Review of Planetary Quarantine Policy

Hoc Committee for Review of Planetary Quarantine Policy (February 3-4, 1972), Space Science Board, National Research Council

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Report

Space Science Board *ad hoc* Committee for
Review of Planetary Quarantine Policy

February 3 and 4, 1972
Denver, Colorado

Introduction

In considering the matter of planetary quarantine policy, the committee's deliberations were essentially divided between (1) the Mars quarantine policy and its effects on the forthcoming Viking mission and (2) the quarantine policies for the other planets (Venus, Mercury, and the Outer Planets).

On the Mars issue, the committee was guided by detailed presentations of the effects on the Viking lander as a result of maintaining or eliminating the terminal heating requirement. In considering the remaining planets, the committee relies on the summary of expert opinions provided to the Space Science Board prior to this formal review (Appendix 1).

The statements of the committee contained in this report are a response to the NASA planetary quarantine policies proposed to the SSB (Appendix 2), and must be approved and/or amended by the SSB prior to transmittal to NASA.

A. MARS

1. The committee heard presentations from NASA on:

   a. Current results of Mariner 9 mission

   b. Viking—planetary quarantine models (with and without terminal heat sterilization)

   c. Viking—engineering considerations resulting from retaining or eliminating terminal heat sterilization.

   d. Costs, risks and effects on Viking science payload as a result of retaining or eliminating terminal heat sterilization.

2. Committee conclusions

   a. The results of Mariner 9 add a significant amount to what we know about Mars. However, to date, none of this new information leads to an agreed-upon reduction of the estimate of P_g for Mars (Woods Hole review, 1970). A first look at these early results could conceivably argue for an increase rather than a decrease in P_g; however, there are other views which advocate, after considering these new results, that terrestrial organisms cannot grow on Mars, and, consequently, P_g should be reduced at least to 10^{-9}.

b. The Viking project is in a difficult situation. The present practical alternatives, as we understand them, are:

i. Maintain the present procedures which require terminal heat sterilization. This alternative provides compliance with current planetary quarantine standards, does not in any way endanger the biology experiments, but does strain the total project funds. Under this alternative, NASA plans at present to reduce the science payload (entry science, seismometry and meteorology) to keep down the mission cost. The project manager is also very concerned with the reliability risks being run by employing terminal heat sterilization.

ii. Eliminate terminal heat sterilization; thus, reducing risk of flight failures, and of problems occurring during development and qualification testing, saving ~$13 million, and thus, enabling NASA to keep the science payload intact, and satisfying the quarantine requirement with $P_c < 1 \times 10^{-9}$. However, the probability of landing more terrestrial organisms on Mars increases

c. If the terminal heat sterilization requirement were to be removed, but good sterilization and clean assembly procedures used at the component and subsystem levels, the project risks would be reduced and some direct costs would be saved. Thus, the project might not, at present, require the reduction of the science payload.

d. We are unaware of any sterilization approach or analysis which considers positions or alternatives intermediate between the limits of terminal heat/no terminal heat. It appears, however, that improved surface cleaning techniques, including the washing of the lander surfaces with liquid sterilizing agents could, in combination with thermal sterilization at the component and subassembly level and aseptic (clean room) handling, reduce the estimated delivered bioload associated with alternative ii. above and yet not severely strain the lander reliability levels.

3. The committee opinion

In the practical situation of being constrained by time and funds, the committee was divided in its opinion as to the proper course of action. Half of the membership favored the retention of the present sterilization standards and procedures, and were willing, with regret, to accept the loss of some of the science payload. The remaining members preferred to see the terminal heat requirement removed, but the procedures should still retain

- good sterilization at the component level, devise the best protection for the biology experiments and adopt other means than terminal heat of reducing the bioloads.

If the situation were not so constrained by time, the committee as a whole would prefer to maintain terminal heat, but not to reduce the science payload. Means by which terminal heating could be reduced (or even removed) should be sought along with further effort to reduce the estimate of the overall bioload delivered to Mars. If such an effort were practicably possible, it is our hope that, within perhaps a year, aided by further results from Mariner 9, the Viking mission might be possible with a much reduced risk at a small increase in overall cost.

