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NASA Procedural Requirements

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COMPLIANCE IS MANDATORY[Printable Format \(PDF\)](#)

Request Notification of Change (NASA Only)

Subject: Planetary Protection Provisions for Robotic Extraterrestrial Missions

Responsible Office: Science Mission Directorate[| TOC](#) | [Preface](#) | [Chapter1](#) | [Chapter2](#) | [Chapter3](#) | [Chapter4](#) | [Chapter5](#) | [AppdendixA](#) | [AppendixB](#) | [AppendixC](#) | [AppendixD](#) | [ALL](#) |

Chapter 2. General Mission Requirements

2.1 NASA Missions

2.1.1 Specific planetary protection requirements for each planned mission are determined by the NASA PPO, in accordance with this document, and consistent with the policy and guidelines of COSPAR, recommendations of the Space Studies Board (SSB) of the National Research Council (NRC), and advice from the NASA Advisory Council, to the extent appropriate.

2.1.2 Requests for PP categorization of missions and associated mission requirements shall be submitted to the PPO by the mission Project Manager or Principal Investigator before the end of Phase A and, preferably, early during mission design.

2.1.3 Such correspondence shall be accompanied by a mission description that identifies the target object and any other solar system bodies that would be encountered under the proposed spacecraft trajectory, as well as an overview of the proposed operations and end-of-mission scenario. A request and justification for a specific mission PP categorization should be included, and a PP category-specific listing of target body/mission types is provided in Chapter 5 for guidance in preparing this request. The PPO will respond, in writing, with the appropriate PP categorization, conveying such explanatory information or supplemental conditions as may be appropriate.

2.1.4 Documentation required for each mission shall be completed and approved on the schedules given in section 2.5, in coordination with the Key Decision Points (KDPs) described in NPR 7120.5. Approval of a mission's Planetary Protection Plan, for missions above PP Category I, completes formal PP categorization of the mission and should be accomplished no later than the end of Phase B.

2.2 NASA Participation in non-NASA Missions

2.2.1 NASA participation in non-NASA missions shall be supported only under the conditions specified.

2.2.1.1 The PP categorization and certification of compliance for the spacecraft shall be the sole responsibility of the lead agency on the mission (that is, the agency designing the mission).

2.2.1.2 When a mission is launched from the United States, documentation of compliance with this NPR's requirements shall be provided to NASA by the lead agency.

2.2.1.3 These activities shall be performed consistent with US obligations under the 1967 Outer Space Treaty.

2.2.2 NASA shall provide hardware, services, data, funding, and other resources to non-NASA missions (including but not limited to resources provided through international agreements, contracts, Space Act agreements, grants, and cooperative agreements) only if the recipient organization(s), whether governmental or private entity, demonstrate adherence to appropriate policies, regulations, and laws regarding planetary protection that are generally consistent with the COSPAR Planetary Protection Policy and Guidelines.

2.2.3 When NASA is providing resources that will be part of a mission on a non-NASA spacecraft, the

NASA-supported entity shall submit for approval by the NASA PPO a Planetary Protection Plan and associated documentation, defining the planetary protection requirements to be implemented and outlining the general procedures to be employed to meet those requirements.

2.2.3.1 A NASA-supported entity anticipating flights on non-NASA spacecraft may receive preliminary guidance by submitting a request to the NASA PPO, outlining its role and details of its role in the anticipated flight opportunity.

2.2.4 When applicable during development and delivery of instruments/experiments, monitoring of the implementation and certification of PP requirements shall be the responsibility of the lead agency (and demonstrated to the launching agency, if different, as part of the launch approval process). The NASA PPO may agree with the lead agency or project to share in or assume such responsibility by separate arrangement.

2.3 Implementation Requirements for U.S. Missions

2.3.1 NASA flight projects shall comply with planetary protection requirements appropriate to the mission PP category provided to them by the PPO. A summary of implementation requirements is provided in Table 2.

A. PP Category I Missions: Certification of a mission as PP Category I relieves a project of all further planetary protection requirements, including further documentation. Solar system missions/bodies classified as PP Category I are listed in Chapter 5.

B. PP Category II Missions: Planetary protection requirements are for documentation only, as detailed in section 2.7. Preparation of a brief Planetary Protection Plan is required for these flight projects in order to state intended or potential impact targets and detailing impact strategies. Projects will also provide Pre-and Post-Launch Reports and an End-of-Mission Report that will provide the location of impact, if such an event occurs. The combinations of solar system bodies and types of missions classified as PP Category II are listed in Chapter 5.

