MSR Planetary Protection

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NASA HQ MSR PP Lead

Committee on Planetary Protection Fall Meeting 2023
October 20, 2023

NASA PP Policies & Requirements

Roles, responsibilities, deliverables (NPR 8715.24)

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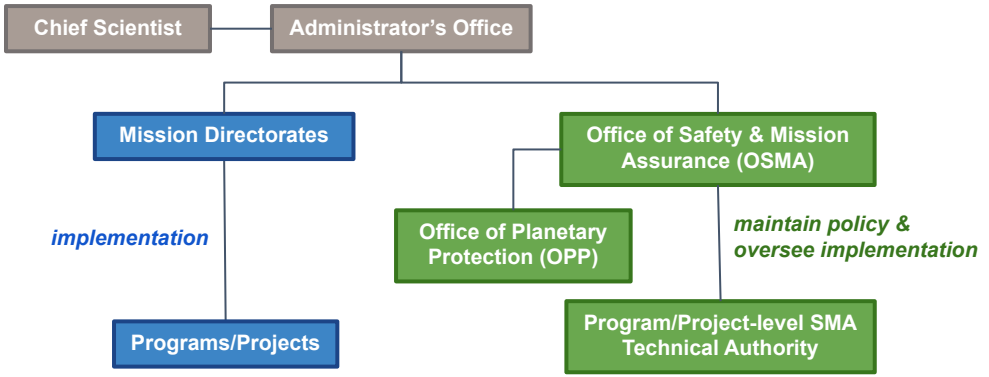

Programmatic / Implementation

Mission Directorate Associate Administrator (MDAA)
- Provides PP categorization
- Provides resources for PP compliance
- Negotiates mission-specific process for partnered missions (consults interagency, commercial, int'l partners)
- Supports R&TD to close knowledge gaps & develop PP requirements to enable future missions.

Program/Project Manager
- Submits PP categorization request to MDAA
- Identifies applicable PP requirements + standards
- Establishes planned implementation approach
- Coordinates verification + assurance activities with PPO
- Documents implementation activities

SMA Technical Authority

Chief, Safety & Mission Assurance (SMA)
- Concurrence on PP categorization
- Consults with Chief HMO and Engineer on restricted Earth return
- Monitors and tracks PP requirements
- Advises MDAA on patnerd missions

Planetary Protection Officer (PPO)
- Concurrence on PP categorization
- Advises on, oversees, verifies PP approach and implementation
- Maintains NASA PP policy
- Represent NASA in external PP-related activities
- Advises MDAA on patnerd missions
- Coordinate with MDAA on R&TD

Program/Project-level SMA Technical Authority
- Advises project to notify PPO
- Assures formulation and execution of implementation is sound
- Facilitates independent verification
- Coordinates with project to identify events for further investigation

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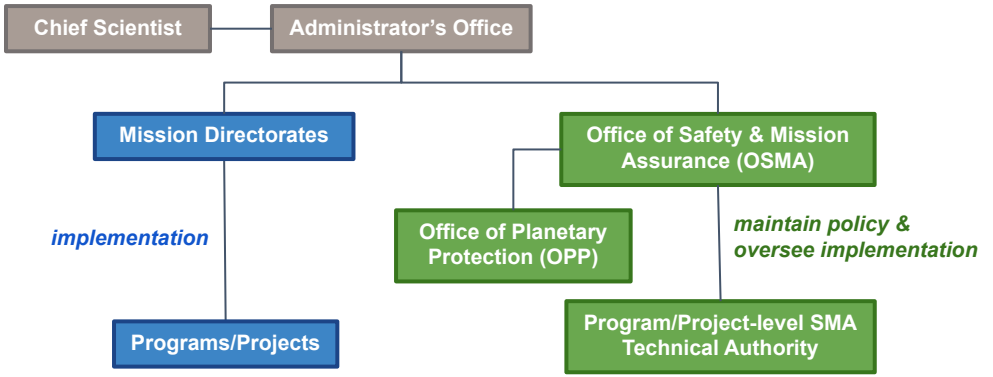
Table 3-1. Planetary Protection Documentation Authorities

