Introduction to Planetary Protection:
Goals, Rationales, and Sources of Policy Advice

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7 March 2017

A Theme for the Presentation

"The SSB of the National Academy of Sciences, together with its representation at COSPAR, served and continues to serve as the main outside scientific source of recommendations to NASA on planetary quarantine."

– Phillips, Charles R., *The Planetary Quarantine Program: Origins and Achievements,* 1956-1973, NASA SP-4902 (1974)

Interim Questions, Addressed (1)

1. What are the rationales for and goals of planetary protection policies?

- COSPAR now cites the OST, Article IX as one rationale:

  "States Parties to the Treaty shall pursue studies of outer space…and conduct exploration of them so as to avoid their harmful contamination and also adverse changes in the environment of the Earth resulting from the introduction of extraterrestrial matter"

- And COSPAR explains its goals for the policy:

  "COSPAR maintains and promulgates this planetary protection policy for the reference of spacefaring nations, both as an international standard on procedures to avoid organic constituent and biological contamination in space exploration, and to provide accepted guidelines in this area to guide compliance with the wording of this UN Space Treaty and other relevant international agreements."

Interim Questions, Addressed (2)

1. What are the rationales for and goals of planetary protection policies? (cont.)

- Rationale for forward contamination control
  - Avoid compromising science, where we have a unique opportunity to learn more about the origin of life in a way that is no longer possible on Earth, and may learn about life, in general, by doing comparative biology (exobiology; similar to comparative planetology)
  - Protect the investment in space science & exploration (and remove the effect of ambiguous information of extraterrestrial life on risk assessments and future exploration pathways)

Interim Questions, Addressed (3)

1. What are the rationales for and goals of planetary protection policies? (cont.)

- Rationale for backward contamination control
  - Simple prudence - protect the Earth!
  - In line with the precautionary principle of environmental protection

(slide showing Bart Simpson writing on blackboard,
“Science class should not end in tragedy…”)

Interim Questions, Addressed (4)

2. Suggest a working definition of planetary protection consistent with the aforementioned goals and rationales?
   - Planetary protection is a policy that imposes controls on organic and biological contamination carried by spacecraft performing certain types of missions to certain target-bodies:
     1) To protect the conduct of scientific investigations of possible extraterrestrial life forms, precursors, and remnants, and
     2) To protect the Earth from the potential hazards posed by extraterrestrial matter carried by a spacecraft returning from another planetary body.

Questions Addressed/Anticipated in this Presentation

- What is the history of planetary protection advice to NASA?
  - What are the sources of advice?
  - How has that advice been provided?
  - What are some of the results of that advice?
- What does planetary protection look like at NASA, today?
- What are the future needs for planetary protection advice to NASA? *(hints, only, today)*
  - What considerations are appropriate to new space actors?
  - What are anticipated NASA interests in future planetary protection provisions?

Planetary Protection: Over 50 Years of International Effort

1956 Rome: International Astronautical Federation meets to discuss lunar and planetary contamination

Feb. 1958: International Council for Science (ICSU) forms committee on Contamination by ExtraTerrestrial Exploration (CETEX); NAS Council Resolution on Contamination of Extraterrestrial Bodies

June 1958: NAS establishes the SSB

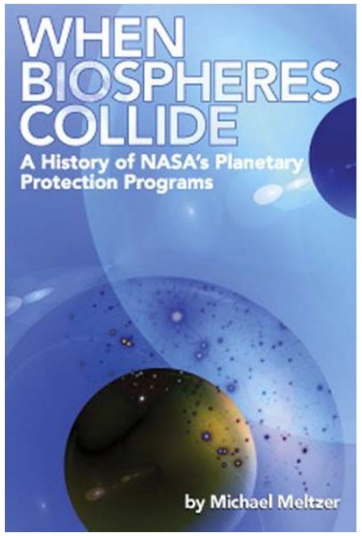
July 1958: Authorization of NASA (Oct. start)

Oct. 1958: Formation of COSPAR by ICSU

Dec.1958: Formation of UN-COPUOS

1959-1962: Publication of guidelines:
US, USSR, COSPAR

1963: NASA acquires the first 'Planetary Quarantine Officer' (on loan from the Public Health Service)



1964: COSPAR Resolution 26.5 defines sterilization level in terms of what is needed to produce probabilities for single viable organism on spacecraft (landing or atmospheric penetration < $1x10^{-4}$ or accidental planetary impact < $3x10^{-5}$)

1967: Outer Space Treaty. Multiple NASA Policy Directives to comply in USG.

1969: COSPAR Decision No. 16 estimated probability of <$1x10^{-3}$ that a planet will be contaminated during the period of biological exploration

1958: National Academy Concerns

- NAS Council Resolution, 8 Feb 1958:
  - "The National Academy of Sciences of the United States of America urges that scientists plan lunar and planetary studies with great care and deep concern so that initial operations do not compromise and make impossible forever after critical scientific experiments. **For example, biological or radioactive contamination of extraterrestrial objects could easily occur unless initial space activities be carefully planned and conducted with extreme care....** The Council of the National Academy of Sciences of the United States of America urges the International Council of Scientific Unions to encourage and assist the evaluation of possibilities of such contamination and the development of means for its prevention."

News of Science: Development of International Efforts to Avoid Contamination of Extraterrestrial Bodies (1958). Science 128 (3329), 887-891.

1958: Approaches to Sterilization

- Phases of sterilization:
  - Sterile assembly of components
  - Built-in sterilization of parts
    - “Built-in sterilization is not so much a specific technique as it is a philosophy of preparation for terminal sterilization.”
  - Terminal sterilization
    - “We estimate that between gas, heat, and radiation, 95% of payload parts can be readily sterilized without fear of degrading their performance characteristics.”
  - Maintaining sterilization
    - “Once the space probe is sterilized, it will be necessary to mount it on the rocket boosters. The technical problem is then one of preventing microbes from coming into contact with the probe.”

Richard W. Davies and Marcus G. Comuntzis, JPL External Publication #698 The Sterilization of Space Vehicles to Prevent Extraterrestrial Biological Contamination (1958), presented to the 10th International Astronautical Congress under NASA contract NASW-6.

1959: CETEX to COSPAR

- Report of 2nd Meeting, 9-10 March 1959:
  - "in the Committee's view there is a real possibility that early experiments might spoil subsequent research. The Committee therefore proposed to the International Council of Scientific Unions that a code of conduct be drawn up for space research with particular reference to the allocation of priorities and sequences of different experiments."
  - "The Committee on Extra-Terrestrial Exploration feels that the detailed functions proposed for its second meeting form and integral and important part of the duties of the Committee on Space Research"

Contamination by Extra-terrestrial Exploration (1959) Nature, 183:4666 pp. 925-928.

1959: SSB/WESTEX Advice

- Summary Report of Meetings, 1959:
  - "The detection and analysis of planetary life is one of the major challenges of contemporary science and should be pre-eminent among the objectives of our space research programs."
  - "On the basis of present information, we would urge that a tolerance level 10^{-6} be adopted as the residual, composite risk of depositing a viable micro-organism on Mars or Venus."
  - "We applaud the respect for these considerations on the part of the USSR in the light of Academician Topchiev's announcement that Lunik-II had been decontaminated."
  - "The hazards of contamination of planetary targets, and even of the Earth itself, can best be met by the fullest co-operation of all nations undertaking space research."

Summary Report of WESTEX (1958) Space Science Board, National Academy of Sciences, National Research Council.

1960s: COSPAR Policy Refinements

- 1964 COSPAR RESOLUTION 26.5 (COSPAR Information Bulletin No. 20, p. 25-26):
  - "accepts, as tentatively recommended interim objectives, a sterilization level such that the probability of a single viable organism aboard any spacecraft intended for planetary landing or atmospheric penetration would be less than $1x10^{-4}$, and a probability limit for accidental planetary impact by unsterilized fly-by or orbiting spacecraft of $3x10^{-5}$ or less."

- 1969 COSPAR DECISION No. 16 (COSPAR Information Bulletin No. 50, p. 15-16):
  - "accepts as the basic objective for planetary quarantine of Mars and other planets deemed important for the investigation of extraterrestrial life, or precursors or remnants thereof, a probability of no more than $1x10^{-3}$ that a planet will be contaminated during the period of biological exploration. The period of biological exploration is assumed to be 20 years ending in 1988, and the number of missions to or near the planets is assumed to be 100..."