C. PP Category III Missions: Planetary protection requirements consist of documentation as detailed in section 2.7 (generally more involved than PP Category II), review requirements in section 2.8, and some implementing procedures, including trajectory biasing, the use of cleanrooms during spacecraft assembly and testing, and possibly microbial reduction. An inventory of bulk constituent organics is required if the probability of impact is considered significant. The combinations of solar system bodies and types of missions classified as PP Category III are listed in Chapter 5. Detailed requirements and associated specification sheets for PP Category III missions to selected solar system bodies are set forth in Chapter 5 and Appendix D, respectively.

D. PP Category IV Missions: Planetary protection requirements include detailed documentation, listed in Section 2.7 (more involved than PP Category III), review requirements in section 2.8, and also include bioassays to enumerate the microbial burden, a probability of contamination analysis, an inventory of the bulk constituent organics, and an increased number of implementing procedures. These implementing procedures may include trajectory biasing, cleanrooms, microbial reduction, possible partial sterilization of the direct contact hardware and use of biobarriers to protect that hardware from recontamination, and, in some instances, system-level (lander/probe) sterilization. The combinations of solar system bodies and types of missions classified as PP Category IV are listed in Chapter 5. Detailed requirements and associated specification sheets for PP Category IV missions to selected solar system bodies are set forth in Chapter 5 and Appendix D, respectively.

E. PP Category V Missions: This PP category comprises all Earth-return missions. The highest priority for these missions is the protection of the terrestrial system, which includes the Earth and the Moon. The Moon must be protected from the potential for backward contamination to retain freedom from planetary protection implementation requirements on Earth-Moon travel. PP Category V missions are designated either "Unrestricted Earth Return" for samples from solar system bodies deemed by scientific opinion to have no indigenous life forms; or "Restricted Earth Return" for samples from solar system bodies that may harbor indigenous life. Unrestricted Earth Return missions have PP requirements on the outbound phase only, corresponding to the PP category of that phase (typically PP Category I or II). Restricted Earth Return missions have PP requirements that encompass those for PP Category IV plus the continued monitoring of related project activities, studies, and research. Documentation requirements are detailed in section 2.7, and review requirements in section 2.8. Specific PP Category V requirements for selected solar system bodies are included in Chapter 5.

Table 2. Summary of Planetary Protection Implementation Requirements by Mission PP Category

<u>Mission PP Category</u>	<u>Implementation Requirements</u>
I (Any)	Documentation only.
II (Any)	Documentation only.

III (Flyby,Orbiter)	Impact avoidance and/or contamination control including: cleanroom assembly, microbial reduction, and trajectory biasing.
IV (Lander, Probe)	Impact avoidance and contamination control including: cleanroom assembly, microbial reduction, trajectory biasing, organics archiving.
V "Unrestricted Earth Return"	As appropriate for the specified PP category of the outbound mission. No inbound PP requirements.
V "Restricted Earth Return"	Impact avoidance and contamination control including: clean room assembly, microbial containment of sample, breaking chain of contact with target planet, sample containment and biohazard testing in receiving laboratory (continuing monitoring of project activities, preproject advanced studies and research, as needed).

2.3.2 Requests for PP categorization as PP Category V "Unrestricted Earth Return" or "Restricted Earth Return" shall be submitted to the PPO when mission PP categorization is requested. After discussion and review, a memorandum will be submitted by the PPO to the SMD AA requesting the appropriate certification for the sample return portion of the mission. The SMD AA, when appropriate, shall respond with a written certification.

2.3.3 For PP Category V missions designated as "Restricted Earth Return," an extensive set of additional documentation, detailed in section 2.7, shall be required. The associated activities and reviews are intended to ensure that the Earth's biosphere is not adversely affected by the introduction of material from returned samples.

2.3.3.1 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.

2.3.3.2 After the flight mission there is a need to conduct, under strict containment and using approved 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.

2.4 Monitoring and Verification

2.4.1 The PPO and/or designee, shall have access to technical and programmatic documentation, as well as areas and operations within the project contractor's or supplier's facilities, in which work is performed or items are stored that relate to the project.

2.4.2 The project shall make appropriate arrangements that allow the PPO, and/or designees, to conduct assays on flight hardware and controlled environments, including launch site, during the course of the project.

2.4.3 At the request of the PPO, the project shall make appropriate arrangement that allow the PPO, or designee, to be present during the transport of the bioburden controlled flight hardware and during the launch operations.

2.5 Schedules of Documentation and Review Requirements

2.5.1 Planetary protection documents shall be prepared as part of the formal documentation for the project and be submitted via the applicable Program Executive to the PPO for approval. A summary of planning and documentation requirements by mission PP category is presented in Table 3. Detailed information regarding document content is provided in section 2.7.