Planetary Protection Documentation[1]	Planetary Protection Mission Category[2]					
	Outbound				Inbound	
	I	II	III	IV	V(r)	V(u)
Final PP Mission Categorization	Concurrence from PPO		Concurrence from Chief, SMA based on recommendations from PPO			
PP Requirements Document	None required	Concurrence from PPO	Concurrence from Chief, SMA based on recommendations from PPO			Refer to outbound planetary protection mission category for concurrence authority
PP Implementation Plan			Concurrence from PPO			
Pre-Launch PP Report			Concurrence from Chief, SMA based on recommendations from PPO			
Post-Launch PP Report						
Extended Mission PP Report						
End of Mission PP Report						

Table 3-2. Planetary Protection Document Schedule

Planetary Protection Documentation	Nominal Document Schedule[1, 2, 3, 4]							
	MCR	SRR	MDR	PDR	CDR	SMSR	PLAR	EOM
PP Mission Categorization[5]	Preliminary	Final						
PP Requirements[6]	Preliminary	Baseline						
PP Implementation Plan			Preliminary	Baseline	Update			
Pre-Launch PP Report						Final Report		
Post-Launch PP Report							Final Report	
Extended Mission PP Report								Prior to extended mission approval
End of Mission PP Report								Final Report



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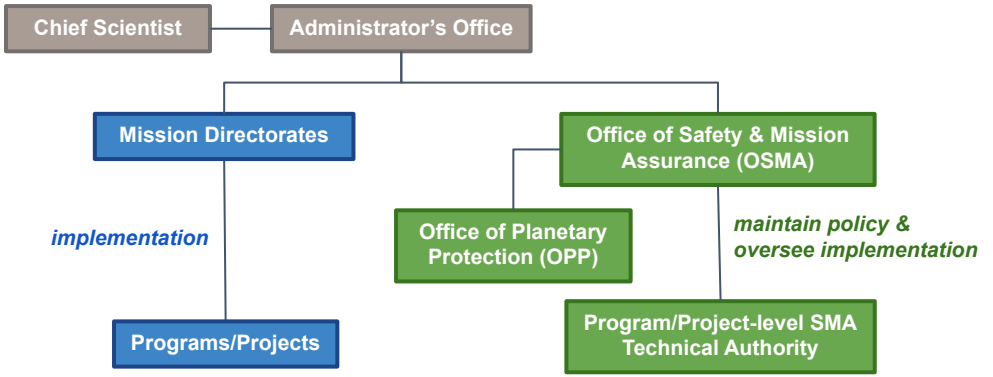

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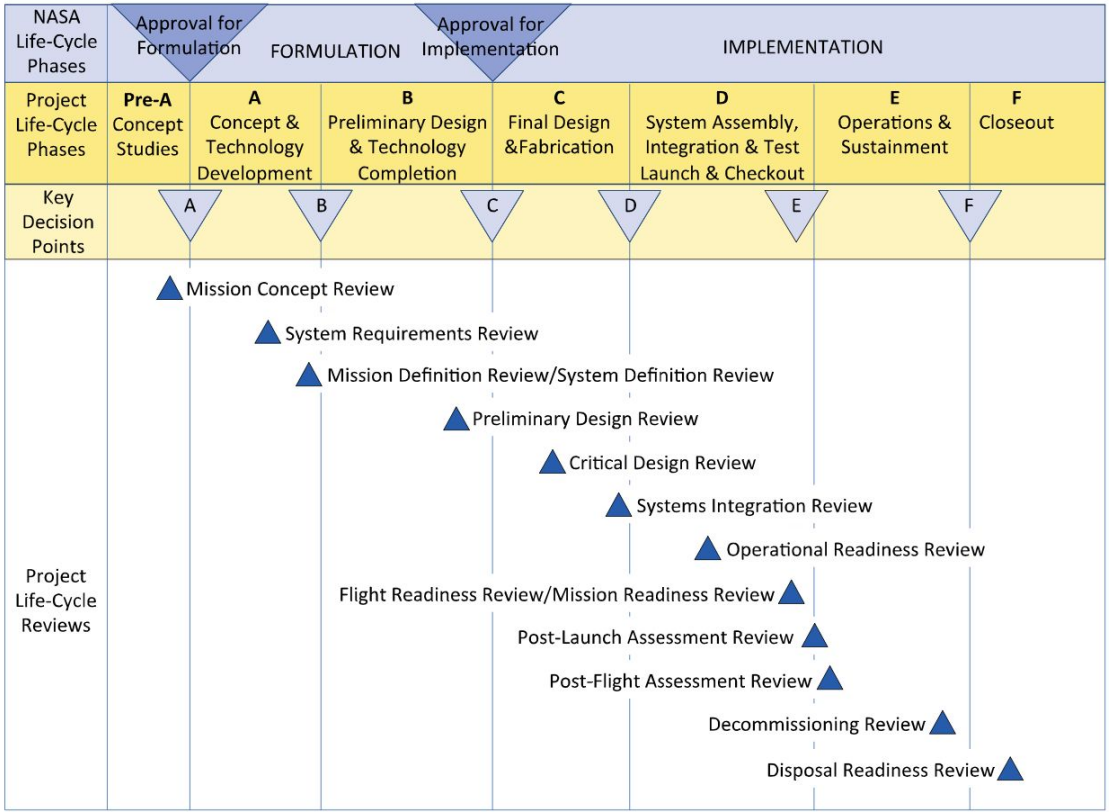

