IISL-97-2.11

EXOBIOLOGY AND THE OUTER SPACE TREATY: FROM PLANETARY PROTECTION TO THE SEARCH FOR EXTRATERRESTRIAL LIFE

By Patricia M. Sterns* and
Leslie I. Tennen**
LAW OFFICES OF STERNS AND TENNEN°
Attorneys and Counselors at Law
Phoenix, Arizona USA

ABSTRACT

The Outer Space Treaty established the legal obligation of states to prevent both forward and back contamination of the Earth, the Moon and other celestial bodies. These policies originated in the planetary quarantine requirements developed by the international scientific community for interplanetary missions. Subsequent instruments, especially the Moon Treaty, have elaborated on the obligations of states in relation to exobiological matters, including the requirement of public disclosure of the discovery of evidence of organic life. The recent announcement of possible fossilized traces of Martian forms of life in meteorite ALH84001 has focused renewed attention on planetary protection policies.

This article discusses the essential purposes and development of environmental protection provisions in the law of outer space. Interplanetary missions and the lunar quarantine procedures utilized in the Apollo program are examined as examples of the application of these obligations. Suggestions are proposed for specific mechanisms to promote and enhance the effectiveness of policies to preserve pristine environments and protect the integrity of scientific investigation in the exploration of our celestial neighbors.

INTRODUCTION

The fundamental questions of science and philosophy concern the origin and existence of life: How did life on Earth begin, and are we alone in the universe? Perhaps clues to these mysteries may be found on our celestial neighbors, as the late 1990's has witnessed a resurgence in interplanetary exploration. Cross-contamination by human intervention to the

* Member IAA, IISL, ASIL, ABA, IBA, ILA
Senior Member AIAA

** Commissioner, Arizona Space Commission
Member IAA, IISL, IEAS, ASIL, ILA
Senior Member AIAA

° Member IAF, IISL

The opinions expressed in this article are those of the authors only and should not be attributed to any organization with which they may be affiliated environments of Earth and celestial bodies by the introduction of biological materials could have unforeseen and catastrophic consequences. Such materials could mutate in unpredictable ways, or cause the mutation of any extant forms of life. It is axiomatic that the maintenance of integrity of scientific investigation mandates that measures be taken to prevent the biological contamination of the environment of Earth and celestial bodies. Accordingly, both the international scientific and legal communities have adopted measures for this purpose.

HISTORICAL DEVELOPMENT OF THE PLANETARY PROTECTION POLICY

The issue of planetary protection has received serious attention since the mid 1950's.[1] Following extensive study, the Committee on Space Research (COSPAR) of the International Council of Scientific Unions called for the imposition of international controls to prevent back contamination, that is, the contamination of Earth's environment by the return of extraterrestrial materials.[2] Further, in 1964, COSPAR approved recommended planetary quarantine requirements (PQR) regarding forward contamination, which declared that the probability of contamination:

> of a single viable organism aboard any spacecraft intended for planetary landing or atmospheric penetration would be less than 1×10^{-4}, and a probability limit for accidental planetary impact by unsterilized flyby or orbiting spacecraft of 3×10^{-5} or less.[3]

The probability of contamination (P(c)) for any mission was determined by application of the following formula:[4]

$$P(c) = m(i)(o) \cdot P(vt) \cdot P(uv) \cdot P(a) \cdot P(sa) \cdot P(r) \cdot P(g)$$

where:

m(i)(o) = initial microbial burden at launch, after decontamination

P(vt) = probability of surviving space vacuum-temperature

P(uv) = probability of surviving ultra-violet space radiation

P(a) = probability of arriving at celestial body

P(sa) = probability of surviving atmospheric entry

P(r) = probability of release

P(g) = probability of growth

The COSPAR guidelines obligated states to take active measures to reduce the initial microbial burden of an interplanetary craft at launch. At a minimum, fly-by craft were subjected to clean room assembly, while landing craft, such as Viking, were sterilized by heat, gas or radiation. Mission profiles were developed which minimized the risk of unintentional and accidental contact between orbiting vehicles and celestial bodies. The PQR were applied to all interplanetary missions, and any deviation from the policy constituted a specific exception.

