CALIFORNIA WESTERN
INTERNATIONAL LAW JOURNAL

VOLUME 19 1988-1989 NUMBER 1

# SOLID, HAZARDOUS, AND RADIOACTIVE WASTES IN OUTER SPACE: PRESENT CONTROLS AND SUGGESTED CHANGES

*Major Bernard K. Schafer, U.S.A.F.*†

## INTRODUCTION

Pollution of outer space, particularly the region of space in proximity to the earth, is a matter of great concern. Although there is no apparent "ecosystem" in outer space due to the harsh conditions there, there are, nevertheless, several reasons why contamination should be avoided. Although there are both conventional and customary international laws which prohibit the pollution of outer space, these laws have not prevented the considerable amount of pollution which has already occurred. In light of proposed plans to expand operation in space into the area of manufacturing and the threat of further pollution that such activity would pose, a new international regime to control pollution in outer space is proposed. Employed as loose models are the Resource Conservation and Recovery Act (RCRA)[1] and the Comprehensive Environmental Re-

* Chief of the Environmental Law Division, Civil Law Directorate, Office of the Staff Judge Advocate, Headquarters Tactical Air Command, Langley Air Force Base, Virginia. B.A., Michigan State University; J.D., Wayne State University; Master of Laws in Environmental Laws, Highest Honors, George Washington University.

† The views expressed in this article are those of the author and do not reflect the official policy or position of the United States Air Force, Department of Defense, or the United States Government.

1. Resource Conservation and Recovery Act, 42 U.S.C. §§ 6901-87 (1982).

sponse, Compensation and Liability Act (CERCLA)[2] which are enforced by the U.S. Environmental Protection Agency (EPA). Enforcement of a set of laws like these, adapted to apply on an international level, could help avoid irreparable contamination of the outer space realm.

Two types of pollution can occur in outer space: 1)back pollution which, though arising in space, adversely affects the surface or atmosphere of earth;[3] and 2) forward pollution, which arises from earth, its atmosphere, or space itself, and which affects the quality of the space environment. This article will focus on this second type of pollution as the environmental effects of pollution on earth have been discussed in detail by others. Little has been written about space pollution despite the likelihood that such pollution will become increasingly visible over the next few decades as commercial exploitation and its accompanying pollution increase, especially in "close" space.

Of the various types of pollution which can occur in space, there are three categories which are of immediate concern, and two that are esoteric. Solid waste[4] is the first category, and it encompasses all forms of debris found in outer space of a nonhazardous nature. This includes chunks of metal, clouds of gas, or even human waste, and the refuse of almost thirty years of space travel and exploration. Aside from the prospect of this solid waste physically crashing into a viable space object, it is really more of a nuisance. The second category is hazardous waste, which includes solid waste which is chemically or physically dangerous, and which can cause serious damage if improperly handled by space travelers (e.g., explosions or toxic contamination of a space station environment may occur if clouds of hazardous waste were to drift in after a space walk). In

2. Comprehensive Environmental Response, Compensation and Liability Act, 42 U.S.C. §§ 9601-57 (1982).

3. No attempt will be made in this article to address the issue of where the earth's atmosphere ends and outer space begins. However, for general reference purposes, Professor Muyres S. McDougal observes that customary law seems to recognize that outer space begins where artificial satellites move in durable orbit. Gorove, *Pollution and Outer Space: A Legal Analysis and Appraisal*, 5 N.Y.J. INT'L L. 53-54 (1972).

4. The terms "solid waste" and "hazardous waste" are freely adapted from the definition of these terms used by the Environmental Protection Agency (EPA) in its enforcement of the Resource Conservation and Recovery Act (RCRA), 42 U.S.C. §§ 6901-87 (1982). As defined by the EPA, a solid waste consists of gases, liquids, semi-solids and solid waste products which are not hazardous wastes. Hazardous wastes are solid wastes which may cause or contribute to an increase in mortal or serious illness, or pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed. OFFICE OF SOLID WASTE, ENVIRONMENTAL PROTECTION AGENCY, RCRA ORIENTATION MANUAL §§ II-5, III-9 (Jan. 1986).

the third category is radioactive waste. This is the residue of nuclear powered space objects which exude doses of radiation causing somatic or long term effects.[5]

The first esoteric category is electromagnetic pollution coming from derelict satellites. Such satellites continue to broadcast unnecessary signals which tie up scarce radio frequencies. The second esoteric category is biological—the contamination of space and celestial bodies by microbes from earth. Both of these categories are called esoteric because the likelihood of harm from them seems rather remote. Wayward satellites need only be incapacitated to stop the harm they cause. Biological contamination, considering the lethality of the space environment, is unlikely, particularly in the vicinity of the earth.[6]

The three categories of pollution which are of immediate concern will be the focus of this article. Specifically:

I. To what extent have solid, hazardous, and radioactive wastes polluted space to date and to what extent do they threaten future pollution?