Table 3. Planning and Documentation Requirements by Mission PP Category

<u>Mission PP Category</u>	<u>Planning and Documentation</u>
I	Certification of PP Category I mission

II	Mission Certification Planetary Protection Plan Pre-Launch Planetary Protection Report Post-Launch Planetary Protection Report (Planetary Protection Extended Mission Report) End-of-Mission Report
III (Flyby, Orbiter)	Mission Certification Planetary Protection Plan Planetary Protection Implementation Plan Pre-Launch Planetary Protection Report Post-Launch Planetary Protection Report (Planetary Protection Extended Mission Report) End-of-Mission Report
IV (Lander, Probe)	Mission Certification Planetary Protection Plan Planetary Protection Implementation Plan Pre-Launch Planetary Protection Report Post-Launch Planetary Protection Report (Planetary Protection Extended Mission Report) End-of-Mission Report
V "Unrestricted Earth return"	Documentation for outbound phase Certification of Unrestricted Earth return
V "Restricted Earth return"	Documentation for outbound phase Earth Safety Analysis Plan Return Implementation Plan Earth Pre-Return Report Earth Pre-Entry Report Sample Pre-Release Report End-of-Mission Report

2.5.2 Planetary protection documents shall be submitted for review and approval, according to the schedule in Table 4, to be coordinated with KDP requirements given in NPR 7120.5. It is expected that the established dates be designated "control items" and reported in the normal monthly Project Management Reports.

2.5.2.1 The exact dates consistent with the schedule shall be determined in a manner agreeable to both PPO and Project Management and documented in the Planetary Protection Plan.

2.5.2.2 The Planetary Protection Implementation Plan and subsidiary documents (described in section 2.7.3.2) shall be made available to the PPO for discussion and review, to ensure that requirements are implemented appropriately, although formal approval is not required.

Table 4. Planetary Protection Documentation Schedule

<u>Report</u>	<u>Required Schedule</u>
Mission PP Categorization	Request for preliminary PP categorization to PPO during pre-Phase A/Phase 0. Request for formal PP categorization to PPO during Phase A.
<i>(if applicable) Certification for "Unrestricted Earth return"</i>	<i>No later than the end of Phase A.</i>
Planetary Protection Plan	Project-approved draft submitted to the PPO no later than end of Project's Conceptual Study Phase (Phase B). Approval and release before the Project's Preliminary Design Review (PDR).
PP Implementation Plan	Drafts made available to the PPO for discussion before the end of phase C. Approval by the project and release before the project's Critical Design Review (CDR).
<i>Earth Safety Analysis Plan</i>	<i>Approval and release prior to CDR.</i>

<i>Return Implementation Plan</i>	<i>Project approval prior to CDR.</i>
Subsidiary Plans	Project-approved draft submitted to the PPO no later than 3 months after completion of draft Planetary Protection Plan. Approval and release of all Subsidiary Plans before the Project's CDR.
Pre-Launch PP Report	Submitted to the PPO no later than 90 days prior to the scheduled launch. Includes Organics Inventory.
Post-Launch PP Report	Submitted to the PPO no later than 60 days after actual launch.
<i>Earth Pre-Return Report</i>	<i>Approval and release prior to the Earth Return Pre-Launch Review.</i>
<i>Earth Pre-Entry Report</i>	<i>Approval and release prior to the Earth Safety Analysis Review.</i>
<i>Sample Pre-Release Report</i> (may be released in sections)	<i>Approval and release prior to the Returned Sample Release Review and any release of sample material.</i>
Extended Mission PP Report	Submitted to the PPO no later than 60 days prior to scheduled end of the mission per the Planetary Protection Plan.
End-Of-Mission Report	Submitted to the PPO no later than 60 days after the formally declared "End-of-Mission."

NOTE: Details of documentation content are presented in Section 2.7

2.5.3 Planetary protection implementation and compliance shall be reviewed as part of the formal documentation for the project. A summary of the required review schedule is presented in Table 5, and detailed requirements on review content are provided in section 2.8.

Table 5. Planetary Protection Review Schedule

<u>Review</u>	<u>Schedule</u>
Planetary Protection Plan	Review within 60 days of draft release.
Subsidiary Plans	Review within 60 days of draft release.
Pre-Ship PP Review	No earlier than 30 days prior to shipment.
Pre-Launch PP Review	Approximately 90 days prior to earliest scheduled launch date.
Flight Readiness Review	Project scheduled review.
Earth Return Pre-Launch Review	No earlier than 30 days or later than 7 days prior to earliest scheduled launch date to return from the sampled object.
Earth Safety Analysis Review	No earlier than 30 days or later than 7 days prior to commencement of Earth-commit trajectory.
Returned Sample Release Review	Following completion of the life detection and (may be done in separate segments) biohazard testing prescribed by the PP protocols and prior to release of sample material from containment.