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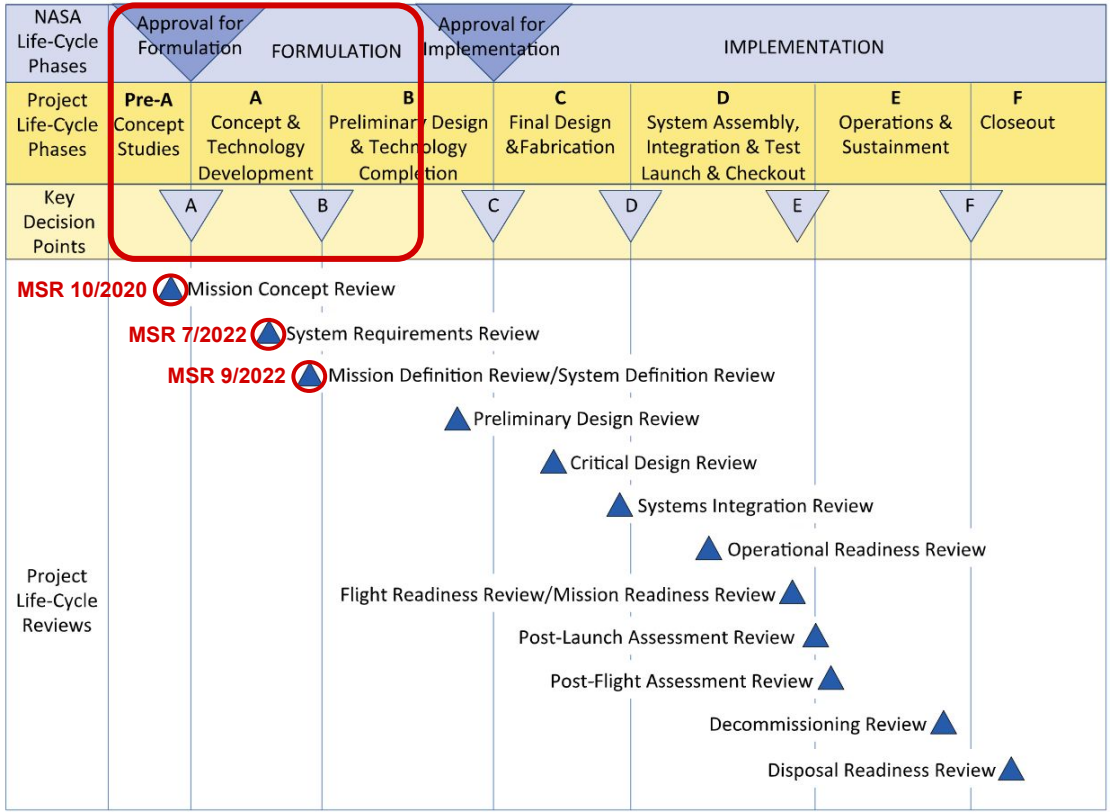