B. MERCURY

From a previous value of probability of growth $\leq 10^{-6}$, NASA has proposed a new policy which states that Mercury is no longer of biological interest and planetary quaratine constraints can be dropped. In view of the high surface temperatures on Mercury, the highly probable absence of surface water and an atmosphere, there is no objection to removing the planetary quarantine constraints from future Mercury missions. While the probability of terrestrial organisms growing and spreading on the planet's surface is very low, Mercury does remain of biological interest. It is the committee's understanding that for future missions the spacecraft (orbiter and surface probes) will be cleaned for purposes other than quarantine requirements. We consider these cleaning procedures as sufficient for near-term missions.

C. VENUS

Two values of probability of growth are used for Venus, one for the planet surface, the other for its atmosphere. Prior to the proposed new quarantine policy these values stood at $P_{g(surface)} \leq 10^{-6}$ and $P_{g(atmosphere)} \leq 10^{-4}$. The proposed new values use $P_{g(surface)} = 0$; $P_{g(atmosphere)} \leq 10^{-9}$.

There is now general agreement that the surface temperatures of Venus are much too high for any known terrestrial microorganism to survive. Consequently, the proposed value $P_g = 0$ is acceptable.

Regarding the atmosphere, there are some uncertainties on the likely presence of sufficient nutrients, a high water activity and the convective rate by which water droplets containing microorganisms are transported downwards and pyrolyzed at the higher temperatures. The probability of contaminating the Venus atmosphere was treated in the SSB 1970 summer study*; in that study, a probability of growth for the atmosphere $\leq 10^{-6}$ was recommended and approved by the Space Science Board (a recommendation which superceded the previous value of $P_g \leq 10^{-4}$).

*Venus, Strategy for Exploration, Report of a Study by the Space Science Board, National Academy of Sciences, June, 1970, pp. 12-13.

The committee recommends that NASA evaluate their sterilization standards for the Pioneer Venus mission (surface probe) in the light of the P_g(atmosphere) number recommended in the Venus 1970 study report. If further elucidation or interpretation on the application of these numbers is needed, the SSB would be willing to review the matter again.

For the Venus/Mercury 1973 flyby mission, the committee recommends a P_g(atmosphere) $\leq 10^{-9}$ (Venus atmosphere).

D. OUTER PLANETS

A report on quarantine considerations for the outer planets[+] was made available to the committee at its meeting. Since there was insufficient time for the committee to consider this report in detail, copies will be distributed to the members requesting by correspondence their comments and recommendations for probability values, especially probability of growth (P_g), for the outer planets. In the interim, the committee suggests that, as a tentative working value, NASA use a $P_g \leq 10^{-4}$ for outer planets quarantine models.

E. LIFETIME OF MARS ORBITERS

The committee recognizes that in the COSPAR recommendation to declare Mars a biological preserve for the period 1968 through 1988, no contingencies were made to extend orbiter lifetime should life be detected on the planet. In such a case, more time would be required to study the planet; an additional thirty years is considered to be a reasonable figure to allow for this contingency. Thus, the committee endorses the NASA proposed policy that spacecraft intended to orbit Mars shall have a probability of 0.95, based on the latest available atmospheric model, of not impacting the planet before December 31, 2018.

F. BUS DEFLECTION

The technique of capsule deflection has been regarded as an additional safety measure to ensure planetary quarantine. The matter of advantage or benefit obtained from capsule deflection versus bus deflection techniques is largely an engineering consideration. If NASA is highly confident that bus deflection can be used with no degrading of the probability of contamination parameters, then the committee has no objection to using the technique for future missions.

G. APOLLO - Identification of Organisms on Outbound Apollo Missions

In the past, NASA has pursued a policy wherein an inventory was made of the probable post-landing biological contamination levels and of the identity of the potential contaminants from outbound Apollo missions. This policy was to provide an interpretation aid for subsequent analyses of microbial findings by future lunar missions. NASA contends that the lunar surface environment "is so hostile to terrestrial microbial life that none can survive for periods of significance", and proposes to eliminate the requirement.

[+]Quarantine Considerations for Outer Planet Missions - Richard Goody, Chairman, (Harvard), Norman Horowitz (CIT), Alexander Rich (MIT) and [illegible]

The committee concurs with the proposed policy change. To extend this practice to the two remaining Apollo missions from a cost standpoint is not justifiable since the inventory and identification of contaminants would produce results quite similar to those gathered from previous Apollo missions. The committee does recommend, however, that the data acquired to date should be retained and, for future access, the scientific community should be informed as to where these data are archived and how they will be made available.