II. What are the legal regimes which presently exist to control this pollution and how effective are they?

III. What improvements could be made to make the controls on outer space pollution more effective?

IV. Why has space become a dumping ground and why are changes in our treatment of the space environment needed?

## I. THE THREAT OF POLLUTION IN OUTER SPACE

### *A. Present Pollution: How Much Is There?*

Today, a significant amount of man-made debris can be found in outer space, principally in the vicinity of the earth. It is located in various orbital paths, the bulk of which can be found approximately 900 kilometers (540 miles) from the earth's surface.[7] It consists of an amazing collection of waste, in a variety of sizes, the detritus of

5. Somatic effects are those which are immediate, serious, and possibly even life threatening. In the area of exposure to radiation this encompasses, for example, the potentially fatal suppression of the immune system. Long term effects are those not realized immediately, but gradually, over a period of years. Again, in the area of radiation, this encompasses maladies such as cancer.

6. Unanswered for the time being is the effect earth microbes might have on certain planets such as Venus, where natural conditions, though rigorous, might in fact be conducive to the unfettered growth or mutation of these organisms. Gorove, *supra* note 3, at 55.

7. Menter, *Legal Regime of International Spaceflight*, in SPACE SHUTTLE AND THE LAW 61-63 (S. Gorove ed. 1980).

almost thirty years of humanity's exploration of the space frontier.

The larger items include discarded rocket bodies; burned out motors; spent fuel boosters; derelict spacecraft and satellites; pieces of launch mechanisms; and payloads which have gone awry. The smaller items include human wastes, in the form of actual trash bags heaped over the side of spacecraft from previous manned space missions;[8] clouds of urine ice crystals;[9] a lost Hasselblad camera;[10] large quantities of small copper needles placed into orbit 3,600 kilometers (2,300 miles) into space to act as passive radio reflectors;[11] millions of metal shards, the product of some sixty explosions in space resulting from unintentional and intentional destruction of space objects;[12] and finally, clouds of gas molecules such as hydrazide, nitrogen, and hydrogen chloride, the propellants and effluents from spacecraft propulsion systems.[13]

In the area of radioactive debris, there are approximately forty nuclear powered devices in space, carrying an estimated ton of radioactive material.[14] Although a number of these devices are on deep space probes, the majority are located in the vicinity of the earth and are still operational. The radioactive substances are Plutonium 238, with a half life of 87.5 years, and Uranium 235, with a half life of 713 million years.[15]

The amount of debris in space, excluding the millions of metal fragments mentioned above, ranges from 10,000 to 15,000 objects. Some of these items, such as the millions of metal fragments, travel at speeds of 22,000 miles per hour as they orbit the earth.[16] For a

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8. Hall, *Comments on Salvage and Removal of Man-Made Objects From Outer Space*, 33 J. AIR L. & COM. 288 (1967).

9. M. FREEMAN, SPACE TRAVELLER'S HANDBOOK: EVERY MAN'S COMPREHENSIVE MANUAL TO SPACE FLIGHT 40 (1979).

10. Morrison, *Star Drek*, ENVTL. ACTION, July 1983, at 10.

11. Scheraga, *Curbing Pollution in Outer Space*, TECH. REV., Jan. 8, 1986, at 9. This experiment, conducted in 1961 and 1963, was called the West Ford Project. Its impact on the world is still being felt. Because many of the needles are still in orbit, radio astronomers must take them into account when designing their experiments. *See also* S. LAY & H. TAUBENFELD, THE LAW RELATING TO ACTIVITIES OF MAN IN SPACE 189 (1970).

12. Examples of intentional destruction are the USSR's practice of blowing up its derelict electronic intelligence satellites to prevent their recovery by the U.S., and the more than 20 anti-satellite experiments the USSR has conducted since 1968. Morrison, *supra* note 10, at 10-11.

13. Smith, *A Review of Contamination Issues Associated With An Orbiting Space Station External Environment*, J. ENVTL. SCI., Jan. 1985, at 53; Christol, *Stratospheric Ozone, Space Objects, and International Environmental Law*, 6 J. SPACE L. 23 (1976).

14. Morrison, *supra* note 10, at 13.

15. C. CHRISTOL, THE MODERN INTERNATIONAL LAW OF OUTER SPACE 765-67 (1982). *See also* Morrison, *supra* note 10, at 10-14.