2.5.4 In addition to the documents listed in Table 4 and detailed in section 2.7, any mission other than PP Category I that intends to enter an extended mission period (beyond the mission duration approved in the Planetary Protection Plan) shall submit a Planetary Protection Extended Mission Report, analogous to a Pre-Launch Report, that must be approved as part of the extended mission approval.

2.5.4.1 The status of planetary protection compliance during the flight mission and the health of the spacecraft shall be reviewed and summarized.

2.5.4.2 Demonstration of compliance with all applicable planetary protection requirements during the extended mission and the results of any necessary analysis for the extended mission shall be provided.

2.6 Deviations

2.6.1 Deviations from the requirements in this document may be permitted only after review and written approval by the PPO. Deviations from implementation procedures set forth in this NPR may be granted when an alternative implementation approach is demonstrated to meet planetary protection policy and objectives and is consistent with effective mission design and operations.

2.6.2 Deviations requested prior to the approval of the Planetary Protection Plan shall be proposed by describing alternative implementation approach(es) in distinct and separately identified part(s) of the Planetary Protection Plan or other applicable subsidiary plan. Approval of the Planetary Protection Plan by the PPO will constitute written approval of proposed deviations so incorporated.

2.6.3 Deviations that are requested subsequent to the formal approval of the Planetary Protection Plan (or other applicable subsidiary plans) shall be obtained by submitting a request to the PPO in writing. Such requests should be transmitted via established program management channels. Requests must describe the need for a deviation and the justification to support the request, and include the impact of the requested change on the original analyses, as well as address possible changes in the PP category of the mission. The degree of compliance with all requirements must be addressed. The PPO will respond, in writing, to each request.

2.6.4 Requests for deviations after launch shall follow the process described in Section 2.6.3.

2.6.5 Changes involving major deviations within PP Category V shall, in addition to the above requirements, be approved, in writing, by the SMD AA.

2.6.6 Each deviation approved after completion of the Planetary Protection Plan shall be documented separately, for the record, in the Pre-Launch or End-of-Mission Report.

2.7 Detailed Documentation Requirements

2.7.1 Missions certified as PP Category II or higher shall comply with additional constraints specific to the mission, as detailed in the PP categorization letter, in addition to those described in this document.

2.7.2 Documentation of compliance with implementation requirements is required based on PP category and shall include:

A. PP Category I missions:

(1) Certification of mission as PP Category I relieves a project of all further planetary protection requirements.

B. PP Category II missions:

(1) A Planetary Protection Plan outlining intended or potential impact targets.

(2) A brief Pre-Launch Planetary Protection Report detailing impact avoidance strategies.

(3) A brief Post-Launch Planetary Protection Report detailing actual trajectory and any updates previous documentation.

(4) End-of-Mission Report providing the final actual disposition of launched hardware and impact location.

C. PP Category III missions:

(1) A Planetary Protection Plan that details the planned approach to compliance with planetary protection requirements, including subsidiary plans.

(2) A Planetary Protection Implementation Plan that details the project's implementation of the Planetary Protection Plan.

(3) A Pre-Launch Planetary Protection Report which documents that all requirements have been met (note that an inventory of bulk constituent organics, if the probability of impact is significant, must be included in the Pre-Launch Planetary Protection Report).

(4) A Post-Launch Planetary Protection Report that updates the Pre-Launch Planetary Protection Report.

(5) An End-of-Mission Report which provides a complete report of compliance, the final actual disposition of launched hardware, and, in the case of accidental impact, the probable location of impact and its region of uncertainty.

D. PP Category IV missions:

- (1) A Planetary Protection Plan that details the planned approach to compliance with the implementation requirements (e.g., mission description, probability estimates, microbial burden estimates, contamination analysis plan, assay plan, microbial reduction plan).
- (2) A Planetary Protection Implementation Plan that details the project's implementation of the Planetary Protection Plan.
- (3) A Pre-Launch Planetary Protection Report that documents the degree to which all requirements have been met and that must include the values of the microbial burden at launch and the organics inventory.
- (4) A Post-Launch Planetary Protection Report that updates the Pre-Launch Planetary Protection Report.
- (5) An End-of-Mission Report that provides a complete report of compliance and the final disposition of all launched hardware.
- (6) An inventory of bulk constituent organics that includes:
 - (a) Parts lists, material lists, and other program documentation containing data relevant to organic material identification that are prepared by a flight project to specify and control the materials that are included in a vehicle destined for planetary landing.
 - (b) The locations of landings and impact points (determined and defined as accurately as mission constraints permit) of major components of space vehicles on the planet surface,
 - (c) Estimates of the condition of each landed spacecraft to assist in calculating the spread of organic materials.