Earlier COSPAR Policy Process

- Previous COSPAR Resolutions & Decisions

  (As passed by COSPAR Bureau- and Council)

- New phenomena reported/new missions proposed/other external considerations

  (Peer reviewed scientific literature/request from private or public entity/recommendations from agency advisory groups, including SSB)

- Possible study by a scientific organization and/or a COSPAR-sponsored workshop

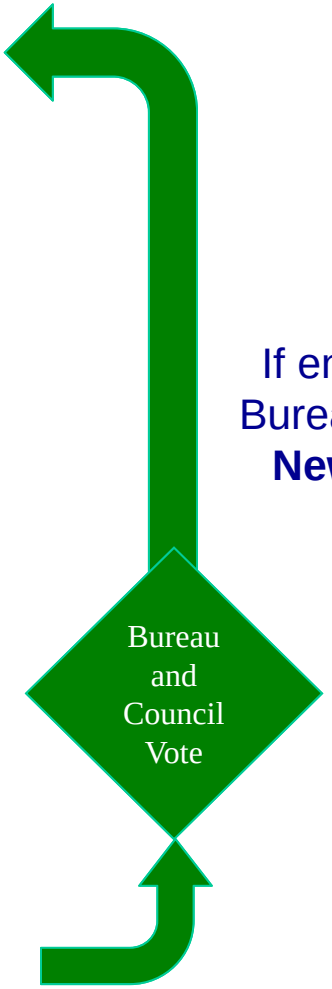
  (May be solicited by space agencies and carried out by a National Scientific Institution or International Scientific Unions)

- Meeting of Panels or Scientific Commissions

  (Business meeting at COSPAR Scientific Assemblies or dedicated COSPAR Panel Colloquium, involving representatives of the scientific community and other relevant stakeholders)

- Recommendation to Bureau & Council

  (At COSPAR Scientific Assemblies or at COSPAR Bureau meetings between Assemblies)



If endorsed by the Bureau and Council, **New Resolution**

1960s: COSPAR Policy Mechanisms

- May 1969: Panel on Planetary Quarantine replaces Panel on Standards for Space Probe Sterilization
- Membership:

Dr. C. Hedén - Chairman (Sweden)*
Dr. A. Brown (U.S.A.)
Mr. L. Hall (U.S.A.)
Dr. C. Sagan (U.S.A.)
Dr. A. Imshenetsky (USSR)
Dr. N. Vashkov (USSR)
Dr. A. Dollfus (France)
Dr. P. H. A. Sneath (U.K.)
Dr. K. Raska (Czechoslovakia), permanent observer

- Reported to The Consultative Group on the Potentially Harmful Effects of Space Experiments

Viking and Probability of Contamination

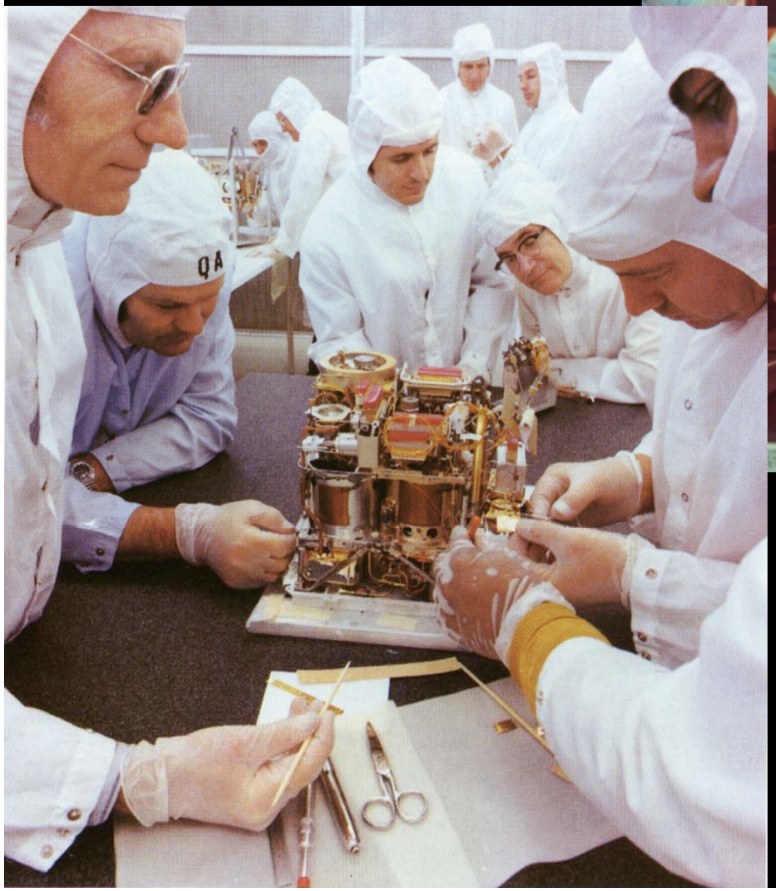
- The COSPAR top level probability of contamination, 1×10^{-3}, was sub-allocated to launching nations
  - U.S.A. 4.4×10^{-4}
  - U.S.S.R. 4.4×10^{-4}
  - Other nations 1.2×10^{-4}
- Of the U.S. allocation, NASA sub-allocated 2×10^{-4} to the two Viking spacecraft
- The contamination probability equation is: $P_c = \Sigma\, N\, P_s P_r\, P_g$

  P_c probability of contaminating Mars
  N number of organisms present before sterilization
  P_s probability that a random organism will survive sterilization
  P_r probability of release on Mars (surface=1, mated=2×10^{-3}, buried=1×10^{-4})
  P_g probability of growth on Mars (per NAS SSB, 1×10^{-6})
- The total probability is the sum of probabilities for organisms on surfaces, between mated surfaces, or buried within components

Determining Probability of Contamination

- The probability of contamination by a lander was revised due to the presence of "hardy" organisms, by adding margin to the probability of survival P_s.
  - For the Viking 1 sterilization cycle, P_s for non-hardy organisms would have ranged from a value of 6.2×10^{-10} to 7.62×10^{-14} for surface spores; from 5×10^{-6} to 2.76×10^{-7} for mated spores; and from 1.7×10^{-1} to 3.87×10^{-2} for encapsulated spores.
  - Conservatively, to address unknown unknowns, P_s was taken to be 1×10^{-4} for surface spores and 1×10^{-3} for mated and encapsulated spores.
- Using these values and the equation $P_c = \sum N P_s P_r P_g$, the probability of contamination for each of the Viking landers was calculated to be $< 3.1 \times 10^{-5}$.
- This is below the allocation of 3.25×10^{-5}.

Viking sets a new standard



Terminal sterilization works, when specified in advance...

Viking
Life Detection
Package

1980s: Changes in COSPAR policy post-Viking

- Data from the Viking life-detection experiments were interpreted as a negative result for life detection at Mars
- Other measurements taken at Mars suggested that the planet was much less hospitable to Earth life than previously hypothesized
- Papers by Barengoltz et al., (1981) and DeVincenzi et al., (1983) proposed a 'by exception' mission categorization framework that eliminated probabilistic requirements for all objects unable to host Earth life
- This framework was presented and discussed at a COSPAR Workshop on 2 July 1984, and accepted as a COSPAR resolution at the 1984 Colloquium in Graz.

1980s: Changes in COSPAR policy post-Viking

COSPAR INTERNAL DECISION No. 7/84

COSPAR,

- considering that the Workshop on Planetary Protection, meeting on 2 July 1984, has proposed new COSPAR guidelines for planetary protection,
- noting that the commitment to protection of planets from biological contamination must be sustained, and
- noting that planetary protection guidelines must be responsive to current state of knowledge regarding planets,
- decides that existing planetary protection guidelines (1964, 1966) be amended as follows: replace "the basic probability of one in one thousand that a planet of biological interest will be contaminated shall be used as the guiding criterion during the period of biological exploration..." with "for certain space mission/target planet combinations, controls on contamination shall be imposed in accordance with a specified range of requirements ...", in five categories as defined by D.L. DeVincenzi et al., Adv. Space Res., 3(8): 13 (1983).

1990s: SSB Recommends Changes in Policy for Mars

- In 1990 NASA requested that SSB provide an update on Mars planetary protection requirements to reflect the Viking results and modern microbiology
  - Report was delivered in 1992 after thorough study and a workshop
- Report recommended stricter requirements for life-detection missions than for non-life-detection missions
  - Full Viking requirements for the one, Pre-system-sterilization levels for the other
- The report also made several other actions by NASA
  - Viking protocols for assessment of spacecraft bioloads be upgraded to include state-of-the-art methods (but did not recommend equivalence of methods)
  - A sequence of unpiloted missions to Mars be undertaken well in advance of a piloted missions
  - NASA should inform the public about current planetary protection plans and provide continuing updates concerning Mars exploration and sample return
  - Efforts should be made (1) to assess the legal limits (and implied liabilities) in existing legislation that relates to martian exploration and (2) to pursue the establishment of international standards that will safeguard the scientific integrity of research on Mars.
  - **NASA should make a strong effort to obtain international agreement for a planetary protection policy.**

1990s SSB Recommendation > Changes in COSPAR Policy

COSPAR DECISION No. 1/94

COSPAR Information Bulletin No. 131, July 1994, p.30

In keeping with the COSPAR Planetary Protection Policy adopted in Graz in 1984, and

Noting:

1. That the Space Studies Board of the US National Research Council in 1992 recommended an update to the requirements for Mars planetary protection consistent with our current knowledge of Mars;

Recommends:

- That COSPAR adopt the following amended version, as outlined in DeVincenzi, Stabekis & Barengoltz (1994: Paper F3.5.2)