The United States implemented the COSPAR requirements by the issuance of a series

---

1. *See generally* C.R. PHILLIPS, THE PLANETARY QUARANTINE PROGRAM: ORIGINS AND ACHIEVEMENTS 10 (1975), NASA Pub. No. SP-4902, U.S. GPO Stock No. 3300-00578; M. WERBER, OBJECTIVES AND MODELS OF THE PLANETARY QUARANTINE PROGRAM 4 (1975), NASA Pub. No. SP-344, U.S. GPO Stock No. 3300-00588.

2. *See generally* J.R. BAGBY, JR., BACK CONTAMINATION LESSONS LEARNED DURING THE APOLLO QUARANTINE PROGRAM, JPL Contract No. 560226 (1975).

3. COSPAR Res. 26, COSPAR INFOR. BULL. at Annex 4 (1964), Fifth International Space Science Symposium, Florence, Italy.

4. Phillips, *supra* note 1, at 38.

of NASA Management Instructions and NASA Policy Directives.[5] In 1978, the Space Science Board of the National Research Council established specific values for the probability of growth (P(g)) factor, which, in their opinion, eliminated the need to employ any decontamination techniques whatsoever in complying with the COSPAR planetary quarantine requirements for exploratory craft to Jupiter, Saturn, Uranus or Neptune.[6] Further revisions to the planetary protection policy in the 1980's provided that planetary protection constraints *may* be imposed, depending upon the nature of the mission and the target body or bodies to be explored. For certain missions and/or target bodies, including the Moon, the policy did not require any planetary protection techniques to be utilized, nor was any specific documentation required. For other target bodies, the classification for planetary protection purposes was to be determined on a case by case basis.

The planetary protection policies were revised most recently in 1994, in relation to exploratory missions to Mars. Specifically, the policy ties the utilization of decontamination and cleanliness controls to mission objectives. That is, craft landing on Mars which carry life detection instruments are subject to Viking level sterilization. However, landing craft without such life detection instruments, such as Pathfinder, are subject to less stringent decontamination techniques.[7]

The issue of back contamination of the environment of Earth mandated the imposition of strict quarantine controls for the Apollo program. The astronauts of the first landing missions, together with the samples of lunar materials returned to Earth, were subject to a rigorous quarantine and examination for several weeks. However, the investigations were focused primarily on whether exposure to lunar materials had any discernable effect on terran life, and not the detection of any evidence of life or the precursors thereof which may have been present. Furthermore, the lunar quarantine experiences were marred by several lapses in procedure, where release of any extraterrestrial life forms present could have occurred.[8]

The discovery of possible evidence of Martian life in meteorite ALH84001,[9] and the current series of missions to the red planet, have renewed concerns over the issue of back contamination. Even prior to the ALH84001 discovery, the scientific community had begun to formulate plans and procedures to ensure that the environment of Earth is not contaminated by organisms which might be present in returned Martian samples, and has stressed that strict quarantine of the material be implemented.[10]

5. *See, e.g., Outbound Spacecraft Basic Policy Relating to Lunar and Planetary Quarantine Control*, NASA Policy Directive 8020.7 (1967); *Outbound Planetary Biological and Organic Contamination Control*, NASA Policy Directive 8020.10A (1972); *Quarantine Provisions for Unmanned Extraterrestrial Missions*, NHB 8020.12A (1976); *Biological Contamination Control for Outbound and Inbound Planetary Spacecraft*, NMI 8020.7A (1988).