E. PP Category V missions certified as "Unrestricted Earth return" have no additional return phase requirements.

F. PP Category V missions certified as "Restricted Earth return" require:

- (1) A Planetary Protection Plan, including outbound phase requirements, if any, and an Earth Safety Analysis Plan.
- (2) A Planetary Protection Implementation Plan and Return Implementation Plan that details the project's implementation of the Planetary Protection Plan.
- (3) A Pre-Launch Planetary Protection Report, including outbound phase requirements, if any, that must document the degree to which all Earth-return requirements to be attained prior to launch have been met.
- (4) A Post-Launch Planetary Protection Report, including outbound phase requirements, if any, to update the Pre-Launch Planetary Protection Report with respect to Earth-return requirements.
- (5) After sample collection, a report analogous to the outbound phase prelaunch reports: i.e., an Earth Pre-Launch Report.
- (6) An Earth Pre-Entry Report demonstrating readiness to enter the Earth's atmosphere in compliance with planetary protection requirements.
- (7) An End-of-Mission Report to address compliance with requirements for the protection of the Earth's biosphere and detailing the transfer of the samples to an appropriate containment facility.
- (8) A Sample Pre-Release Report to provide verification of sample analysis procedures subsequent to the End-of-Mission and demonstrating that any planned sample release will not harm the Earth's biosphere.

2.7.3 Missions assigned PP Category II or higher shall provide the following planetary protection documentation, tailored appropriately to the mission PP category. Planning and documentation requirements for the return leg of PP Category V missions, including subsidiary plans, are described separately in section 2.7.4.

2.7.3.1 The Planetary Protection Plan is the primary planning document describing how a planetary flight project will meet its planetary protection requirements. It is a contractual agreement between the project and the NASA PPO.

a. The Planetary Protection Plan shall describe plans for compliance with applicable requirements and include, as a minimum, the items given in the following outline:

A. General

- (1) Introduction
- (2) NASA Planetary Protection Constraints
 - a. Designation of Mission PP Category
 - b. Planetary Protection Specifications

B. Planetary Protection Management and Organization

- (1) Organization Description
- (2) Responsibilities and Relationships
- (3) System Interface Management

- (4) Contractor Management
- (5) Data Management

C. Documentation

- (1) Identification of References and Applicable Documents

D. Facilities

- (1) Identification and Description of Controlled Facilities
- (2) Activities Performed
- (3) Hardware Affected

E. Schedules

- (1) Identification of Milestones
- (2) Preliminary Schedules

b. It is recognized that each project will prepare various other documents that may adequately cover some of the topics in the outline (e.g., the Project Plan may thoroughly cover the subject of Planetary Protection Management). In such instances, the Planetary Protection Plan may include only the major aspects of the topic and reference be made to other project documents that provide specificity. Such documents shall also be made available to the PPO.

c. The Planetary Protection Plan shall be prepared according to the schedule in section 2.5.

2.7.3.2 The following paragraphs modify specific PP Category II-V Mission Planning and Documentation requirements for the Planetary Protection Plan.

a. For PP Category II missions, sections B (Planetary Protection Management and Organization) and D (Facilities) of the Planetary Protection Plan may be omitted. No subsidiary plans are required.

b. For PP Category III missions, all of the items listed in sections 2.7.3.1.b shall be included, as well as subsidiary and implementation plans as appropriate. Probability of impact and planned contamination control procedures must also be directly addressed in the Planetary Protection Plan for PP Category III missions. If the mission involves an orbiter, the minimum planned periapsis altitude and planned final disposition of the hardware must be noted. If the orbiter chooses to meet the bioburden requirement, the Microbial Reduction Plan is required.

c. For PP Category IV missions, all of the items listed in sections 2.7.3.1.b describing the Planetary Protection Plan, plus relevant subsidiary documents, shall be provided. The Contamination Analysis Plan and the Microbiological Assay Plan (subsidiary plans) are required. If any microbial reduction procedures are contemplated, the Microbial Reduction Plan is also required. These subsidiary plans are described in section 2.7.3.2.

2.7.3.3 For PP Category III and IV missions, including the outbound leg of PP Category V "Restricted Earth Return" missions, the following subsidiary implementation plans shall be prepared as appropriate for the particular PP category assigned:

a. Contamination Analysis Plan (PP Category III and IV) b. Microbiological Assay Plan (PP Categories IV and III orbiters meeting the bioburden requirement) c. Microbial Reduction Plan (PP Categories IV and III orbiters meeting the bioburden requirement)

a. The Contamination Analysis Plan shall be the primary planning document covering the major analyses that are performed by the project and ultimately used to demonstrate to the PPO that the project is meeting the planetary protection requirements on microbial burden. This plan should include, but is not limited to, the items given in the following outline:

A. General

- (1) Introduction
- (2) Rationale and Assumptions

B. Potential Contaminating Sources

C. Microbial Burden Estimate Model

- (1) Contamination Sources Analysis
 - a. Analytical Techniques
 - b. Assumptions
 - c. Substantiation of Parameter Values
- (2) Allocation Model
 - a. Systems Allocations (Spacecraft, Launch Vehicle, etc.)
 - b. Subsystem and Lower Level Allocations

D. Analysis Documentation

b. The Microbiological Assay Plan shall identify the space vehicle hardware, facilities, and associated environments which are subject to microbiological assay; present the rationale, concepts, and detailed procedures pertaining to

such assays; and describe the microbiological quality assurance procedures used to ensure validity of the assay results. The plan includes, but is not limited to, the items given in the following outline:

A. General

- (1) Introduction
- (2) Rationale and Assumptions

B. Assay Methods

- (1) Utilization of NASA HDBK 6022 , NASA Standard Procedures for the Microbiological Examination of Space Hardware. Alternative procedures, consistent with mission and life detection objectives, may be proposed by the Project for approval by the PPO.
- (2) Laboratory Assay Procedures
- (3) Sampling Procedures
- (4) Provision for Verification Assays
- (5) Quality Assurance Provisions

C. Facilities

- (1) Controlled Facilities
 - a. Assay Laboratories
 - b. Hardware Areas
- (2) Uncontrolled Facilities
 - a. Monitoring
 - b. Environmental Estimates

D. Space Hardware (Flight) Assay and Control

- (1) Identification
- (2) Hardware Exceptions
- (3) Contingency Planning

E. Assay Data

- (1) Traceability
- (2) Analysis and Interpretation
- (3) Management and Handling

c. A Microbial Reduction Plan shall be submitted for planetary missions involving hardware elements that must have their microbial burden reduced to a specified or measured (assayed) level. The Microbial Reduction Plan includes, but is not limited to, the items in the following outline.

A. General

- (1) Introduction
- (2) Rationale and Assumptions

B. Spacecraft Hardware Subject to Microbial Reduction Processes

- (1) Identification
- (2) Exceptions/Deviations (see section 2.6)

C. Process Analysis

- (1) Analytical Techniques
- (2) Assumptions
- (3) Process Parameters
- (4) Process Modification

D. Process Verification and Control

- (1) Process Description and Boundaries
- (2) Process Qualification
- (3) Equipment and Facilities Qualification
- (4) Acceptance Criteria
- (5) Process Interruption and Modification
- (6) Quality Assurance Provisions

E. Maintaining Reduced Microbial Level/Protection from Recontamination

- (1) Monitoring/Assaying
- (2) Using Microbial Barriers
- (3) Controlling Macro-organisms (Insects, Animals, etc.)
- (4) Contingency Planning

2.7.3.4 The Planetary Protection Implementation Plan (PP Categories III-V) is the reference document that shall describe, in detail, the processes, procedures, analyses, and facilities that are used to implement the Planetary Protection Plan and subsidiary plans.

2.7.3.5 The Pre-Launch Report is the main document used by a flight project to provide verification to the PPO that planetary protection requirements have been met (at the issue date of the document) and that the project will continue to satisfy planetary protection requirements throughout the mission. This document shall include, but not be limited to, the following information, which may be included as a part of the document or referenced from other documents. Reference documents may be submitted to the PPO as they are published.

- a. A demonstration that all planetary protection constraints and requirements as noted in the Planetary Protection Plan will be met.
- b. Identification of all approved planetary protection deviations (see section 2.6) from the Planetary Protection Plan.
- c. Summaries of potentially significant violations of planetary protection requirements or procedures that could occur and thorough discussion of contingency planning associated with each potential event.

2.7.3.6 The following paragraphs modify specific PP Category II-IV Mission Planning and Documentation requirements.

- a. For PP Category II missions, a report on any required contamination control measures shall be provided.
- b. For PP Category III missions, the following information shall be provided:

- (1) Calculations of microbial burden estimates.
- (2) Report on required contamination control measures.
- (3) Calculations of probability of impact.
- (4) Organic materials inventory.

c. If the mission involves the use of hardware subject to microbial reduction processes, the verification that such processes have been properly applied shall be included. If the mission involves an orbiter as part of the launched hardware, the issue of orbital lifetime must also be addressed.

d. For PP Category IV missions, the requirements shall include the same information as for PP Category III, with information provided detailing the microbial reduction procedures employed and documentation supporting the results of the process.

2.7.3.7 After the launch of a planetary vehicle, PP Category II-V flight projects shall submit to the PPO a "Post-Launch Planetary Protection Report." This contains a brief summary document based on the "Pre-Launch Planetary Protection Report" but is updated to include the effects of launch and early postlaunch events. It demonstrates compliance with the overall planetary protection requirements through these early mission events.