16. Morrison, *supra* note 10, at 10; Scheraga, *supra* note 11, at 8.

perspective on the velocity power of even a small object, it is illuminating to realize that an object weighing 10 grams, traveling 40 kilometers per second (24 miles per second or 86,000 miles per hour), upon hitting a spacecraft, has the same impact as two kilograms (4.4 pounds) of TNT.[17] The amount, location, identity, and ownership of this debris is catalogued by the United States Air Force's Space Defense Operations Center (SPADOC). SPADOC has the capability of tracking items as small as four inches by radar. Although this function is performed for national defense purposes, SPADOC also uses the information to advise space users of "launch windows" and safe orbits based on the location of this debris.[18] It is certainly a reflection of the significance of the space pollution when a federal agency of the United States is entrusted with such a mission.

### *B. Is This Pollution Really A Threat?*

The answer to the question whether man-made pollution is a threat is yes and no. On one hand, there are many arguments against fretting over the environmental state of the heavens. This argument is basically that there is no known ecosystem in space to despoil. Outer space, after all, is a lethal area with incredible extremes of cold and heat, and constant bombardment by radiation.[19] The absence of oxygen and the existence of a vacuum prohibit any sort of biological life from existing. About the only advantages of space as a respite from the earth is the absence of noise pollution and the view. The only ecosystem in space is that of nature in its rawest form, and since none of the traditional earth bound environmentalist considerations (e.g., purity of air, water, and soil; and protection of human health) are applicable in outer space, it makes no sense to worry about its "contamination."

Further, in relation to the vastness and infinity of space, the amount of debris in orbit is minuscule. As for what does exist, the natural self cleansing action of the earth's gravity and the friction generated upon entering its atmosphere, or the sun's gravity and heat, will eventually purge space of this debris anyway. Earth

17. M. FREEMAN, *supra* note 9, at 155.
18. Morrison, *supra* note 10, at 10-11.
19. A hypothetically unprotected astronaut in space would receive (in the absence of solar flares) about 10 rems of radiation per year. In comparison, the average person on the face of the earth receives only about .1 rems of radiation per year from background sources (i.e., from the earth and from space). M. FREEMAN, *supra* note 9, at 154.

bound incineration of hazardous waste requires temperatures of 1250°C (2282°F),[20] while the reentry heat experienced by a spacecraft can reach 1600°C (2912°F) and the sun's temperature is approximately 6000°C (10,000°F).[21] The bottom line on environmental protection for outer space is, therefore, how can anyone contaminate, pollute or harm such an inhospitable realm that few people will ever visit?

On the other hand, the argument that man-made pollution is a threat starts with the observation that much of the skepticism voiced above is similar to the skepticism of those who used to question the need to protect the deserts on earth. Skeptics painted the deserts in stark colors, stressing that there was no ecosystem or environmental values to justify protecting them. Today humanity is aware that deserts do have an ecosystem. Tomorrow it may well find an ecosystem in space too, if given a chance to study it in its natural, untainted form. Just as dioxin contaminated waste oil was simplemindedly sprayed on the roads of Times Beach, Missouri, to control a dust problem (causing this town to become another hazardous waste horror story in the spirit of the Love Canal in Niagara Falls, New York), so too could humanity's dim-witted fouling of space have a traumatic impact on the environment of outer space and the earth, in ways not yet understood.[22] Finally, there is one important and traditional environmental value being championed by those seeking an end to the pollution of space. Human health issues aside, there is the desire to have untrammeled natural vistas, and to protect scenic wonders from disruption, purely for aesthetic reasons. Outer space, a source of wonder and inspiration for centuries, deserves to be preserved in its original pristine state, for its own sake and for future generations to enjoy.

Furthermore, there are four practical arguments for keeping space free of waste. First, it poses a genuine safety hazard to space travelers. An example is an incident in 1984 when the space shuttle Challenger was struck in the windshield by a fast moving piece of debris.[23] Although the object only pitted the glass, it demonstrated

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20. 4 TOXIC AND HAZARDOUS WASTE DISPOSAL 177 (R. Bojasek ed. 1980).

21. D. SHAPLAND & M. RYCROFT, SPACELAB: RESEARCH IN EARTH ORBIT 22, 55 (1984).

22. Boraiko, *Storing up Trouble . . . Hazardous Waste*, 167 NAT'L GEOGRAPHIC, Mar. 1985, at 330.

23. Scheraga, *supra* note 11, at 8. The space shuttle Challenger exploded shortly after launching on January 28, 1986. All seven crew members died in the explosion, which occurred 74 seconds after lift-off, at 11:38 a.m., from Cape Canaveral. On March 21, 1988, NASA officials conceded that the failure of a synthetic rubber O-ring safety sealing at a

that pollution can endanger lives and missions unless better controls are not established. One can also speculate that the debris and clouds of gas could become so prevalent that space walking astronauts risk returning to their space ships carrying hazardous substances which could incapacitate the crew. Certainly in the case of larger objects which still carry fuel (radioactive or nonradioactive), the risk of harm to passing spacecraft caused by explosions, collisions, or just plain exposure, cannot be ignored.