6. Committee on Planetary Biology and Chemical Evolution, Space Science Board, NATIONAL RESEARCH COUNCIL, RECOMMENDATIONS ON QUARANTINE POLICY FOR MARS, JUPITER, SATURN, URANUS, NEPTUNE AND TITAN 27-28 (Appendix C) (1978).

7. *See* AN EXOBIOLOGICAL STRATEGY FOR MARS EXPLORATION 49 (1995), NASA Pub. No. SP-530.

8. *See generally* Bagby, *supra* note 2.

9. *See* McKay, Gibson, Thomas-Keprta, Vali, Romanek, Clemett, Chillier, Maechling & Zare, *Search for Past Life on Mars: Possible Relic Biogenic Activity in Martian Meteorite ALH84001*, 273 SCIENCE 924 (1996).

10. *See* DeVincenzi, *Planetary Protection Issues and the Future Exploration of Mars*, in 12 ADV. S. RES., No. 4, 121 (1992); D.L. DEVINCENZI, H.P. KLEIN & J.R. BAGBY, JR., PLANETARY PROTECTION ISSUES AND FUTURE MARS MISSIONS, NASA Conf. Pub. 10086 (1991).

The formulation of planetary protection policies, especially in the context of a Mars sample return mission, will attract public involvement and scrutiny, and thereby involves issues of both science and politics.[11] A substantial grey area exists between the two, in which political issues overlap onto areas of scientific uncertainty. Although all available scientific data must be considered, a residual level:

> [of] uncertainty means that decisionmakers cannot determine policy on purely scientific grounds. At this point uncertainty itself becomes an aspect of the factual picture, and the question of what level of risk is acceptable in light of the uncertainty becomes a question of value, requiring political determination. . . . Failure to recognize the trans-scientific character of such questions too often lends 'scientific' credibility and authority as well as an air of 'factuality' to assertions or determinations that are at least as dependent on value choices as they are on 'scientific fact.'[12]

Viewed in this light, it may be questioned whether the relaxation in the planetary protection policies over the past three decades is prudent. There is no doubt that the utilization of decontamination and cleanliness controls adds to the cost and complexity of missions, and that the scientific data on which the policies have been based are constantly subject to review and re-evaluation. The advances in scientific knowledge on which the reductions in the policy requirements have been predicated generally centered on an assessment of the probability of growth for terrestrial organisms in the anticipated Martian environment. Nevertheless, these revisions in policy have occurred in a virtual scientific vacuum, especially in relation to Mars, as no new data had been collected *in situ* in the twenty years between Viking and Pathfinder. Moreover, Pathfinder does not carry life detection instruments, and the examinations conducted by the Viking landers were inconclusive.[13]

The risk of harm presented by biological contamination necessarily is unknown and difficult to quantify, and should not be determined solely with reference to the current state of knowledge. At best, our understanding of celestial environments is incomplete. Moreover, it would be premature to conclude that life does not exist elsewhere in the solar system merely because the scientific community has not been able to identify any alien organisms from the investigations conducted to date. Life on Earth has demonstrated that it is adaptable and resilient, and that once it takes hold, it is imbued with a tenacious will to continue to exist.[14] Therefore, prudence would dictate that planetary protection policies continue to be developed and enforced pending future scientific investigations.[15]

---

11. *See* Race, *Planetary Protection: Legal Ambiguity and the Decision Making Process for Mars Sample Return*, 18 ADV. S. RES., No. 1/2, 345 (1996).

12. Allen, *The Current Federal Regulatory Framework for Release of Genetically Altered Organisms into the Environment*, 42 FLORIDA L. REV. 531, 538-39 (1990).

13. *See generally* ORBITING QUARANTINE FACILITY: THE ANTAEUS REPORT 39-40, (D. DeVincenzi & J.R. Bagby, Jr., eds. 1981) NASA SP-454.