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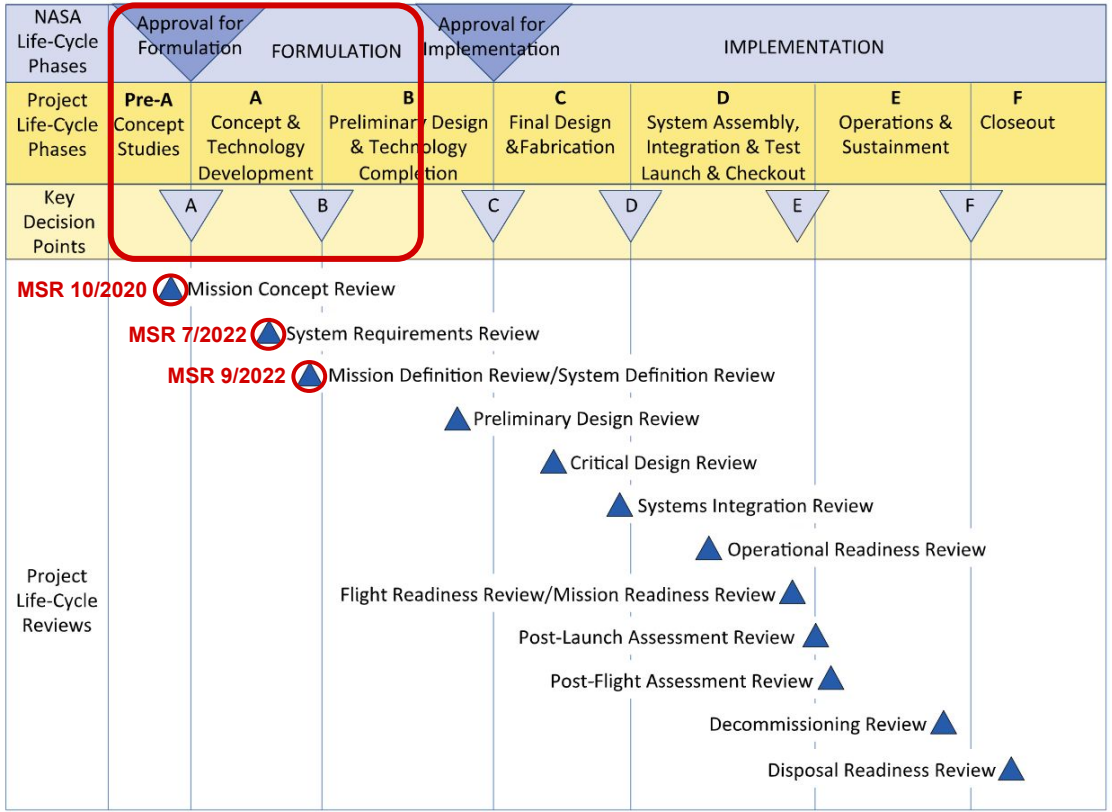
KDP-B request to identify PP policies and approaches driving MSR complexity, risk, cost, etc.

- MSR identified main driver as heat sterilization approach to small amount (<40 mg) of uncontained wind-blow dust exterior to OS and its required Primary Containment Vessel (PCV) and aseptic transfer/sealing system
- After several months of review, MSR identified alternative UV sterilization approach to achieve needed reductions in complexity, risk, cost, etc.

MSR PP development was consistent with standard activities expected during mission formulation phase



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- **Assurance Case used to establish PP compliance + communicate PP approach**
  - Updated NASA PP policy + standards allows usage of Assurance Case to demonstrate PP compliance via risk-informed, reasoned arguments (in addition to more traditional prescriptive approach)
  - MSR Assurance Case will address sample return risks informed by modern biological risk assessments and confirmation of UV sterilization efficacy via laboratory testing for MSR-specific environments

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- **Redundant + robust containment remains primary method for MSR BPP**
  - Samples + material inside OS still treated as hazardous with same level of containment as previous approach
  - Small amount of uncontained material outside OS would be UV sterilized before secondary containment
  - System remains tolerant to failure of any of the 3 containment elements: PCV (now the OS), sterilization, SCV