Second, space experiments require that the pristine nature of space remain intact in order to be effective. During a number of Gemini space flights, for instance, a noticeable amount of contamination occurred in the area of the spacecraft, arising from some of the craft's subsystems such as its fuel cells and water evaporators. Due to an accumulation of debris on the windows of the vessel, star gazing was impaired.[24]

Third, the various gases given off by space operations may be a threat to the vital ozone layer in the earth's upper atmosphere. Depletion of the ozone layer is of concern because it provides humanity with protection from harmful, cancer-causing, ultra-violet radiation emanating from outer space.[25]

Fourth, the ability of the earth and the sun to purge space of pollution is not as reliable as it may appear. In the case of controlled reentry of space objects, there are no guarantees of complete destruction—the most that can be predicted is when and where the object or its pieces might land within a strip 50 miles wide and 1700 miles long.[26] In addition, uncontrolled reentries are just as likely to happen, as many space objects are used until devoid of the fuel which would be needed to achieve a controlled reentry. The harm of such a reentry is demonstrated by the reentries of Skylab, Cosmos 954, and several U.S.-owned, radioactive powered satellites, which showed that it is practically impossible to predict when, where, or in how many pieces a satellite will land during an unprogrammed reentry. Indeed, the interaction of the earth's gravity and

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joint on the right side rocket booster was the probable cause of the explosion. The failure of this seal allowed superheated gases to escape and ignite the fuel in the shuttle's external tank. The rupture of this seal was due to a combination of cold weather experienced at the launch site, and design flaws in the seal itself. 46 FACTS ON FILE no. 2358, Jan. 31, 1986, at 49; 46 FACTS ON FILE no. 2366, Mar. 28, 1986, at 210; 46 FACTS ON FILE no. 2372, May 9, 1986, at 334.

24. Smith, *supra* note 13, at 52.

25. Christol, *supra* note 13, at 1.

26. Doyle, *Reentering Space Objects: Facts and Fiction*, 6 J. SPACE L. 107, 119 (1978).

atmospheric friction can be an efficient method of spreading pollution, as in the case of the 1964 uncontrolled reentry of a U.S.-owned, nuclear powered navigation satellite, which smeared 17,000 curies of fine Plutonium 238 dust into the earth's atmosphere.[27]

The uncertainties arising from the laissez-faire approach to pollution control and the practical reasons for trying to control it indicate that man-made pollution should be considered a threat. Given that there is a certain amount of pollution of space, and that it does pose a threat, the threat of future pollution will be examined next.

### *C. Is There A Threat Of Future Pollution?*

The answer to the question whether future pollution will occur is yes, based on humanity's past practice of polluting outer space and the continuation of this practice today. However, there is a special threat of future pollution found in current plans to expand the use of outer space. These plans are to use outer space on a commercial basis to manufacture items which cannot be produced on earth. It is due to these plans that the amount of pollution may increase, and the nature of the substances themselves may become more hazardous than mere orbiting garbage.

Over the last year or so, interest in the commercial exploitation of space has increased significantly.[28] Ironically, the tragic destruction of the space shuttle Challenger[29] has helped accelerate interest in private enterprise launch services. The Reagan Administration has announced that future shuttle missions will be primarily military projects (to make up for the backlog of military payloads caused by the lack of an operational shuttle), and that private enterprise will need to find other providers for launch services for their payloads.[30] In response, several companies have proposed plans to provide not only launch services, but space stations and research labs as well, to be leased or purchased to conduct manu-

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27. Morrison, *supra* note 10, at 11.

28. Isikoff, *U.S. Firms Unveil Plan For Space Lab*, Washington Post, Sept. 30, 1986, at C3, describes plans between Westinghouse Electric Co. and Space Industries Inc. to build the first commercial space research lab. Tucker, *Fairchild Bids to Build First Gas Station in the Heavens*, Washington Post, Sept. 15, 1986, at Washington Business 3, describes Fairchild Space Company's plans to design a system to refuel satellites and extend their useful lives.

29. The Challenger disaster is discussed *supra* note 23.

30. Sawyer, *Military Payloads Dominate New Schedule For Shuttle*, Washington Post, Oct. 1, 1986, at A1; Levine, *Commercialization of Space: Policy and Administrative Issues*, PUB. ADMIN. REV., Sept. 1985, at 562.

facturing operations.[31] The threat of further contamination of space prompted by this new commercial interest is probably best typified by the plan to put in orbit a drum containing 5,000, 2" long metal capsules, each containing the cremated remains of a human.[32]