1990s: SSB Recommendations on NASA Policy

- *Stricter requirements for life-detection missions than for non-life-detection missions, based on Viking requirements*
  - Implemented by COSPAR as COSPAR DECISION No. 1/94, citing DeVincenzi, Stabekis & Barengoltz (1994: Paper F3.5.2).
- *Efforts should be made (1) to assess the legal limits (and implied liabilities) in existing legislation that relates to martian exploration and (2) to pursue the establishment of international standards that will safeguard the scientific integrity of research on Mars.*
- *NASA should make a strong effort to obtain international agreement for a planetary protection policy.*
  - NASA increased its investment in COSPAR to enhance its continuation as consensus forum for international standards
  - NASA proposed the formation of a Panel on Planetary Protection, which COSPAR chartered in 1999
  - NASA proposed a consolidation of various COSPAR decisions on Planetary Protection into a single policy document (first time since 1964), which was accomplished in 2002 at the World Space Congress

1999: COSPAR Planetary Protection Panel
(Proposed July 1998; Chartered March 1999)

- Charter:
  - Develop, maintain, and promulgate planetary protection knowledge, policy, and plans to prevent the harmful effects of such contamination
  - Through symposia, workshops, and topical meetings at COSPAR Assemblies to provide an international forum for exchange of information in this area
  - Inform the international community, e.g., the Committee on the Peaceful Uses of Outer Space (COPUOS) of the United Nations, as well as various other bilateral and multilateral organizations, of COSPAR decisions in this area
- John D. Rummel (US) was appointed first Chair of the Panel, and François Raulin of France was appointed the Vice-Chair
- The first Panel meeting was held at Warsaw in 2000
- An international workshop was planned for Williamsburg, Virginia, USA, April 1-4, 2002

2000s: COSPAR Consolidated Policy

- Proposed, officially, at the Warsaw Assembly in 2000
- Draft proposed policy was presented as poster for discussion at the Assembly, and promulgated as a paper published in *Advances in Space Research*
- Workshop (co-sponsored by IAU) held in Williamsburg, Virginia in April 2002 to incorporate feedback and propose any necessary changes in the consolidated policy to update it to 2002
  - Incorporation of Mars "Special Regions"
  - Provisions of SSB report on Small Bodies Sample Return (1998)
  - Provisions of SSB report on Europa contamination (2000)
- Consolidated policy proposed to PPP Business Meeting (joint session with IISL), then to the COSPAR Bureau and Council, and adopted at WSC 2002

Current COSPAR Policy Process

- COSPAR Planetary Protection Policy

  (COSPAR Bureau- and Council-endorsed version in this publication)

- New phenomena reported/new missions proposed/other external considerations

  (Peer reviewed scientific literature/request from private or public entity/recommendations from agency advisory groups, including SSB)

- Possible study by a scientific organization and/or a COSPAR-sponsored workshop

  (May be solicited by space agencies and carried out by a National Scientific Institution or International Scientific Unions)

- Panel on Planetary Protection meeting

  (Panel business meeting at COSPAR Scientific Assemblies or dedicated COSPAR Panel Colloquium, involving representatives of the scientific community and other relevant stakeholders)

- Panel recommendation to Bureau & Council

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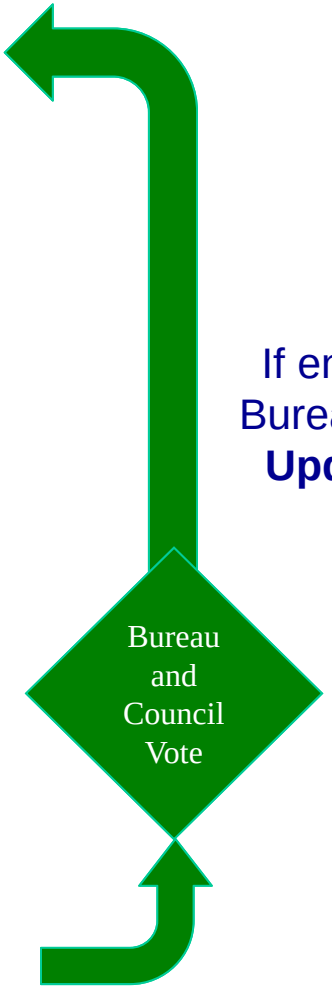


If endorsed by the Bureau and Council, **Update to Policy**

Current COSPAR PP Policy References

- COSPAR. COSPAR RESOLUTION 26.5, COSPAR Information Bulletin 20, 25-26, 1964.
- COSPAR. COSPAR DECISION No. 16, COSPAR Information Bulletin 50,15-16, 1969.
- COSPAR. COSPAR DECISION No. 9/76, COSPAR Information Bulletin 76, 14, 1976.
- **DeVincenzi, D. L., P. D. Stabekis, and J. B. Barengoltz, A proposed new policy for planetary protection, Adv. Space Res. 3, #8, 13-21, 1983.**
- COSPAR. COSPAR INTERNAL DECISION No. 7/84, Promulgated by COSPAR Letter 84/692-5.12.-G. 18 July 1984, 1984.
- COSPAR. COSPAR DECISION No. 1/94, COSPAR Information Bulletin 131, 30, 1994.
- **DeVincenzi, D. L., P. D. Stabekis and J. Barengoltz, Refinement of planetary protection policy for Mars missions, Adv. Space Res. 18, #1/2, 311-316, 1996.**
- Kminek, G., et al. Report of the COSPAR Colloquium on Mars Special Regions, COSPAR, Paris, France, 2008.
- Rummel, J. D., et al. Report of the COSPAR/IAU Workshop on Planetary Protection, COSPAR, Paris, France, 2002. (The Williamsburg Workshop)
- Rummel, J. D., et al. Report of the COSPAR Workshop on Planetary Protection, COSPAR, Paris, France, 2008. (The Montréal Workshop)
- *Space Studies Board, National Research Council (US), Evaluating the Biological Potential in Samples Returned from Planetary Satellites and Small Solar System Bodies, Task Group on Sample Return From Small Solar System Bodies, National Academy of Sciences, Washington, D.C., 1998.*
- *Space Studies Board, National Research Council (US), Preventing the Forward Contamination of Europa. Task Group on the Forward Contamination of Europa, National Academy of Sciences, Washington, D.C., 2000.*
- United Nations, Treaty on principles governing the activities of states in the exploration and use of outer space, including the moon and other celestial bodies, Article IX, U.N. Doc. A/RES/2222/(XXI) 25 Jan 1967; TIAS No. 6347, 1967.

1990s: SSB Proposed a NASA Advisory Committee

- SSB (1997) *Mars Sample Return: Issues and Recommendations* Study recommended:
- A panel of experts, including representatives of relevant governmental and scientific bodies, should be established as soon as possible once serious planning for a Mars sample-return mission has begun, to coordinate regulatory responsibilities and to advise NASA on the implementation of planetary protection measures for sample-return missions.
- SSB (1998) *Evaluating the Biological Potential in Returned Samples from Planetary Satellites and Small Solar System Bodies: Framework for Decision Making* recommended:
- NASA should consult with or establish an advisory committee with expertise in the planetary and biological sciences relevant to such an assessment
- NASA should consult with or establish an advisory committee of experts from the scientific community when developing protocols and methods to examine returned samples for indicators of past or present extraterrestrial life forms."

➢ Planetary Protection Task Force established by Space Science Advisory Committee in 1999 for a one-year study on feasibility of a Planetary Protection Advisory Committee

NASA Planetary Protection Advisory Committee
Origins

- November 1998 PPO proposal to SScAC for an advisory committee, based on recommendations from two Space Studies Board committees (Mars, Small Bodies)
- SScAC accepted charter for interim Planetary Protection Task Force (PPTF) for a one-year period (1999-2000)
  - Norine Noonan was appointed Chair
- PPTF made a report in February 2000 to the SScAC recommending a new committee be formed
- SScAC recommended the new committee to the NAC
  - June and August 2000 meetings
- The NAC concurred in August 2000

NASA Planetary Protection Task Force Membership

Dr. Norine Noonan (Chair)
Office of Research and Development
US Environmental Protection Agency
Washington, DC

Prof. Michael A'Hearn
Department of Astronomy
University of Maryland
College Park, MD

Prof. James Arnold
Dept. of Chemistry
University of California, San Diego
La Jolla, CA

Prof. Donald E. Brownlee
Department of Astronomy
University of Washington
Seattle, WA

Dr. Michael H. Carr
U.S. Geological Survey
Menlo Park, CA

Dr. Sherwood Chang
Palo Alto, CA

Dr. Gary B. Ellis
Office of Protection from Research Risks
National Institutes of Health
Bethesda, MD

Prof. Klaus Keil
Hawai'i Institute of Geophysics and Planetology
University of Hawai'i, Manoa

Mr. Edward Korwek
Hogan and Hartson, LLP
Washington, DC

NASA Planetary Protection Task Force Membership (cont.)