14. *See* Sterns & Tennen, *Preserving Pristine Celestial Environments: The Planetary Protection Policy*, 77 SCIENCE AND TECHNOLOGY SERIES, SPACE SAFETY & RESCUE 1988-1989 399 (1990); *see also* Phillips, *supra* note 1, at 36-7 (discussing the discovery of an alpha hemolytic *Streptococcus mitis* bacterium in a camera from Surveyor 3 returned from the lunar surface by Apollo 12).

15. *See* DeVincenzi, *supra* note 10; DeVincenzi, Klein & Bagby, *supra* note 10; Sterns & Tennen, *Legal Aspects of Planetary Protection for Mars Missions*, 15 ADV. S. RES., No. 3, 281 (1995).

EXOBIOLOGY CONSIDERATIONS IN THE OUTER SPACE TREATY

The conclusion of the Outer Space Treaty[16] in 1967 was a remarkable achievement by the international legal community. Born of political necessity, the instrument reflects both the ideological tensions of the cold war, as well as the most positive of mankind's aspirations. The Outer Space Treaty contains numerous provisions which relate directly or indirectly to matters of exobiology, particularly concerning forward and back contamination.

Article IX of the Outer Space Treaty requires that:

> States 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.

This provision applies both to forward as well as back contamination by biological materials. A strict construction of this provision may obligate States parties only to *avoid* harmful contamination or adverse changes in the environment.[17] Nevertheless, the introduction of biological materials to a new environment should be considered as potentially harmful, at least until demonstrated otherwise. Although interpretive questions remain concerning what constitutes "harmful contamination" or "adverse changes" to the environment, this article of the Outer Space Treaty comprised the primary statement of international policy to protect and preserve the environmental integrity of Earth and space during the initial period of interplanetary exploration.

The protection and preservation of the natural environments of space and celestial bodies properly is considered as an extension of the principle of the common province of mankind as referenced in article I of the Outer Space Treaty. That is, the interests to be promoted by ensuring the continued existence of pristine environments is common to all mankind. No state, political philosophy or generation can claim the right to jeopardize or destroy a natural environment. In the event biological contamination of a natural environment were to occur, the rights of all states to use and explore that environment would be jeopardized.

The principle of non-appropriation, as expressed in article II of the Outer Space Treaty, prohibits claims of national sovereignty in space by claim of appropriation, by means of use or occupation, or by any other means. A substantial alteration of a celestial environ would deny other entities the right to use and explore the pristine balance previously existing on that body. Thus, it could be argued that appropriation had occurred by virtue of the modification of the environment.[18] Such biological contamination also could be considered as an interference with the activities of other states parties.[19]

---

16. Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, *opened for signature* January 27, 1967, 18 U.S.T. 2410, T.I.A.S. No. 6347, 610 U.N.T.S. 205, *text reproduced in* UNITED NATIONS TREATIES AND PRINCIPLES ON OUTER SPACE 4 (1996)[hereinafter referred to as the "Outer Space Treaty"].

17. *See* Almond, *A Draft Convention for Protecting the Environment of Outer Space*, in PROCEEDINGS OF THE 23RD COLLOQUIUM ON THE LAW OF OUTER SPACE 97 (1981).

18. *See* Sterns & Tennen, *Current U.S. Attitude Concerning Protection Of The Outer Space Environment*, in PROCEEDINGS OF THE 27TH COLLOQUIUM ON THE LAW OF OUTER SPACE 398 (1985).

19. *See* Outer Space Treaty, *supra* note 16, at art. IX; *see also* Agreement Governing the Activities of States on the Moon and Other

The issue of back contamination may be governed, to some extent, by Article VIII of the Outer Space Treaty. This provision imposes international liability on states for damages to another state party, or its natural or juridical persons, caused by a space object or its component parts.[20] This provision could become applicable where damage is caused by a craft, due to its exposure to or release of harmful extraterrestrial biological contaminants. Additionally, the Liability Convention obligates states to examine the possibility of rendering appropriate and rapid assistance upon request where damage caused by a "space object presents a large scale danger to human life or interferes with the living conditions of the population or the functioning of vital centers."[21] Although numerous interpretive and factual issues may be present, the release of exobiological materials could present such a large scale danger to life or interference with living conditions.