2.7.3.8 At the formally declared "end-of-mission," PP Category II-V missions shall submit an End-of-Mission Report which documents the degree to which the mission has met the planetary protection requirements throughout the complete mission and reports the final disposition of all launched hardware.

- a. This report shall document instances where planetary protection requirements were not fully met, including reasons for any deviations and projected consequences, to the degree they are known.
- b. For some PP Category II and all III missions, an inventory of organic materials shall also be provided in the End-of-Mission Report for any spacecraft hardware, which unintentionally impacted or may impact protected solar system bodies within 50 years after launch.

2.7.4 PP Category V Earth-return missions certified for "Unrestricted Earth Return" have no formal implementation requirements on the return phase. Missions certified "Restricted Earth Return" shall complete the following plans:

2.7.4.1 The Earth Safety Analysis Plan is the primary planning document covering the Earth-return portion of the mission. Its purpose is to demonstrate to the PPO that the project is meeting its planetary protection requirements. This plan shall include, but is not limited to, the items given in the following outline:

A. General

- (1) Identification
- (2) Rationale and Assumptions

B. Potential Contaminating Sources

- (1) Sample Containment Approach
- (2) Decontamination Approach (if required)
- (3) Earth Entry Plan

C. Probability of Contamination Model

- (1) Mission Probability of Contamination Equation
- (2) Critical Parameters
- (3) Contamination Sources Analysis

- a. Analytical Techniques
- b. Assumptions

- c. Substantiation of Parameter Values
 - (4) Probability of Contamination Allocation Model
 - a. Level of Risk (provided to the Project by the PPO)
 - b. System Allocations (Return Capsule, Return Vehicle, etc.)

D. Analysis Documentation

2.7.4.2 The "Return Implementation Plan" is a document patterned after the Planetary Protection Implementation Plan used by a flight project. This document shall provide documentation to the PPO on how planetary protection requirements outlined in the Earth Safety Analysis Plan will be met and that the project can and will continue to satisfy them throughout the Earth-Return portion of the mission.

2.7.4.3 The "Earth Pre-Return Report" is a document patterned after the Planetary Protection Plan used by a flight project. This document shall provide verification to the PPO that planetary protection requirements outlined in the Earth Safety Analysis Plan have been met and that the project can and will continue to satisfy them throughout the Earth-Return portion of the mission.

2.7.4.4 After the launch of the Earth-return portion of the mission, the flight project shall submit to the PPO an "Earth Pre-Entry Report." This document updates the "Earth Pre-Return Report," to include the effects of launch and early postlaunch events, and demonstrates how the mission meets the overall planetary protection requirements.

2.7.4.5 In addition to the information provided and consistent with outbound phase requirements at the formally declared "end-of-mission," an End-of-Mission Report shall be submitted which documents the degree to which the mission has met its planetary protection requirements through landing and delivery of sample to containment in a Sample Receiving Facility. Special attention must be paid to the Earth's biosphere safety requirements of the mission.

2.7.4.6 Before an extraterrestrial sample is released to the general scientific community for investigation, a "Sample Pre-Release Report" shall be prepared certifying that, if released, the sample will not harm the Earth's biosphere. This report verifies that biohazard and life detection protocols have been executed and that samples are free of hazard to the Earth's biosphere and are, therefore, safe for release.

2.8 Detailed Review Requirements

2.8.1 For PP Categories III, IV, and V (Restricted Earth return), reviews shall be held to assure that planetary protection activities are proceeding properly. At a minimum, these include the reviews listed in Table 5. Additional formal and informal reviews may be held as warranted and as requested by the PPO or the project.

2.8.2 The PPO and/or designee shall be in attendance at these reviews. Generally, it is intended that formal planetary protection reviews be scheduled near the dates of project reviews or other technical reviews. Alternatively, the formal Planetary Protection reviews specified (see Table 6) may be incorporated as a segment of a broader project review.

Table 6. Planetary Protection Review Requirements

<u>Mission PP Category</u>	<u>Required Review</u>
I (Any)	None
II (Any)	Project PP Review (PPO Option)
III (Flyby, Orbiter)	<ol style="list-style-type: none"> 1. Project Planetary Protection Planning 2. Pre-Ship Planetary Protection Review 3. Pre-Launch Planetary Protection Review 4. Flight Readiness Review
IV (Lander, Probe)	<ol style="list-style-type: none"> 1. Project Planetary Protection Planning Review 2. Pre-Ship Planetary Protection Review 3. Pre-Launch Planetary Protection Review 4. Flight Readiness Review
V "Unrestricted Earth Return"	No further reviews beyond those for the outbound phase of the mission, as appropriate (see PP Categories I-IV)

- V "Restricted Earth Return"
1. Project Planetary Protection Planning Review
 2. Pre-Ship Planetary Protection Review
 2. Pre-Launch Planetary Protection Review
 3. Flight Readiness Review
 4. Earth Return Pre-Launch Review
 5. Earth Safety Analysis Review
 6. Returned Sample Release Review

2.8.3 The content and scheduling of planetary protection reviews shall be developed in discussions between the PPO and various organizational elements of the project. Planetary protection reviews may be held as splinter meetings of other required project reviews. Action items which may result from these reviews should be tracked and closed out by the same quality control processes/procedures the project uses for resolving action items resulting from other formal technical reviews.