Dr. Anna Palmisano
Department of Energy
Germantown, MD

Dr. Jonathan Richmond
Office of Health Safety
Centers for Disease Control and Prevention
Atlanta, GA

Dr. Mitchell Sogin
Marine Biological Laboratory
Woods Hole, MA

Dr. Diana Wall
Natural Resource Environmental Laboratory
Colorado State University
Fort Collins, CO

Dr. Catherine Woteki
Food Safety and Inspection Service
US Department of Agriculture
Washington, DC

Dr. G. Michael Purdy
Division of Ocean Sciences
National Science Foundation
Arlington, VA

Dr. David Des Marais
NASA Ames Research Center
Moffett Field, CA
(SScAC liaison)

Dr. John D. Rummel
NASA Headquarters
Washington, DC
(Executive Secretary)

2000: NASA Creates a New Advisory Committee

- NASA Advisory Council accepted Space Science Advisory Committee's recommendation to form the Planetary Protection Advisory Committee in August 2000

- Chartered by NASA in early 2001:

"The Committee will advise the NASA Administrator through the NASA Advisory Council on Agency programs, policies, plans, and other matters pertinent to the Agency's responsibilities for biological planetary protection, as defined in NPD 8020.7, including NASA planetary protection policy documents and components, implementation plans, and organization. The Committee will provide a forum for advice on interagency coordination and intergovernmental planning related to planetary protection. The Committee will review and recommend appropriate planetary protection categorizations for all bodies of the solar system to which spacecraft will be sent. The scope of the Committee's responsibilities will not include issues that pertain solely to the quality and interpretation of scientific experiments and data."

NASA Planetary Protection Advisory Committee: Broad Expertise, including Societal Issues

- Membership:

"The Committee will consist of 15 to 20 members selected to ensure a balanced representation among industry, academia, and Government. The Committee members, collectively, should have the skills and capabilities to assess the issues and risks of forward and backward biological contamination for planetary missions and for biological contamination associated with the launch and return of spacecraft in interplanetary missions and their potential failure modes. At least four of the Committee members shall be persons knowledgeable in one or more of the fields of bioethics, law, public attitudes and the communication of science, the Earth's environment, or related fields. One member shall be also a member of the Space Science Advisory Committee, and one shall be a member of the Life and Microgravity Sciences and Applications Advisory Committee."

NASA Planetary Protection Advisory Committee: Representation from US Gov't/Other Agencies

Membership (cont.):

- In addition to the above-designated members, non-voting representatives shall be solicited from the following US Government agencies:

  Department of Agriculture
  Department of Energy
  Department of Health and Human Services
  – National Institutes of Health
  – Centers for Disease Control and Prevention
  Department of Interior
  Department of Transportation
  Environmental Protection Agency
  National Science Foundation
  Executive Office of the President.

- The Committee shall also invite the participation of non-voting liaison representatives from other national and international organizations undertaking joint solar system exploration missions with NASA.

- The Chair will be a member of the NASA Advisory Council.

2005: PPAC is “Last” NASA Science Advisory Committee

- April 29, 2005, Administrator Griffin Signs Final PPAC Charter (Combined ESAC and SScAC Expired on 30 April 2005)
- “The Committee will draw on the expertise of its members and other sources to advise the NASA Administrator, through the NASA Advisory Council, on Agency programs, policies, plans, and other matters pertinent to the Agency's responsibilities for biological planetary protection, including NASA planetary protection policy documents and components, implementation plans, and organization. The Committee will review and recommend appropriate planetary protection categorizations for all bodies of the solar system to which spacecraft will be sent. The scope of the Committee's responsibilities will not include issues that pertain solely to the quality and interpretation of scientific experiments and data.”
- “The Committee chair will be appointed by the Administrator and will also serve as a member of the NASA Advisory Council.”

Last PPAC:
Balanced Expertise, Plus Agencies

"The Committee will be comprised of members appointed by the Associate Administrator for Science Mission Directorate. Membership will be selected to ensure a balanced representation of expertise and points of view in scientific and technical areas and in points of view represented and the functions performed."

"In addition to the designated members, nonvoting representatives shall be solicited from the following U.S. Government agencies:

Department of Agriculture
Department of Energy
Department of Health and Human Services
– National. Institutes of Health
– Centers for Disease Control and Prevention
Department of the Interior
Department of Transportation
Environmental Protection Agency
National Science Foundation
Executive Office of the President"

"The Committee may also invite the participation of nonvoting liaison representatives from other national and international organizations undertaking joint solar system exploration missions with NASA."

New PPS Terms of Reference (2006)

- In late 2005 the PPAC was directed (by the ACMO) not to meet again. In early 2006, Mike Griffin moved all of the advisory committees around to reflect a hierarchical view of receiving advice from the NAC. As such, the PP Subcommittee was formed as a Subcommittee of the NAC Science Committee.

"The Planetary Protection Subcommittee is a standing subcommittee of the NASA Advisory Council (NAC); it also supports the advisory needs of the Science Mission Directorate (SMD). The scope of the Subcommittee includes programs, policies, plans, and other matters pertinent to the Agency's responsibilities for biological planetary protection, including NASA planetary protection policy documents and components, implementation plans, and organization. The Subcommittee will review and recommend appropriate planetary protection categorizations for all bodies of the solar system to which spacecraft will be sent. Outside the scope of the Subcommittee's responsibilities are issues that pertain solely to the quality and interpretation of scientific experiments and data. Per NPD 1150.11, the Subcommittee will be managed under procedures that ensure the same spirit of openness and public accountability that is embodied by the Federal Advisory Committee Act (FACA), including public meetings and maintenance of publicly available records."

New PPS Terms of Reference (2006)

Membership

- "The Subcommittee will consist of 12-15 members with relevant expertise drawn from industry, academia, and Government institutions. Members will be appointed by the Administrator, generally for a three-year term, and approximately one third of members will be replaced annually."

- "In addition to regular members, nonvoting representatives shall be solicited from other U.S. Government agencies with an interest in planetary protection. SMD may also, from time to time, invite the participation in meetings of nonvoting liaison representatives from other national and international organizations undertaking joint solar system exploration missions with NASA."

PPS in the Federal Register for NEPA

- NASA is no stranger to the National Environmental Policy Act (NEPA), with perhaps the largest NASA Environmental Impact Statement (EIS), so far, focused on the Space Shuttle Program (1978)
  - Numerous EISs and Environmental Assessments have been issued for all major missions and numerous minor actions
  - A commitment to its due regard of the interests of "all other States Parties" was spelled out in the Final Rule published on NASA's Procedures for Implementing NEPA (2012)
- Under "Actions normally requiring an EIS," the Final Rule gives the example:
  - Development and operation of a space flight project/program which would return samples to Earth from solar system bodies (such as asteroids, comets, planets, dwarf planets, and planetary moons), which would likely receive a Restricted Earth Return categorization. . . from the NASA Planetary Protection Office or the NASA Planetary Protection Subcommittee"

PPAC in Action Shows Results (2002):
Williamsburg Consideration of MUSES-C mission, and Its Target Body, 1998 SF36

"At the request of the Japanese Institute for Space and Astronautical Science (ISAS), and Environment Australia, the Workshop considered the case of the MUSES-C mission, which is intended to return a sample from an S-type asteroid, 1998 SF36, in 2007. The Workshop heard presentations from Professor Akira Fujiwara of ISAS on the mission, and from Dr. John Rummel of NASA on the deliberations of NASA's Planetary Protection Advisory Committee about the mission and its target body."

– COSPAR/IAU Workshop on Planetary Protection, 2-4 April 2002

Williamsburg Consideration of MUSES-C Mission, and Its Target Body, 1998 SF36 (a second target for MUSES-C)

PPAC:

"The Committee heard presentations on the MUSES-C mission, and on the nature of the MUSES-C target body, 1998 SF36. We have evaluated the mission for the purpose of assessing planetary protection requirements. Based on the framework presented in *Evaluating the Biological Potential in Samples Returned from Planetary Satellites and Small Solar System Bodies: Framework for Decision Making* (NRC 1998), the Committee affirms that the target body belongs to class Ib. After discussion of this mission and the target body, the Committee recommends that no special containment for samples returned from 1998 SF36 is required for the purposes of planetary protection, provided that subsequent information obtained prior to sample return remain consistent with the classification of that body as an undifferentiated metamorphosed asteroid. As such, we recommend that for NASA purposes, the mission be designated Planetary Protection Category V, "unrestricted Earth return."