States are obligated to provide assistance to astronauts as a result of accident or other conditions of distress pursuant to article V of the Outer Space Treaty. Furthermore, astronauts making an emergency landing in the territory of another, together with objects and components, are to be returned to the launching state.[22] The Return and Rescue Agreement obligates states to recover objects or component parts if requested by the launching state.[23] There is a question, however, whether the independent duties to return personnel or space objects to the launching state would be applicable if the object or astronauts had become exposed to or infected with some type of harmful exobiological contamination, particularly if the mere handling and transportation of the objects or persons would pose a hazard to the state party. A distinction may be drawn between astronauts and objects in this regard. Astronauts are declared to be envoys of mankind,[24] thereby constituting a special and protected class of personnel. Moreover, humanitarian considerations would dictate that nations render aid to and return contaminated personnel.

The national registries of objects launched into space referred to in the Outer Space Treaty,[25] and as required by the Registration Convention,[26] may assist in the imposition of international responsibility and liability by aiding in the identification of the responsible state of registry. The Registration Convention provides that where a state party is unable to identify the state of registry of a space object which "caused damage to it or to any of its natural or juridical persons,

Celestial Bodies, *entered into force* July 11, 1984, art. 8, ¶ 3, 1363 U.N.T.S. 3, *text reproduced in* UNITED NATIONS TREATIES AND PRINCIPLES ON OUTER SPACE 28 (1996), *and* 18 I.L.M. 1434 (1979)[hereinafter referred to as the "Moon Treaty"].

20. *See also* Convention on International Liability for Damages Caused by Space Objects, *opened for signature* March 29, 1972, arts. II, III, 24 U.S.T. 2389, T.I.A.S. No. 7762, 961 U.N.T.S. 187, *text reproduced in* UNITED NATIONS TREATIES AND PRINCIPLES ON OUTER SPACE 14 (1996).

21. *Id.* at art. XXI.

22. Outer Space Treaty, *supra* note 16, at art. VIII.

23. Agreement on the Rescue of Astronauts, the Return of Astronauts, and the Return of Objects Launched Into Outer Space, *opened for signature* April 22, 1968, art. V, ¶ 2, 19 U.S.T. 7570, T.I.A.S. No. 6599, 672 U.N.T.S. 119, *text reproduced in* UNITED NATIONS TREATIES AND PRINCIPLES ON OUTER SPACE 10 (1996).

24. *Id.* at Preamble; *see also* Outer Space Treaty, *supra* note 16, at art. V; Moon Treaty, *supra* note 19, at art. 10, ¶ 1.

25. Outer Space Treaty, *supra* note 16, at arts. V, VIII.

26. *See* Convention on Registration of Objects Launched Into Outer Space, *opened for signature* January 14, 1975, 28 U.S.T. 695, T.I.A.S. No. 8480, 1023 U.N.T.S. 15, *text reproduced in* UNITED NATIONS TREATIES AND PRINCIPLES ON OUTER SPACE 23 (1996).

or which may be of a hazardous or deleterious nature," other states parties shall render assistance to the greatest extent feasible when requested.[27] This provision could encompass the hazards presented by contamination from exobiological materials. Such language is not restricted to circumstances where damage has already occurred, but could include situations which pose a risk of harm.

The provisions of the Outer Space Treaty with direct application to issues of exobiology have been supplemented by the Moon Treaty. Article 7, paragraph 1, of the Moon Treaty provides as follows:

> In exploring and using the moon, States Parties shall take measures to prevent the disruption of the existing balance of its environment, whether by introducing adverse changes in that environment, by its harmful contamination through the introduction of extra-environmental matter or otherwise. States Parties shall also take measures to avoid harmfully affecting the environment of the earth through the introduction of extraterrestrial matter or otherwise.