Use of space to manufacture items was tested as far back as 1974, with the U.S. National Aeronautics and Space Administration's (NASA) Skylab project.[33] Subsequent space shuttle missions confirmed the utility of space manufacturing processes.[34] With the joint NASA and European Space Agency (ESA) Spacelab mission of 1983, experimentation in this area reached its zenith.[35] A sampling of some of the intriguing possibilities of the near zero gravity of space[36] resulted in the following observations: air can be whipped into molten metal to create a light but strong metal soufflé; crystals for microchips grow faster and purer in space, particularly gallium arsenide crystal microchips which are faster, require less power, generate less heat than regular silicon crystals microchips, and are very hard to grow on earth; impurities in medicines can be removed more easily and more completely because the electrophoresis process used on earth works far more efficiently in space; and substances such as metals, plastics, and glass can be manufactured more purely and uniformly because electromagnetic forces hold the substances suspended in place during the manufacturing process,

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31. Simpson, *Small Space Flight Office Sees Business Taking Off*, Washington Post, Sept. 17, 1986, at A23; Corrigan, *Space-Age Speculators Plan Orbiting Industrial Parks with NASA's Help*, NAT'L J., Sept. 7, 1985, at 1986-87. There are two likely locations for these factories in space: geostationary orbits around the earth, and in deep space at the Lagrange libration points. Geostationary orbits are an ideal spot because this will place the factories in a position to be managed more easily by the owners of the project. Also, such a location puts the factory close to the markets on earth where the manufactured products are intended to be used. An alternative location may be those spots in deep space where the gravity of the earth is cancelled by the gravity of the moon, referred to as the Lagrange libration points. These points may be suitable for the location of space stations due to the congestion of the geostationary orbit locations, the proximity of the points to the natural resources of the moon, and the natural advantage the points offer of reducing the expenditure of energy to maintain a zero gravity status. NATIONAL COMMISSION ON SPACE, PIONEERING THE SPACE FRONTIER 131-32 (1986).

32. TIME, Sept. 29, 1986, at 59. This is somewhat reminiscent of the West Ford Project. *See supra* note 11 and accompanying text.

33. Finch & Moore, *Ecospace and Some of Its Legal Implications*, 4 J. SPACE L. 117 (1976).

34. E. FINCH & A. MOORE, ASTROBUSINESS: A GUIDE TO THE COMMERCE AND LAW OF OUTER SPACE 6 (1985).

35. Bourely, *The Spacelab Program and Related Legal Issues*, 11 J. SPACE L. 27 (1983); D. SHAPLAND & M. RYCROFT, *supra* note 21, at 186-87.

36. Space gravity is considered near zero because some gravitational disturbances are experienced as a result movements of the astronauts within the spacecraft, the movement of the craft itself, and the influences of the earth's atmosphere and gravitational pull. D. SHAPLAND & M. RYCROFT, *supra* note 21, at 67.

eliminating the need for containers.[37] This is important because almost all containers leak impurities into the mixtures, causing the materials to cool and form at uneven rates.[38]

These operations pose a distinct threat of increased pollution because the manufacturing processes described above will undoubtedly have waste by-products. After all, the goal in many of these activities is to remove impurities. Some of these impurities will undoubtedly be hazardous, such as wastes from the creation of gallium arsenide crystals. What will industry do with them? If one looks at its record on earth, the answer is clear—they will be tempted to dump them in space. In the United States alone, as of September 1984, over 17,000 abandoned hazardous waste sites were discovered for possible listing under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), a law passed to clean up such facilities.[39] Since space is something out of sight and out of mind to the average citizen, and since there has been a practice of dumping debris in outer space for the last thirty years, it is easy to see why industry might feel it is acceptable to dump space manufacturing wastes in space, untreated and untended—after all, who will know or care?

One final point should be made. At first, the amount of manufacturing waste will probably not be very large, and may be carried back to earth by spacecraft. This is because of the great cost of putting materials in space—it currently costs $10,000 per kilogram. Once an item is placed in space, manufacturing costs will be even greater. Therefore, only small scale, expensive items, such as medicines and electronics, will be created at first.[40] This is not a reason for the international community to fail to address the pollution issue. There is a danger in bringing such waste back to the earth. The returning spacecraft might crash while landing and spread its hazardous cargo onto the earth. Also, as manufacturing processes in space expand over the next several decades, the amount of waste generated will eventually be too large to pack into valuable cargo space, and will be left in space for disposal purposes. Although this problem will increase very slowly over time, there is an opportunity now for the world community to address the use of

37. THE ECONOMIST, Aug. 4, 1984, at 74.
38. *Id.*
39. Hill, CERCLA New-Hire Training Information, EPA Memorandum (June 13, 1986) (available at Office of Solid Waste and Emergency Response, Environmental Protection Agency).
40. THE ECONOMIST, Aug. 4, 1984, at 4.

space as a dumping ground, and to develop a legal regime for controlling such activity.