– *NASA Planetary Protection Advisory Committee, 19 March 2002*

Space Studies Board Report 1998

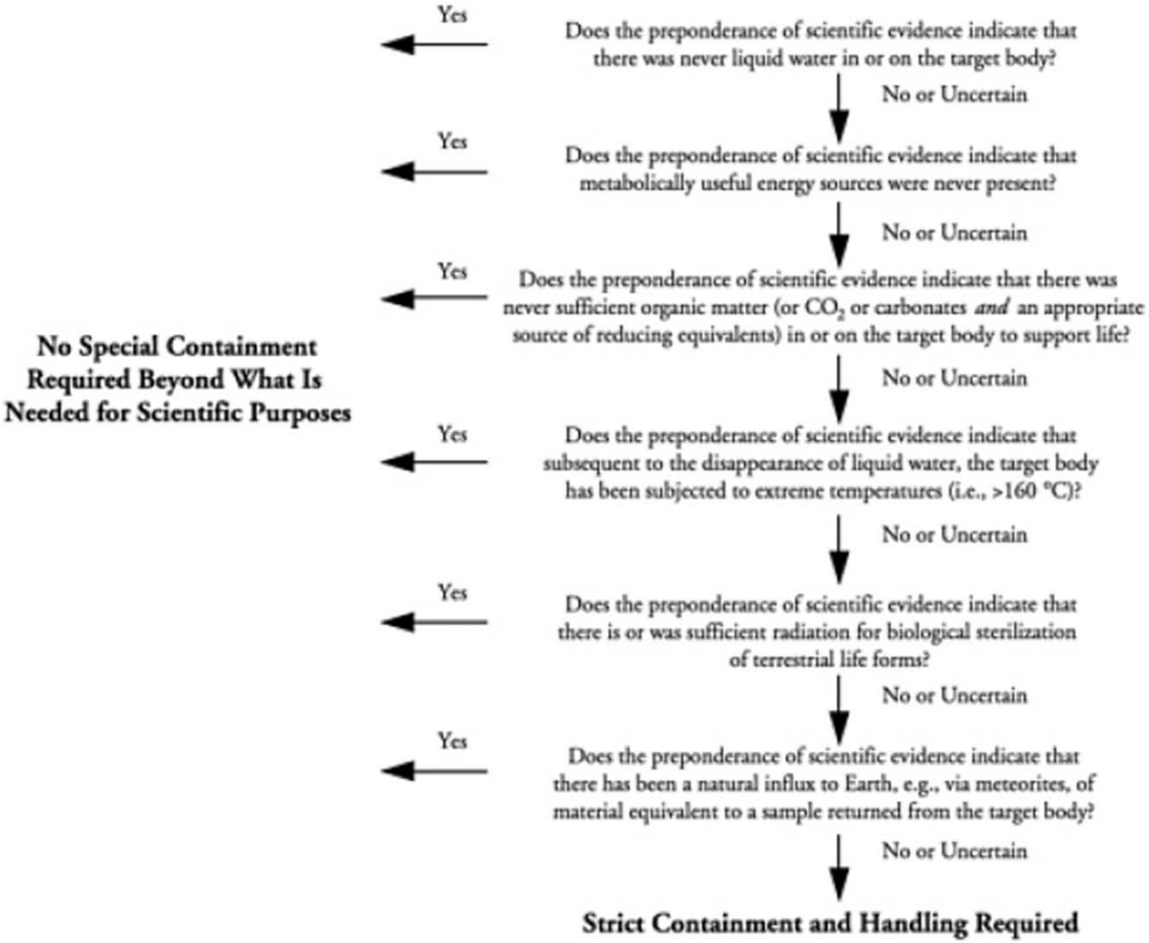


FIGURE 1.1 Relationship of the task group's criteria for assessing biological potential to its assessment of the need for sample containment.

The terms "contained" and "containment" are used in this report to indicate physical and biological isolation and handling of returned samples as specified for samples returned from Mars (see NRC, 1997). For the purposes of this report, the term "preponderance of scientific evidence" is not used in a legal sense but rather is intended to connote a nonquantitative level of evidence compelling enough to research scientists in the field to support an informed judgment.

Space Studies Board Report Adopted for COSPAR (2002)

Category V. Determination as to whether a mission is classified "Restricted Earth return" or not shall be undertaken with respect to the best multidisciplinary scientific advice, using the framework presented in the 1998 report of the US National Research Council's Space Studies Board entitled, *Evaluating the Biological Potential in Samples Returned from Planetary Satellites and Small Solar System Bodies: Framework for Decision Making* (SSB 1998). Specifically, such a determination shall address the following six questions for each body intended to be sampled:

1. Does the preponderance of scientific evidence indicate that there was never liquid water in or on the target body?
2. Does the preponderance of scientific evidence indicate that metabolically useful energy sources were never present?
3. Does the preponderance of scientific evidence indicate that there was never sufficient organic matter (or CO2 or carbonates and an appropriate source of reducing equivalents) in or on the target body to support life?
4. Does the preponderance of scientific evidence indicate that subsequent to the disappearance of liquid water, the target body has been subjected to extreme temperatures (i.e., >160°C)?
5. Does the preponderance of scientific evidence indicate that there is or was sufficient radiation for biological sterilization of terrestrial life forms?
6. Does the preponderance of scientific evidence indicate that there has been a natural influx to Earth, e.g., via meteorites, of material equivalent to a sample returned from the target body?

For containment procedures to be necessary ("Restricted Earth return"), an answer of "no" or "uncertain" needs to be returned to all six questions.

Williamsburg Consideration of MUSES-C Mission, and Its Target Body, 1998 SF36

"After careful consideration with respect to the revised COSPAR policy presented in this report, the Workshop agreed to the following statement regarding the mission and its planetary protection categorization:

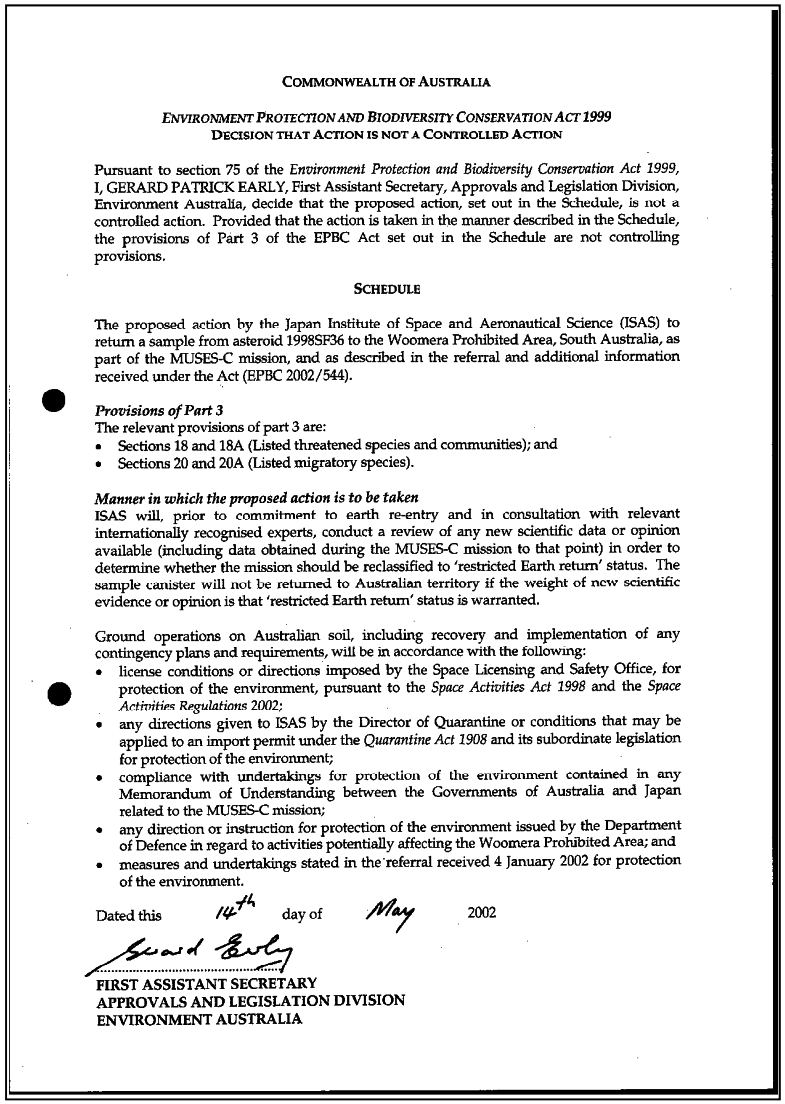
The COSPAR Workshop on Planetary Protection considered the categorization of the MUSES-C mission, and concurred with the recommendations of the NASA Planetary Protection Advisory Committee on the Muses-C mission, agreeing that its asteroid target (1998 SF36) meets the SSB classification for a body from which a Category V mission with "unrestricted Earth-return" is warranted."

– COSPAR/IAU Workshop on Planetary Protection, 2-4 April 2002

Result of Williamsburg Consideration of MUSES-C and Its Target Body, 1998 SF36

- Environment Australia issued a one-page decision instrument that the action by the Japan Institute of Space and Aeronautical Science to return a sample from 1998 SF36 is "not controlled."

- Biosecurity Australia issued a 38-page document for public comment on the action, and after receiving comments issued a two-page policy memorandum permitting the sample return.



COMMONWEALTH OF AUSTRALIA

ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT 1999
DECISION THAT ACTION IS NOT A CONTROLLED ACTION

Pursuant to section 75 of the *Environment Protection and Biodiversity Conservation Act 1999*, I, GERARD PATRICK EARLY, First Assistant Secretary, Approvals and Legislation Division, Environment Australia, decide that the proposed action, set out in the Schedule, is not a controlled action. Provided that the action is taken in the manner described in the Schedule, the provisions of Part 3 of the EPBC Act set out in the Schedule are not controlling provisions.

SCHEDULE

The proposed action by the Japan Institute of Space and Aeronautical Science (ISAS) to return a sample from asteroid 1998SF36 to the Woomera Prohibited Area, South Australia, as part of the MUSES-C mission, and as described in the referral and additional information received under the Act (EPBC 2002/544).