This article of the Moon Treaty is more specific and comprehensive than article IX of the Outer Space Treaty. Pursuant to the Moon Treaty, states are required to *prevent* the disruption of natural celestial environments. Furthermore, the Moon Treaty, in Article 7, paragraph 2, imposes an affirmative obligation on states to report to the Secretary-General the measures taken to comply with the Treaty. The expression of this obligation implies that it is incumbent upon states to take precautions for *all* missions to prevent forward and back contamination.

Article 7, paragraph 3, of the Moon Treaty, provides for the establishment of areas with special scientific interest as "international scientific preserves." Article 5, paragraph 3, further provides that states shall inform the Secretary-General of the United Nations of the discovery of any indication of organic life on celestial bodies. Presumably, areas containing evidence of organic life will be designated as "international scientific preserves," and subject to more rigorous standards of environmental protection to be developed.[28]

The Outer Space Treaty requires states to immediately inform the Secretary-General or other states parties of any phenomena they discover in space, including the Moon and other celestial bodies, which could constitute a danger to the life or health of astronauts.[29] The Moon Treaty expands this obligation, and requires disclosure "of any phenomena they discover in outer space, including the moon, which could endanger human life or health, *as well as any indication of organic life*."[30] The Moon Treaty does not limit disclosure to other states parties or the Secretary-General, but requires that the information be disseminated to the public and the international scientific community. Nevertheless, there is a considerable degree of discretion allowed to the discovering state in making the disclosure.

THE FUTURE OF SPACE LAW AND EXOBIOLOGY: THE DETECTION OF EXTRATERRESTRIAL INTELLIGENCE

The current exobiological considerations in the law of outer space primarily relate to matters of environmental protection and the prevention of forward and back contamination. These policies help to ensure scientific integrity in the search for life in the universe, as well as to protect indigenous life on Earth from possible extraterrestrial contaminants. We must be

27. *Id.* at art. VI.

28. *See* DeVincenzi, Klein & Bagby, *supra* note 10, at 18.

29. Outer Space Treaty, *supra* note 16, at art. V, ¶ 3.

30. Moon Treaty, *supra* note 19, at art. 5, ¶ 3 (emphasis added).

prepared, however, for the possibility that a discovery will be made not just of extraterrestrial life, but of intelligent extraterrestrial life. The *corpus juris spatialis* can and should foresee the interaction of humankind with such beings.

The detection of an ETI signal will require mankind to consider the circumstances and implications from a planetary environmental and sociological perspective.[31] Any ETI will be beings "with their own understanding of a kind of 'rules of behaviour' and thus, be legal subjects."[32] Furthermore, in regard to contact between two intelligent races, a basic understanding of "mutual rules will lead to a 'code of conduct.'"[33] This is the starting point for metalaw and a fundamental link for exobiological interaction between humankind and extraterrestrial life.

Haley's classic principle of metalaw states that:

> We must do unto others as they would have done unto them. To treat others as we would desire to be treated might well mean their destruction. We must treat them as they desire to be treated. This is the simply expressed but vastly significant premise of metalaw.[34]

This principle could present a significant dilemma if the ETI were to desire us to act in a manner toward them which would be repugnant to our moral code or sensibilities, scientific or otherwise. A further dilemma could arise in circumstances where a race is unaware that its acts are harmful to the other intelligent life.[35]

An ETI's ability to think and reason will be derived from its indigenous environment, its unique history, and its biology. We must consider the possibility that in logic, as in physics, everything may be relative.[36] The rules relating to exobiology will need to be expanded *vis-a-vis* the political, psychological and sociological implications for both intelligent beings. The ultimate philosophical question and driving force, however, may be the respective positions of humankind and an ETI relative to the origin of life and their respective views of self, prior to discovery and verification of the other's existence.[37] Upon discovery of an ETI, our legal and scientific obligations will clearly cross over into another realm of consideration, where any remaining distinction between science and politics disappears. At this juncture, exobiological concerns will become the primary focus for survival of both species.