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- **UV sterilization efficacy testing – ✔ Ongoing**
  - 1) Solar UV sterilization of Mars material in Mars orbit + 2) active UV sterilization of OS after capture by CCRS
  - Testing both approaches ongoing (expected completion in 2024 but dependent on CCRS design finalization)

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- **Independent review by NASA Office of Chief Scientist (OCS) – ✔ Completed**
  - NASA OPP requested OCS independent review of 1) UV sterilization and 2) management of host-dependent (sub-cellular) biology; reviewer SMEs from across US Gov't (NASA, CDC, DOE, USDA, NIST) + academia
  - OCS review report delivered on 7/23 is supportive of UV sterilization for both cellular + sub-cellular biology and provided recommendations on how to ensure effective usage of UV sterilization for MSR
  - MSR BPP approach will be consistent with OCS review; MSR response to OCS review currently in work

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- **Socialization with scientific community + external stakeholders – ✔ Ongoing**
  - Briefings to scientific community, US government stakeholders in launch/return approval path, ESA

MSR PP – Launch & Return Approval

Developing compliance paths with Presidential Directive PD/NSC-25

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THE WHITE HOUSE

WASHINGTON

December 14, 1977

PRESIDENTIAL DIRECTIVE/NSC-25

TO: The Secretary of State
The Secretary of Defense
The Secretary of Energy
The Secretary of the Interior
The Secretary of Agriculture
The Secretary of Commerce
The Secretary of Health, Education, and Welfare
The Secretary of Transportation
The Acting Director, Office of Management and Budget
The Assistant to the President for National Security Affairs
The Chairman, Council on Environmental Quality
The Director, Office of Science and Technology Policy
The Director, Arms Control and Disarmament Agency
The Administrator, Environmental Protection Agency
The Administrator, National Aeronautics and Space Administration
The Director, National Science Foundation
The Chairman, Nuclear Regulatory Commission

SUBJECT: Scientific or Technological Experiments with Possible Large-Scale Adverse Environmental Effects and Launch of Nuclear Systems into Space (C)

Two earlier Presidential memoranda dealt with the conduct of scientific or technological experiments that might have large-scale or protracted effects on the physical or biological environment (NSAM 235 of April 17, 1963) and the launching into space of systems involving nuclear power (NSAM 50 (revised) of April 10, 1965). These two NSAMs are hereby rescinded. The general purpose, however, behind these two directives--to give the President the opportunity to consider all factors before any such experiment is carried out--remains valid. The President has approved the policy and procedures below to accomplish that purpose.

It should be understood that experiments which by their nature could reasonably be expected to result in domestic or foreign allegations that they might have major and protracted effects on the physical or biological environment,

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or other areas of public or private interest, are to be included under this policy even though the sponsoring agency feels confident that such allegations would in fact prove to be unfounded.

Where such experiments constitute major action either licensed or funded by Federal Agencies that significantly affect the quality of the human environment, an environmental impact statement will be prepared. The data from such statement may be used in complying with the following procedures which do not affect the requirement to comply with the provisions of the National Environmental Policy Act:

1. The head of any agency that proposes to undertake a large-scale scientific or technological experiment that might have major and protracted effects on the physical or biological environment, or on other areas of public or private interest, will call such proposals to the attention of the Director of the Office of Science and Technology Policy (hereafter the Director). The Director will consult with the Chairman of the Council on Environmental Quality (hereafter, the Chairman). Notification of such experiments will be given sufficiently in advance that they may be modified, postponed, or cancelled, if such action is judged necessary in the national interest.

2. In support of proposals for such experiments, the sponsoring agency will prepare for the Director a detailed evaluation of the importance of the particular experiment and the possible direct or indirect environmental effects that might be associated with it. The data from an environmental impact statement may be used in complying with this procedure.

3. The Director in consultation with the Chairman will review the proposals and supporting materials presented by the sponsoring agency in order to assure that the need for the experiment has been properly weighed against possible adverse effects.

4. On the basis of this review, the Director in consultation with the Chairman will recommend to the President what action should be taken on the proposed experiment. If the Director, in consultation with the Chairman, judges that inadequate information is available on which to make a judgment, the Director may request that additional studies be undertaken by the sponsoring agency or may undertake an independent study of the problem. Agencies will be notified if an extended delay is anticipated in approval.