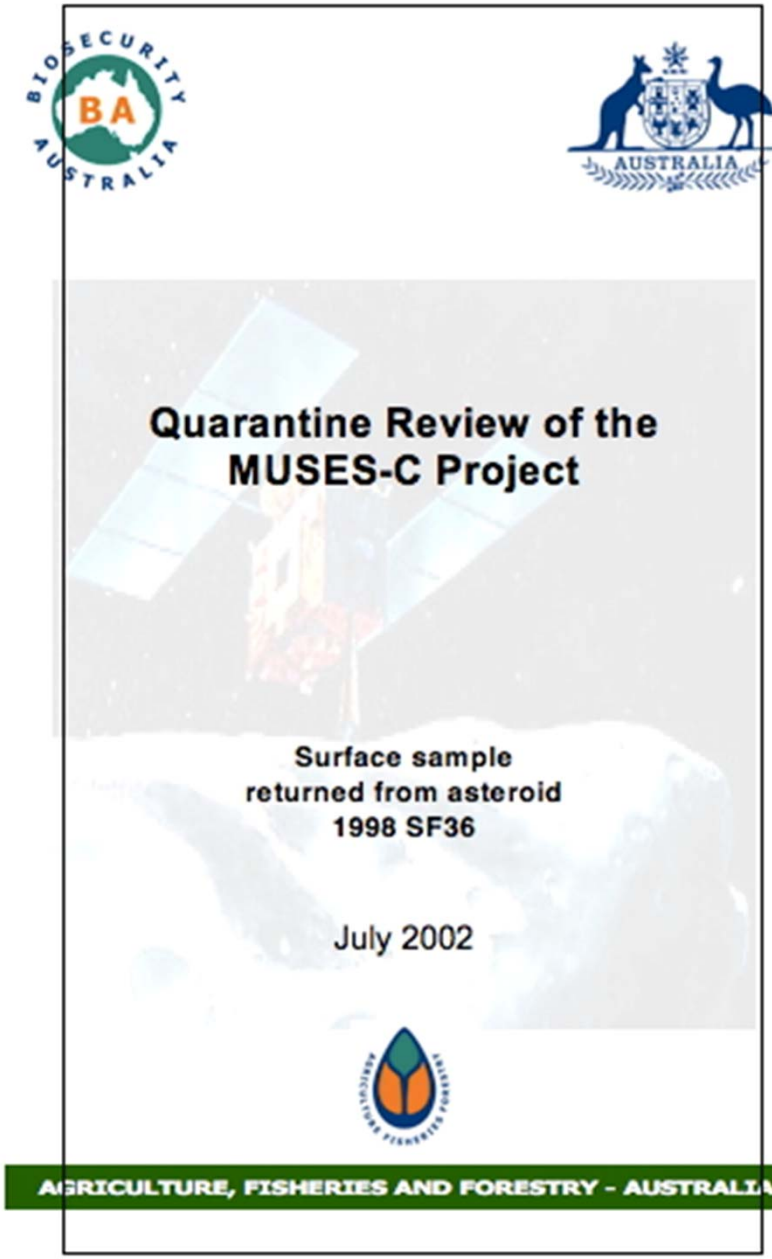
Provisions of Part 3
The relevant provisions of part 3 are:
- Sections 18 and 18A (Listed threatened species and communities); and
- Sections 20 and 20A (Listed migratory species).

Manner in which the proposed action is to be taken
ISAS will, prior to commitment to earth re-entry and in consultation with relevant internationally recognised experts, conduct a review of any new scientific data or opinion available (including data obtained during the MUSES-C mission to that point) in order to determine whether the mission should be reclassified to 'restricted Earth return' status. The sample canister will not be returned to Australian territory if the weight of new scientific evidence or opinion is that 'restricted Earth return' status is warranted.

Ground operations on Australian soil, including recovery and implementation of any contingency plans and requirements, will be in accordance with the following:
- license conditions or directions imposed by the Space Licensing and Safety Office, for protection of the environment, pursuant to the *Space Activities Act 1998* and the *Space Activities Regulations 2002*;
- any directions given to ISAS by the Director of Quarantine or conditions that may be applied to an import permit under the *Quarantine Act 1908* and its subordinate legislation for protection of the environment;
- compliance with undertakings for protection of the environment contained in any Memorandum of Understanding between the Governments of Australia and Japan related to the MUSES-C mission;
- any direction or instruction for protection of the environment issued by the Department of Defence in regard to activities potentially affecting the Woomera Prohibited Area; and
- measures and undertakings stated in the referral received 4 January 2002 for protection of the environment.

Dated this 14th day of May 2002

FIRST ASSISTANT SECRETARY
APPROVALS AND LEGISLATION DIVISION
ENVIRONMENT AUSTRALIA



Department of AGRICULTURE FISHERIES & FORESTRY - AUSTRALIA

11 July 2002

ANIMAL BIOSECURITY POLICY MEMORANDUM 2002/35

OUTCOME OF QUARANTINE REVIEW: ASTEROID SAMPLE

This Animal Biosecurity Policy Memorandum (ABPM) notifies stakeholders of the outcome of the quarantine review that will allow the return of a small amount (a few grams) of an asteroid sample into Woomera Prohibited Area in Australia as part of the MUSES-C space mission (Attachment A).

On 5 June 2002, Biosecurity Australia released a draft of its quarantine review (ABPM 2002/28). This was in response to a formal access request from the Japanese government to bring a small amount (a few grams) of an asteroid sample into Woomera Prohibited Area in Australia as part of the MUSES-C space mission.

Six stakeholders responded. Comments received on the draft have lead to the following:

. addition of details on
  - the existing quarantine import requirements for rocks, minerals and soil; and
  - the rationale for the separate consideration of return samples.
. Amendments to address recent changes to the United Nations Committee on Space Research (COSPAR) structure.
. Recognition that the landing site on the asteroid is likely to have sufficient light for photosynthesis (but only if there is air and water available).
. Increased flexibility of the proposed landing zone within the Woomera Prohibited Zone.

A copy of the final review can be obtained either on request from Biosecurity Australia or from the following web address:
http://affa.gov.au/corporate_docs/publications/word/market_access/biosecurity/animal/2002/2002-35a.doc

Biosecurity Australia has established requirements for the secure containment, transport and export of the sample and treatment of surrounding soil, machinery and equipment. The biosecurity risks are considered to be extremely low to negligible.

Next step

These conditions will take effect immediately. We would be grateful if you would pass details of this notice to other interested parties, who should advise the contact officer if they wish to be included in future communications on this matter.

Edmund Barton Building
Barton ACT
GPO Box 858
Canberra ACT 2601
ph +61 2 6272 3933
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ABN 24 113 085 695

Today's International Framework

- The Outer Space Treaty of 1967
  - Proposed to the UN in 1966; Signed in January 1967
  - Ratified by the USSR and US Senate by May, 1967
  - Article IX of the Treaty states that:

    "...parties to the Treaty shall pursue studies of outer space including the Moon and other celestial bodies, and conduct exploration of them so as to avoid their harmful contamination and also adverse changes in the environment of the Earth resulting from the introduction of extraterrestrial matter and, where necessary, shall adopt appropriate measures for this purpose..."

- The Committee on Space Research of the International Council for Science maintains an international consensus policy on planetary protection
  - COSPAR policy represents an international scientific consensus, based on advice from national scientific members, including the US Space Studies Board
  - COSPAR is consultative with the UN (through UN COPUOS and the Office of Outer Space Affairs) on measures to avoid contamination and protect the Earth
  - NASA and ESA policies specify that international robotic missions with agency participation must follow COSPAR policy, as a consensus basis for requirements

Current NASA Planetary Protection Policy Documents

- NASA Policy Directive (NPD) 8020.7G

  "Biological Contamination Control for Outbound and Inbound Planetary Spacecraft" (original replaced NMI-4-4-1 of 1963)

  –Policy statement

  –Applies to NASA Headquarters and NASA Centers, including Component Facilities and Technical and Service Support Centers, and to NASA contractors where specified by contract

  –Provisions of this directive cover all space flight missions, robotic and human, which may intentionally or unintentionally carry Earth organisms and organic constituents to the planets or other solar system bodies, and any mission employing spacecraft which are intended to return to Earth and/or its biosphere from extraterrestrial targets of exploration

Planetary Protection Policy

(DeVincenzi et al, 1983; NPD 8020.7G; COSPAR)

- "The conduct of scientific investigations of possible extraterrestrial life forms, precursors, and remnants must not be jeopardized.
- In addition, the Earth must be protected from the potential hazard posed by extraterrestrial matter carried by a spacecraft returning from [an interplanetary mission] / [another planet or other extraterrestrial sources].
- Therefore, for certain space-mission/target-planet combinations, controls on organic and biological contamination carried by spacecraft shall be imposed, in accordance with [issuances] / [directives] implementing this policy."

Note: This language appeared originally in JPL Publication 81-90, 'A Proposed New Policy for Planetary Protection' (1981), by J.B. Barengoltz, S.L. Bergstrom, G.L. Hobby and P.D. Stabekis, under contract to NASA.

NASA Planetary Protection Policy Documents
(cont.)