## II. PRESENT CONTROLS ON OUTER SPACE POLLUTION

### *A. Conventional International Law*

There are five international treaties which can be cited as proof that international laws against the pollution of outer space exist. As treaties they comprise that body of international law known as conventional law. Conventional law is binding only on the parties who signed the treaties. The nations of the world who are most involved in space exploration, now and in the foreseeable future, have signed the treaties. These nations are namely the United States; the Union of Soviet Socialist Republics; the European Space Agency (ESA) which is comprised of: Belgium, Denmark, France, Great Britain, Ireland, Italy, Netherlands, Spain, Sweden, Switzerland, and West German; Japan; and the Peoples Republic of China (PRC). Chronologically, the treaties are as follows:

*1. Test Ban Treaty of 1963.*[41] Entitled the "Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water," the Test Ban Treaty, as it is more commonly known, was the first treaty signed by the "space powers" to limit the abuse of outer space by harmful contamination.

In its Preamble, the treaty's goal is to "put an end to the contamination of man's environment by radioactive substances."[42] In Article I, the parties to the treaty promise "not [to] carry out any nuclear weapon test explosion . . . in the atmosphere; beyond its limits, including outer space."[43] This treaty clearly prohibits contamination of outer space by nuclear materials, although it only addresses contamination by explosion. It does not, for example, cover leaks of radioactive materials from a satellite's nuclear reactor. Although France and the PRC have not signed this agreement, they have apparently acquiesced to it insofar as explosions in outer space are concerned, because they have not conducted such tests.

*2. Outer Space Treaty of 1967.*[44] Entitled the "Treaty on Princi-

41. Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space, and Underwater, Aug. 5, 1963, 14 U.S.T. 1313, T.I.A.S. No. 5433, 480 U.N.T.S. 43.

42. *Id.* at preamble.

43. *Id.* at art. I.

44. 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* Jan. 27, 1967, 18 U.S.T. 2410, T.I.A.S. No. 6347, 610 U.N.T.S. 205 [hereinafter OST].

ples Governing the Activity of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies," the Outer Space Treaty (OST) or the Principles Treaty as it is also called, addresses space pollution more directly than any other international treaty. This treaty designates the realm of space as a *res communis*. *Res communis* means that space is an area common to all mankind, used by all but never to be owned.[45] Another label for this concept is that space is the "common heritage of mankind" (CHOM).[46] The U.S. policy is that the two terms are not synonymous.

The CHOM principle is presented in the Preamble, Article I, and Article IX, which state that the treaty recognizes "the common interest of all mankind in the progress of the exploration and use of outer space . . . that the exploration and use of outer space should be carried on for the benefit of all peoples . . . in the interests of all countries, irrespective of their degree of economic or scientific development."[47] These words indicate that no State has the right to foul space as if it were its own territory. The CHOM principle creates a global commons in space.[48]

Other articles explore a State's liability for the harm caused by its space activities. Article VII holds that a State that launches, procures the launch, or allows the launch of an object on its own

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45. BLACK'S LAW DICTIONARY 1173 (5th ed. 1979); C. CHRISTOL, *supra* note 15, at 286.

46. *See Agreement Governing the Activities of States on the Moon and other Celestial Bodies*, Dec. 5, 1979, G.A. Res. 34/68, 34 U.N. GAOR Supp. (No. 46) at 77, U.N. Doc. A/Res/34/68; Menter, *Commercial Space Activities Under the Moon Treaty*, 7 SYRACUSE J. INT'L L. & COM. 213, 216 (1979).

47. OST, *supra* note 44, at art. I & IX.

48. C. CHRISTOL, *supra* note 15, at 286. Other articles make this even clearer. Article III provides: "State parties to the treaty shall carry on activities in the exploration and use of outer space including the moon and other celestial bodies, in accordance with international law." OST, *supra* note 44, at art. III. This suggests that in addition to the body of conventional international law created by the OST, customary international law relating to the terrestrial environment, applies as well. *See infra* sec. IIB. Article IX states that parties 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 . . . where necessary, shall adopt appropriate measures for this purpose." OST, *supra* note 44, at art. IX. If a party has "reason to believe that an activity or experiment planned by it or its nationals in outer space . . . would cause potentially harmful interference with the activities of other Parties in the peaceful exploration and use of outer space . . . it shall undertake appropriate international consultations before proceeding with any such activity or experiment." *Id.* A party "may request consultation concerning the activity or experiment of other Parties, if it has reason to believe the activity or experiment of the other party would cause potentially harmful interference with its activities." *Id.* This language clearly prohibits the pollution of outer space. It places a duty on potential polluters to notify others of harmful activities by the State or private enterprise. It creates a right for potentially affected parties to request consultation with polluting countries about their harmful outer space activities.

territory or that of another, is liable for the harm the launched object causes another State. Article VI expands Article VII, and makes clear that a State is liable even if a nongovernment entity causes the harm. The State's responsibility for the activities of these entities requires States to authorize and continually supervise nongovernment activities in space.[49]

Article VIII establishes property rights in space: "Ownership of objects launched into outer space, and of their component parts, is not affected by their presence in outer space." This cuts both ways however, and is interpreted to prohibit a State from disowning a harmful and contaminating item that is placed in space. It creates a responsibility to deal with all of the incidence of ownership of such an item, including the contamination it may cause the space environment.