CONCLUSIONS AND RECOMMENDATIONS

The legal protection of natural celestial environments must be supported and supplemented by effective policies and procedures of the international scientific community. The planetary protection policies developed by

---

31. *See* E. FASAN, METALAW: RELATIONS WITH ALIEN INTELLIGENCES (1970); Kopal, *International Law Implications of the Detection of Extra-terrestrial Intelligent Signals*, in PROCEEDINGS OF THE 29TH COLLOQUIUM ON THE LAW OF OUTER SPACE 118 (1987); Reijnen, *Extraterrestrial Intelligence and Earthians*, in PROCEEDINGS OF THE 18TH COLLOQUIUM ON THE LAW OF OUTER SPACE 126 (1976).

32. Fasan, *Legal Consequences of SETI Detection*, IAF Paper No. IAA-95-IAA.9.2.04 (1995).

33. *Id.*

34. A. HALEY, SPACE LAW AND GOVERNMENT 395 (1963).

35. *See* Sterns, *SETI and Space Law: Jurisprudential and Philosophical Considerations for Humankind in Relation to Extraterrestrial Life*, IAF Paper No. IAA-96-IAA.9.2.08 (1996).

36. *See* Körner, *Laws of Thought*, in 4 THE ENCYCLOPEDIA OF PHILOSOPHY 416-17 (P. Edwards ed. 1972); Von Muldau, *Has the Fact that Humans are Alone on the World (or Not) Begun to Influence Ethics?*, IAF Paper No. IAA-96-IAA.9.2.09 (1996).

37. Sterns, *supra* note 35.

COSPAR and other entities have been important contributions to this process. However, extreme caution must be exercised in the consideration of reductions in decontamination and sterilization requirements, particularly where scientific knowledge is incomplete. Samples of Martian materials returned for study, for example, must be presumed to be hazardous until thorough examination and analysis establishes otherwise.

In relation to the legal obligations of states, recognition should be given to the fact that harmful or potentially harmful exobiological contamination of the environment of the Earth, by its very nature, would present exigent circumstances. Thus, the law of outer space should contain a clear and express requirement to disclose and provide detailed information concerning the nature, scope, extent and location of the contamination and the risk of harm. In the face of possible global catastrophe from extra-terrestrial contamination, states cannot be allowed to withhold information which could be crucial in counter-acting the threat of damage.

The law of outer space also should obligate states to report to the Secretary-General of the United Nations of the measures taken by any mission or program to ensure the preservation of natural environments of space and the Earth prior to launch of the spacecraft.[38] The requirements of reporting phenomena which may endanger human life[39] should include natural phenomena in space or on celestial bodies which may present a risk of danger or contamination, as well as phenomena caused by man's activities which may pose such a risk. Finally, the obligation to disclose the discovery of organic life found on the Moon or elsewhere[40] should be clarified and strengthened by requiring the public release and disclosure of both the fact and content of a detected signal or other discovery of an ETI within a specified period of time following verification.

This paper is dedicated to my Father, Lawrence P. "Waco" Sterns, a true aviation pioneer who helped pilot the way to the stars. PMS and LIT

38. *See* Moon Treaty, *supra* note 19, at art. 7, ¶ 2 (requiring advance disclosure, to the maximum extent feasible, of the intended use or placement of radioactive materials on the surface or subsurface of the Moon); *see also* Moore & Leaphart, *Manipulation and Modification of the Outer Space Environment: International Legal Considerations*, in PROCEEDINGS OF THE 25TH COLLOQUIUM ON THE LAW OF OUTER SPACE 115, 119 (1983).

39. *See* Moon Treaty, *supra* note 19, at art. 5, ¶ 3.

40. *Id.*