- NASA Policy Directive (NPD) 8020.7G (original version, 1967)
  - The Associate Administrator for the Science Mission Directorate, or designee, is responsible for overall administration of NASA's planetary protection policy
  - The Planetary Protection Officer shall be responsible for the following, as the designee of the SMD AA
    1) Prescribing standards, procedures, and guidelines applicable to all NASA organizations, programs, and activities to achieve the policy objectives of this directive.
    2) Certifying to the Associate Administrator for the Science Mission Directorate and to the Administrator prior to launch; and (in the case of returning spacecraft) prior to the return phase of the mission, prior to the Earth entry, and again prior to approved release of returned materials, that—
       a. All measures have been taken to assure meeting NASA policy objectives as established in this directive and all iimplementing procedures and guidelines.
       b. The recommendations, of relevant regulatory agencies with respect to planetary protection have been considered, and pertinent statutory requirements have been fulfilled.
       c. The international obligations assessed by the Office of the General Counsel and the Office of External Relations have been met, and international implications have been considered.
    3) Conducting reviews, inspections, and evaluations of plans, facilities, equipment, personnel, procedures, and practices of NASA organizational elements and NASA contractors, to discharge the requirements of this directive.
    4) Keeping the Associate Administrator for the Science Mission Directorate informed of developments and taking actions as necessary to achieve conformance with applicable NASA policies, procedures, and guidelines

NASA Planetary Protection Policy Documents
(cont.)

- NASA Policy Directive (NPD) 8020.7G
  - The Associate Administrator for the Human Exploration and Operations Mission Directorate and the Associate Administrator for the Space Technology Mission Directorate, or designees, will ensure that applicable standards and procedures established under this policy, and detailed in subordinate implementing documents, are incorporated into human space flight missions. Any exceptions will be requested and justified to the Administrator through the Associate Administrator for the Science Mission Directorate.

  - Program Managers, through their respective Center Director, will be responsible for the following:

1) Meeting the biological and organic contamination control requirements of this directive and its subordinate and implementing documents during the conduct of research, development, test, preflight, and operational activities.
2) Providing for the conduct of reviews, inspections, and evaluations by the Planetary Protection Officer, pursuant to this directive.

NASA Planetary Protection Policy Documents
(cont.)

- NASA Policy Directive (NPD) 8020.7G

  Measurements/Verification

  –Specific constraints imposed on spacecraft involved in solar system exploration will depend on the nature of the mission and the identity of the target body or bodies. These constraints will take into account current scientific knowledge about the target bodies through recommendations from both internal and external advisory groups, **but most notably from the Space Studies Board of the National Academy of Sciences**. The most likely constraints on missions of concern will be a requirement to reduce the biological contamination of the spacecraft, coupled with constraints on spacecraft operating procedures, an inventory of organic constituents of the spacecraft and organic samples, and restrictions on the handling and methods by which extraterrestrial samples are returned to Earth. In the majority of missions, there will also be a requirement to document spacecraft flyby operations, spacecraft impact potential, and the location of landings or impact points of spacecraft on planetary surfaces or other bodies. Specific requirements (reviews, documentation, and levels of cleanliness) are detailed in implementing procedures and guidelines, primarily NPR 8020.12, "Planetary Protection Provisions for Robotic Extraterrestrial Missions" for robotic missions and the robotic component of human missions, and NPD 8900.5, NASA Health and Medical Policy for Human Space Exploration and relevant requirements documents for human missions, which will be used to measure adherence to this directive.

Planetary Protection Studies by the US Space Studies Board (1990-2017)

1992: *Biological Contamination of Mars: Issues and Recommendations*, which reported advice on measures to protect Mars from contamination by Earth organisms, as well as overall policy guidance.

1997: *Mars Sample Return: Issues and Recommendations*, which reported advice to NASA on Mars sample return missions.

1998: *Evaluating the Biological Potential in Returned Samples from Planetary Satellites and Small Solar System Bodies: Framework for Decision Making*, which reported advice on sample return missions from small bodies, including places like Europa, asteroids, and comets.

2000: *Preventing the Forward Contamination of Europa*, which reported advice on measures to be taken to prevent the contamination of Europa by Earth organisms.

2002: *The Quarantine and Certification of Martian Samples*, which reported recommendations on actions to be taken to implement containment and biohazard testing measures recommended in 1997.

2006: *Preventing the Forward Contamination of Mars*, which reported advice on measures to be taken to prevent the contamination of Mars by Earth organisms.

2009: *Assessment of Planetary Protection Requirements for Mars Sample Return Missions*, which reported advice to NASA on Mars sample return missions.

2012: *Assessment of Planetary Protection Requirements for Spacecraft Missions to Icy Solar System Bodies*, which reported advice on measures to be taken to prevent the contamination of icy satellites in the outer solar system.

2015: *Review of the MEPAG Report on Mars Special Regions*, *jointly with the European Science Foundation* evaluated the report and reported advice on how best to implement it in Mars exploration.

A Disturbance in The Force (Why?)

| NODIS Library | Program Management(8000s) | Search |

NASA Procedural Requirements

NPR 8020.12D
Effective Date: April 20, 2011
Expiration Date: April 20, 2017

COMPLIANCE IS MANDATORY

Request Notification of Change (NASA Only)

Subject: Planetary Protection Provisions for Robotic Extraterrestrial Missions

Responsible Office: Science Mission Directorate

View all pages in PDF

Table of Contents

SPECIAL ATTENTION: ONLY USE NID 8020.109: NASA Interim Directive(NID): Planetary Protection Provisions for Robotic Extraterrestrial Missions, as it is the interim directive to NPR 8020.12D and contains the most recent requirements. !

- Changed < to this V

NID 8020.109
NPR 8020.12D

NASA Interim Directive (NID)

Effective Date: December 5, 2016

Planetary Protection Provisions for Robotic Extraterrestrial Missions
Responsible Office: Science Mission Directorate

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CHANGE HISTORY

A Disturbance in The Force (Why?)

- NASA has not explained the rationale nor the internal significance of the change, nor its timing, but the most obvious change is in the following:

NPR 8020.12D:

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.

NID 8020-109:

2.2.3 Instrument projects anticipating flights on non-NASA spacecraft may receive preliminary guidance by submitting a request to the NASA PPO, outlining the nature of the instrument(s) to be flown and details of the anticipated flight opportunity. PP requirements shall be as provided by the PPO (or equivalent authority) of the lead and launching organization(s).

- ***The reference to COSPAR planetary protection policy has been removed.***

What is the Status of the PPS?

- The current status/charter for the PPS is “a work in progress” according to the Science Committee Chair

– There are only six members remaining, and no agency reps named

– The *online* description is familiar – but no meeting is scheduled:

“The scope of the PPS includes programs, policies, plans, hazard identification and risk assessment, and other matters pertinent to the Agency's responsibilities for biological planetary protection. This scope includes consideration of NASA planetary protection policy documents, implementation plans, and organization. The subcommittee will review and recommend appropriate planetary protection categorizations for all bodies of the solar system to which spacecraft will be sent. The scope also includes the development of near-term enabling technologies, systems, and capabilities, as well as developments with the potential to provide long-term improvements in future operational systems to support planetary protection. Outside the scope of the Subcommittee's responsibilities are issues that pertain solely to the quality and interpretation of scientific experiments and data in support of solar system exploration.”

<https://science.nasa.gov/science-committee/subcommittees/nac-planetary-protection-subcommittee>

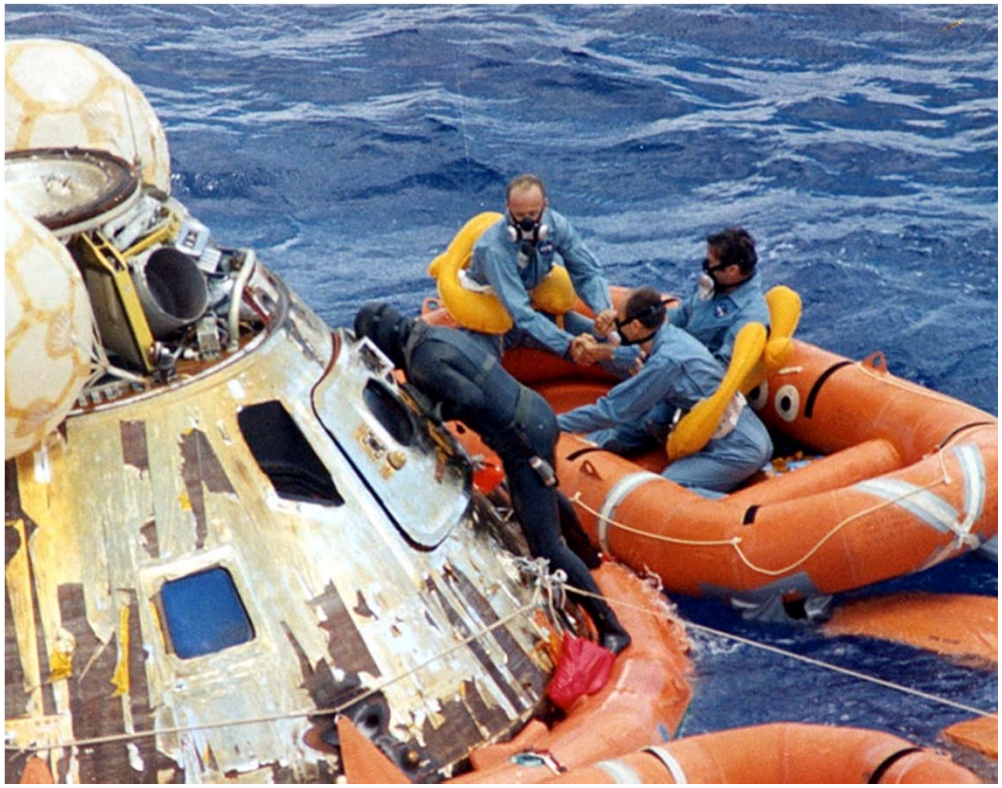
Meanwhile, Future Missions Beckon

- Missions with humans to other planets, especially Mars

- Mars missions returning samples to Earth
  - Not really “future,” given Mars 2020
  - Earth-return leg will be critical, and preparations must occur long before….