Finally, Article XI requires parties to notify, to the extent feasible and practicable, the Secretary General of the United Nations, the public, and the international scientific community, of the nature, conduct, locations and results of space activities.

*3. The Rescue and Return Agreement of 1968.*[50] "The Agreement on the Rescue of Astronauts, the Return of Astronauts, and the Return of Objects Launched Into Outer Space," commonly referred to as the Rescue and Return Agreement (RRA), expands on Article V of the OST.[51] Article 5, paragraph 4 of the RRA says that "[A] Contracting Party which has reason to believe that a space object or its component parts discovered in territory under its jurisdiction or recovered by it elsewhere, is of a hazardous or deleterious nature, may so notify the launching authority, which shall immediately take effective steps . . . to eliminate the possible danger of harm."[52] Therefore, if a hazardous object is discovered in an area of outer space where another nation is conducting space operations, the finder can demand that the owner (the launching State) do what is necessary to eliminate the problem. Japan and Spain are not parties to this agreement.

*4. The Liability Convention of 1973.*[53] Formally entitled "The

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49. Esposito, *The Commercial Exploitation of Space*, 25 A.F.L. REV. 159, 160 (1985).

50. Agreement on the Rescue of Astronauts, the Return of Astronauts, and the Return of Objects Launched into Outer Space, *opened for signature* Apr. 22, 1968, 19 U.S.T. 7570, T.I.A.S. No. 6599, 672 U.N.T.S. 119 [hereinafter Rescue and Return Agreement].

51. Trimble, *The International Law of Outer Space and Its Effect on Commercial Space Activity*, 11 PEPPERDINE L. REV. 521, 536 (1984).

52. Rescue and Return Agreement, *supra* note 50, at art. 5, para. 4.

53. Convention on International Liability for Damage Caused by Space Objects, Mar. 29, 1972, 24 U.S.T. 2389, T.I.A.S. No. 7762 [hereinafter Liability Convention].

Convention on International Liability for Damage Caused by Space Objects," the Liability Convention expanded on the guidelines of Articles VI and VII of the OST.[54] The Liability Convention establishes two different standards of liability for damages caused by space activities which are determined by where the harm was experienced. According to Article II, an absolute liability standard applies to harm caused to an aircraft in flight or on the surface of the earth.[55] Article III uses a fault standard for harm caused in outer space.[56] Article XII says that the amount of compensation to be paid is determined "in accordance with international law and principles of justice and equity . . . ." which should restore the victim "to the condition which would have existed if the damage had not occurred."[57] Japan has not signed this treaty.

*5. The Registration Convention of 1976.*[58] "The Convention on the Registration of Objects Launched Into Outer Space," referred to as the Registration Convention, expands on Article XI of the OST. It establishes a regime for notifying the Secretary General of the United Nations about objects launched into outer space. It also requires a State to report any launch by a private firm.[59] Significantly, Article IV requires that the Secretary General be notified about the general function of the space object as well as its location. Article VI provides a remedy for harm to a State by a space object whose location and nature have not been properly reported to the Secretary General.[60] Taken together, Articles IV and VI require States to declare what they have put into orbit, including any hazardous or potentially polluting aspects of the object, in order to lessen the chance of harming another State party to this treaty.

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54. Martin, *Legal Ramifications of the Uncontrolled Return of Space Objects to Earth*, 45 J. AIR L. COM. 457, 461 (1980).

55. Liability Convention, *supra* note 53, at art. II; *see also* SPACE SHUTTLE AND THE LAW 15 (S. Gorove ed. 1980).

56. Deem, *Liability of Private Space Transportation Companies*, 51 INS. COUNS. J. 340, 355 (1984).

57. This suggests that one could look to cases such as the Trail Smelter Arbitration, which deal with environmental issues on an international scale to determine what the fair measure of damages would be in a space environmental pollution case. *See* Trail Smelter (Can. v. U.S.), Arbitral Tribunal Under the Convention of Apr. 15, 1935, 3 R. Int'l Arb. Awards 1905 (1949).

58. Convention on the Registration of Objects Launched into Outer Space, *opened for signature* Jan. 14, 1975, 28 U.S.T. 695, T.I.A.S. No. 8480.

59. *Id.*

60. In such a case, Article VI requires, to the greatest extent feasible, other States to assist the State damaged by a space object either by a collision or by the object's "harmful or deleterious nature." It requires monitoring and tracking assistance and identification of the previously unreported object. N. MATTE, AEROSPACE LAW: FROM SCIENTIFIC EXPLORATION TO COMMERCIAL UTILIZATION 175 (1977).