2.8.3.1 A Planetary Protection Planning Review shall be held, at the request of either the PPO or the project's authorized representative, at the start of the project's planning phase and no later than when the draft version of the project's Planetary Protection Plan is near completion. The purpose of conducting this review at this time is to enable the PPO to review the implementation strategies considered by the project and suggest such changes to the project's planetary protection planning as are necessary for the formal version of the Planetary Protection Plan to be approved without major change or delay. The PPO may require that all action items resulting from these reviews be closed out before formal approval of the Planetary Protection Plan. Approval of the mission's Planetary Protection Plan constitutes formal PP categorization of the mission for planetary protection purposes.

2.8.3.2 The Pre-Ship Planetary Protection Review shall be conducted, prior to the shipment of the spacecraft to the launching site, for all missions assigned to PP Categories III, IV, and V. The PPO conducts this review to ascertain the project's compliance with PP requirements and the adequacy of planned PP-related activities and staffing at the launch site.

2.8.3.3 The Pre-Launch Planetary Protection Review shall be conducted, approximately 90 days prior to launch, for all missions assigned to PP Categories III, IV, and V. The PPO conducts this review to ascertain whether a project has, to that date, met its planetary protection requirements. As a part of this review, the PPO will also examine, in detail, the planetary protection activities accomplished prior to this review, as well as those remaining prior to launch. The "Pre-Launch Planetary Protection Report" (see section 2.7.3.5) forms the framework for this review.

2.8.3.4 The project's formal Flight Readiness Review, for all missions assigned to PP Categories III, IV, and V, shall include planetary protection as a topic. The PPO participates in this review to ensure that planetary protection requirements continue to be met. Various events detrimental to planetary protection could occur subsequent to the Pre-Launch Planetary Protection Review and prior to actual launch of the vehicle. Significant planetary protection events, problems, changes, open action items, etc., that have occurred since the Pre-Launch Planetary Protection Review must be addressed.

2.8.3.5 The Earth Return Pre-Launch Review shall be conducted, prior to initiation of the Earth return portion by launch from the sampled object, for all missions assigned to PP Category V "Restricted Earth Return." The PPO conducts this review to ascertain that a project has, to that date, met its planetary protection requirements and makes a recommendation to the SMD AA regarding readiness for Earth Return. As a part of this review, the PPO will also examine, in detail, the planetary protection activities accomplished prior to this review, as well as those remaining prior to initiation of Earth return. The formally released edition of the "Earth Pre-Return Report" (see section 2.7.4.3) forms the framework for this review.

2.8.3.6 The Earth Safety Analysis Review shall be conducted prior to committing a spacecraft to the Earth return portion of its mission for all missions assigned to PP Category V, "Restricted Earth Return." The PPO conducts this review to determine whether all planetary protection requirements have been met and will continue to be met throughout the duration of the mission. The formally released document "Earth Safety Analysis Plan" (see section 2.7.4.1), as updated by the Earth Pre-Entry Report (see section 2.7.4.4), forms the framework for this review. This review may be attended by the SMD AA and members of an Interagency Committee, which will be overseeing activities related to the handling and testing of the returned sample in the Receiving Facility.

2.8.3.7 One or more Returned Sample Release Review(s) shall be conducted prior to release of any extraterrestrial sample that was returned by a mission assigned to PP Category V "Restricted Earth Return." The PPO conducts this review to ascertain that all planetary protection requirements, including the execution of prescribed life detection and biohazard protocols have been met. The formally released document "Sample Pre-Release Report" (see section 2.7.4.6), or an appropriate section of that report, forms the framework for the review. This review must be attended by members of the Interagency Committee and by the SMD AA, whose approval must be obtained before release of the samples.

2.9 Coordination with Orbital Debris Requirements

2.9.1 Planning for the Earth Return portion of PP Category V missions shall be coordinated with relevant requirements for limiting orbital debris, particularly NPR 8715.6.

2.9.2 Planetary protection documentation for end-of-mission scenarios that involve hardware disposition in the vicinity of Earth or the Earth's Moon may be coordinated with activities and documentation required for purposes of orbital debris mitigation. For example, projects may request the NASA Orbital Debris Program Office to provide analysis and review support for Planetary Protection reentries, including survivability modeling, reentry heating, and interface with USAF tracking resources.

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