- Commercial missions to “pioneer the space frontier”
  - Or whatever….
  - How does NASA help? What regulation is needed?

Apollo-Era “Restricted Earth Return” Back Contamination’ Control is Not a Guide for Future Missions



What happened to the water that got into the capsule?

But we didn’t go to the Moon to find life, and most scientists didn’t believe that the Moon had any.

Apollo-Era Restricted Earth Return: Lax 'Back Contamination' Control, But *We Got E.T.!*

The character, "Keys" in E.T. was intended to be the NASA Planetary Protection Officer (although that role was vigorously denied by the NASA General Counsel, who pointed to *Immigration and Naturalization*).

Under NPD 8020.14, the Planetary Quarantine Officer could arrest anyone who was "extraterrestrially exposed," although technically only while they were on the grounds of the MSC. It was cancelled in 1992.

Think Kudzu!

The Kudzu vine was first brought to the United States in 1876 when it was featured at the Philadelphia Centennial Exposition as a hardy, fast-growing vine that could help inhibit soil erosion

•It is also known as the "mile-a-minute vine" or "the vine that ate the South"

•Kudzu has been spreading across the U.S. at a rate as fast as 150,000 acres annually, due primarily to the fact that its individual vines can grow upwards of a foot per day

Development of Guidelines for Human Missions

- In June, 2001, Human Exploration and Planetary Protection were considered in Pingree Park, Colorado
- In April and May, 2005, subsequent workshops were held in Houston and in Noordwijk, The Netherlands

Key Points:

- It is conceptually possible to develop systems, approaches and operational plans to enable safe, productive human missions in remote, hostile martian environments
- PP will affect design, operations and costs of EVA, life support, environmental health, and scientific systems
- Risk of contamination will be an element of each human mission that can not be avoided, but only characterized, evaluated, and controlled.

Prior-to or with Humans: Category V Restricted Earth Return Requirements

- Previous requirements developed over decades of MSR preparation and adopted by COSPAR
- ESA and NASA are continuing a program of requirements refinement
- Key recommendations driving implementation:

  NRC: samples returned from Mars by spacecraft should be contained and treated as though potentially hazardous until proven otherwise

  ESF: a Mars sample should be applied to Risk Group 4 (WHO) *a priori*

  NRC: No uncontained martian materials ... should be returned to Earth unless sterilized

  ESF: the probability of release of a potentially hazardous Mars particle shall be less than one in a million

  Both: Protocol development is still in early stages

2002 Mars Draft Protocol
Oversight and Review Committee Membership

Lynn Goldman, M.D. *Co-chair*
Johns Hopkins School of
Public Health

Joshua Lederberg, Ph.D. *Co-chair*
Rockefeller University

Members:
James R. Arnold, Ph.D.
University of California, San Diego
Purnell W. Choppin, M.D.
Howard Hughes Medical Institute
Dominique Dormont, M.D.
CEA - Service de Neurovirologie
Carol Heilman, Ph.D.
National Institutes of Health
Nina V. Fedoroff, Ph.D.
The Pennsylvania State University
Patricia N. Fultz, Ph.D.
University of Alabama
John E. Hobbie, Ph.D.
Marine Biological Laboratory
Heinrich D. Holland, Ph.D.
Harvard University
Debra Hunt, D.P.H.
Duke University Medical Center
Stuart A. Kauffman, M.D.
Bios Group LP
Florabel G. Mullick, M.D.
Armed Forces Institute of Pathology
Robert Naquet, Ph.D.
Institut Alfred Fessard
Gilbert S. Omenn, M.D., Ph.D.
University of Michigan
Leslie Orgel, Ph.D
The Salk Institute for Biological Studies
Mary Jane Osborn, Ph.D,
University of Connecticut Health Center
Lucy S. Tompkins, Ph.D.
Stanford University Medical Center
Robert M. Walker, Ph.D.
Washington University in St. Louis
Jean-Didier Vincent, Ph.D.
Director, L'Institut Alfred Fessard

Apollo Lunar Planetary Protection Consultant:
John R. Bagby, Ph.D.
ex. CDC Deputy Director
Historical Consultant:
Steven J. Dick, Ph.D.
U.S. Naval Observatory
NASA Administrator's Liaison:
Kathie L. Olsen, Ph.D.
NASA Headquarters
Executive Secretary:
John D. Rummel, Ph.D.
Office of Space Science
NASA Headquarters

Apollo-Era Restricted Earth Return: Oversight of 'Back Contamination' under NSAM 235

1963	The NAS Space Science Board recommends that NASA establish a quarantine program 'to ensure that Earth and its ecology would be protected from any possible hazard associated with the return of lunar material'
1963	Interagency Committee on Back Contamination (ICBC) is formed, with representatives from Public Health, Agriculture, and Interior, as well as NAS and NASA
1965	Is determined that Public Health Service should be responsible for the back contamination aspects of the Lunar Receiving Laboratory
1967	NASA, the Public Health Service, the Dept. of Agriculture, and the Dept. of the Interior sign an Interagency Agreement on Back Contamination, and formally charter the ICBC as the coordinating body for oversight of returned lunar astronauts and samples
1969	ICBC meets to evaluate the Apollo 11 returned sample test results
1971	Apollo Lunar Quarantine Program is ended after Apollo 14

PD/NSC-25 replaces NSAM 235: Scientific or Technological Experiments with Possible Large-scale Adverse Environmental Effects

- Applies to "all experiments that might have major and protracted effects on the physical or biological environment, or other areas of public or private interest ... even though the sponsoring agency feels confident that such allegations would in fact prove to be be unfounded."
- Federal Agencies' experiments must comply with PD/NSC-25 procedures independent of NEPA compliance

1) Agency Head must report proposed experiments to OSTP Director sufficiently early to conduct appropriate reviews.

2) Agency must provide a detailed evaluation of the experiments' importance, and possible direct or indirect environmental effects.

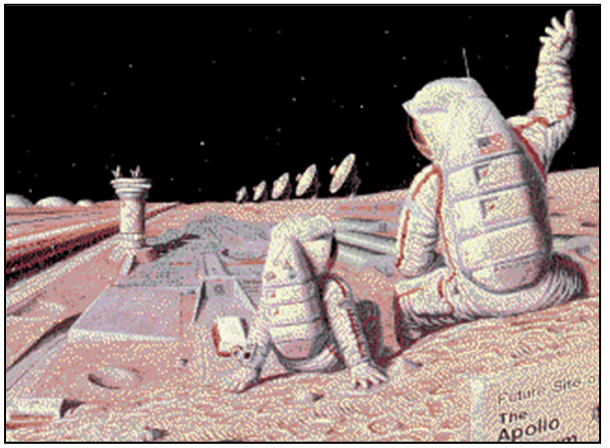
...

6) In the case of experiments with potential global adverse effects, the Secretary of State will be consulted. The US National Academy of Sciences and international scientific bodies and intergovernmental organizations may be consulted.

7) Experiments that may involve particularly serious or protracted adverse effects will not be conducted without approval of the President, and the head of the Agency involved, with advice of other concerned agencies.

The Current Situation: Proposed Deep Space Commerce

- Using space resources to “live off the land” was a feature of science fiction long before it was taken up for serious study by any space agency (e.g., for L-4/5 colonies, etc.)
- Recent interest has been evidenced by a variety of private entities which intend to gather resources in space and sell them in space
  - Names include “Planetary Resources,” “Deep Space Industries,” “Moon Express,” and “Shackleton Energy,” among others
- Precise timelines, costs, and planned customer these endeavors are not tightly d



The Current Situation:
Proposed Deep Space Commerce and Planetary Protection

- The recent Planetary Science Vision 2050 meeting showcased the motivation for continued space science missions and for a search for extraterrestrial life that will not dissipate easily or early-on
  - Space science research has a benefit to all humanity, including NASA and the US
- In addition to traditional space science missions, it is clear that there are partnerships between space commerce concerns and NASA that would that could be mutually beneficial, in a number of ways
  - For example, the joint exploration and characterization of one or more lunar polar craters could be one of those opportunities
- NASA is not only a repository/funder of planetary science expertise that can benefit the planetary resources community, but responsible in its own right for the benefits that exploration can bring to the US taxpayer, if done properly. It will need advice on how to do this.
- I will let the State Department address the benefits of Treaty compliance.

- Questions ?