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5. In the case of experiments that have major national security implications, the head of the sponsoring agency will notify me so that I may determine on an individual basis the procedure to be followed in reviewing these experiments.

6. While the final decision to conduct such experiments must continue to reside with the government, the National Academy of Sciences and, where appropriate, international scientific bodies or intergovernmental organizations may be consulted in the case of those experiments that might have adverse effects beyond the US. When experiments are expected to have such impacts in foreign countries the Secretary of State will be notified. In arriving at decisions on specific projects, foreign policy considerations should be taken into account. Recommendation on the advisability of the courses of action will be made by the Director in consultation with the Chairman and with the sponsoring agency and the State Department as appropriate.

7. Any large scale scientific or technological experiment that may involve particularly serious or protracted adverse effects will not be conducted without the President's approval. Any experiment that may involve serious or protracted adverse effects will not be conducted without the approval of the head of the department or agency involved, with, in appropriate cases, the advice of other concerned agencies.

8. To the extent that it is consistent with national security, and subsequent to approval of the experiment, there should be early and widespread dissemination of public information explaining the purpose, benefits, and assessments of impacts.

9. A separate procedure will be followed for launching space nuclear systems. An environmental impact statement or a nuclear safety evaluation report, as appropriate, will be prepared. In addition, the President's approval is required for launches of spacecraft utilizing radioactive sources containing more than 20 curies of material in Radiotoxicity Groups I and II and for more than 200 curies of material in Radiotoxicity Groups III and IV (as given in Table I of the NASC report of June 16, 1970 on "Nuclear Safety Review and Approval Procedures.") An ad hoc Interagency Nuclear Safety Review Panel consisting of members from the Department of Defense, Department of Energy, and National Aeronautics and Space Administration will evaluate the risks associated with the mission and prepare a Nuclear Safety Evaluation Report. The Nuclear Regulatory Commission should be requested to participate as an observer when appropriate. The head of the sponsoring agency will request the President's approval for the flight through the Office of Science and Technology Policy. The Director is authorized to render approval for such launchings, unless he considers it advisable to forward the matter to the President for decision.

Zbigniew Brzezinski

MSR PP – Launch & Return Approval

Developing compliance paths with Presidential Directive PD/NSC-25

- **MSR launch & return approval governed under PD/NSC-25**
  - PD = Presidential Directive = Executive Order on **national security policy** with high-level requirements
  - PD/NSC-25 covers scientific/technological activities that could have "**major and protracted effects on the physical or biological environment**"
  - Process: **NASA Administrator** notifies **OSTP Director**; during OSTP review other **relevant USG agencies** and groups can be consulted; OSTP Director makes recommendation to **President**, who must approve

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- **MSR is currently formulating its compliance path with PD/NSC-25**
  - Some lessons learned from compliance with PD/NSC-25 (paragraph 9) for nuclear-powered spacecraft
  - Initial engagement with relevant USG agencies via MSR reviews (OCS study, SRP tiger teams)
  - Bottom-up approach (e.g., Lunch & Learns) followed by formal engagement at higher levels
  - Process of engagement with external stakeholders expected to be iterative

MSR PP – NASA & ESA Coordination

Coordinating PP requirements & compliance across MSR elements

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- **MSR PP Roles & Responsibilities**
  - **MSR NASA-ESA MOU (Article 19)**: ESA and NASA apply their own PP measures
    - Consistent with COSPAR PP policy & recognizing potential BPP items not yet addressed in policy
    - Agreement to establish an MSR Joint PP Management Plan
  - **Joint PP Management Plan (draft)**: Roles & responsibilities for implementing overall MSR PP strategy
    - NASA MSR Program does not levy PP requirements on ESA-provided or -operated elements
    - ESA PPO is responsible for the approval of ESA's PP implementation for its MSR elements

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- **ESA MSR Re-Entry Safety Review Panel**
  - ESA has organized a PP Re-entry Safety Review Panel to be held in conjunction with major ERO and MSR program/mission reviews until release of the EEV and execution of the ERO Earth Avoidance Maneuver
  - Panel will assess ERO Project compliance with its PP requirements; output report will be distributed to relevant stakeholders and used as input for certification at ERO launch and decision to release the EEV