to, the use of cleanrooms during spacecraft assembly, application of different cleaning and sterilization techniques, and utilization of biobarriers. The five categories based on planetary target are:

I
Target: undifferentiated; metamorphosed asteroids; Io; etc.
Mission type: flyby, orbiter, lander

II
Target: Venus, Earth's Moon, comets, the outer planets, some satellites of the outer planets, some icy satellites, etc.
Mission type: flyby, orbiter, lander

III
Target: Mars, Europa, Enceledus, etc.
Mission type: flyby, orbiter

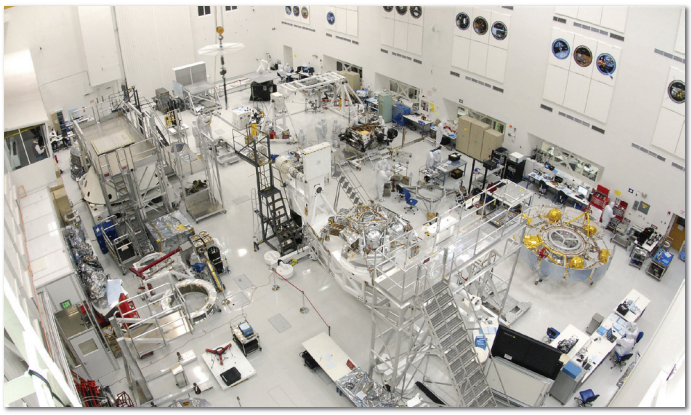
IV
Target: Mars, Europa, Enceledus, etc.
Mission type: lander, probe

V
Target: Sample return from any body
Mission type: Restricted Earth-Return (e.g., Mars, Europa)
Unrestricted Earth-Return (e.g., Moon, Venus)

**Restricted* - *Sample return missions from bodies that have a scientific potential life.*
***Unrestricted* - *Sample return missions from bodies that have no indication of life.*

Understanding and Reducing Bioburden

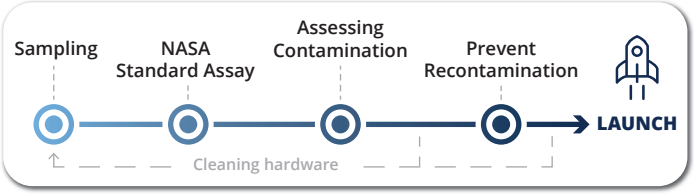
Bioburden is the number of microorganisms, including spores, in or on the flight hardware. The bioburden of the external surfaces of the spacecraft can be controlled by solvent cleaning (generally wiping), and contamination procedural and facility controls during assembly and testing. These approaches significantly reduce the bioburden on the spacecraft to meet NASA requirements. Large surface areas and those that are difficult to clean are often subject to heat microbial reduction (HMR). Thermal sensitive components many require different modes of microbial reduction such as vapor phase hydrogen peroxide (VHP) or radiation.



A cleanroom at NASA Jet Propulsion Laboratory with flight hardware.

PP Implementation and Sampling

Sampling events typically occur in cleanrooms during spacecraft assembly. The sampling process, includes the following: 1) sample the hardware using swabs and/or wipes, 2) use the NASA Standard Assay culture method to determine the bioburden on spacecraft, 3) calculate the bioburden density value to determine if the sampled hardware meets the planetary protection requirements. Cleaning and bioburden assessment occur throughout flight implementation including Assembly, Test, and Launch Operations (ATLO). To prevent re-contamination of hardware on exposed surfaces, engineers use a variety of methods like increasing cleanroom gowning requirements, covering hardware, and utilization of biobarriers.



A process flow for PP flight implementation.

More About Flight Support

Each exercise, from cleaning the hardware to verifying hardware cleanliness to taking action to prevent re-contamination, requires the coordinated participation of a myriad of hardware engineers, quality assurance engineers, and planetary protection engineers. JPL is committed to leveraging state-of-the-art technology and current best practices to ensure each NASA mission meets PP requirements. If you would like to know more about PP flight support, then visit our website for further information.

Find out more about us!

NASA Jet Propulsion Laboratory
Planetary Protection Center of Excellence

https://planetaryprotection.jpl.nasa.gov/

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