The PRC, Japan, Ireland, and Italy have not signed this treaty.

From this examination of the conventional international law dealing with the pollution of outer space, several observations can be made. There is a requirement that nations respect the CHOM aspect of space just as they do other *res communis* areas, by not polluting space to the detriment or exclusion of other nations. There is a duty to notify the world of dangerous activities in space. Liability will be imposed on nations responsible for causing harm to other nations by their activities in space. General concepts of international law will be applied to gauge a nation's conduct and to determine compensation for harm. And, at the very least, there is a requirement to not explode nuclear devices in outer space.

Although these treaties are binding only on signatories, they are significant because the preeminent space powers, the United States and the USSR, as well as the majority of the members of the ESA, have signed them. Of greater significance is that all of the space powers have signed the OST, the most important space treaty of all. This conventional law effectively controls all activities in space until such time as a nonsignatory makes its appearance on the space scene. One must look to customary international law to determine what controls apply to the activities of nonsignatory nations.

### *B. Customary International Law*

Independent of conventional international law is a body of law called customary international law. Customary law is "international custom, as evidence of a general practice accepted by law."[61] To prove the existence of an international custom, one must establish two elements: an empirical element, or uniform practice by the world's States; and a psychological element, or *opinio juris*, the opinion of the world community as reflected in its practice and in the writings of experts in the field. The significance of establishing a customary international law against pollution of space is twofold: it acts as a body of law applicable to non-signatories of treaties, binding them just as if they were signatories; and it bolsters the prohibition of outer space pollution by conventional international law. As noted by the International Court of Justice, conventional international law can generate rules which pass "into the general corpus of international law and [are] now accepted as such by the

61. Statute of the International Court of Justice, as annexed to the Charter of the United Nations, June 26, 1945, 59 Stat. 1055, T.S. No. 993, Article 38(1)(b).

*opinio juris*, so as to have become binding even for countries which have never, and do not, become parties to the Convention."[62]

There are some things purely in the realm of space law which can be cited as evidence of a general practice against the pollution of space. First, the various treaties discussed above are empirical evidence of a uniform practice by the world against the pollution of space. Second, the psychological element is established by the wide acceptance of these treaties,[63] by the failure of any nation to reserve unto itself the right to pollute, and by the writings of experts who have noted that States have a duty not to pollute outer space.[64] Of course, based on the description of current space pollution made earlier in this article, it is questionable whether the actual practice of the world's space powers has been to avoid space pollution. There is an argument, however, that the pollution which has occurred to date has been a natural, though undesired, by-product of humanity's early steps into space.[65]

The large body of international and domestic law relating to the protection of the earth's environment provides a second form of customary international law against space pollution. Clearly, this body of law is not directed at the space environment, but instead to the surface of the earth and its atmosphere. However, the line separating the earth's atmosphere from space has been difficult to draw legally,[66] as well as environmentally.[67] Therefore, this body of law can be cited as evidence that the world community does not accept pollution of space, any more than it does on earth or in other *res communis* areas, such as the sea. The psychological element is established by the wide acceptance of these earth-based environmental laws, and by the acceptance of basic outer space environmental protection principles by some of the world's nations and experts in the space law field.

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62. The court further noted that "this process is a perfectly possible one and does from time to time occur: it constitutes indeed one of the recognized methods by which new rules of customary international law may be formed." North Sea Continental Shelf (W. Ger. v. Den. & Neth.) 1969 I.C.J. 12, at para. 71, (Judgment Feb. 20, 1969), *reprinted in* MCDOUGAL & REISMAN, INTERNATIONAL LAW IN CONTEMPORARY PERSPECTIVE (1981).

63. The OST in particular, which 84 of 154 countries have signed.

64. C. CHRISTOL, *supra* note 15, at 912. *See also infra* notes 106-15 and accompanying text.

65. *See infra* sec. V.

66. Gorove, *supra* note 3.

67. *Id. E.g.*, the issue of back pollution recognizes that space activities can have an adverse impact on the earth's environment.

### *1. Customary International Law: The Empirical Element*

International and domestic laws creating customary international law against outer space pollution will be examined by first looking at the empirical element: international environmental treaties, declarations, organizations, cases, and domestic practices.

#### a. International Treaties

A number of multilateral and bilateral treaties exist which clarify the responsibility of all States to protect the world's environment:

(1) *Antarctic Treaty.*[68] Signed in 1959, this treaty establishes the use of Antarctica for peaceful purposes. In the area of environmental protection, it prohibits the disposing of radioactive wastes in Antarctica.

(2) *International Convention on Civil Liability for Oil Pollution Damage.*[69] This 1969 treaty seeks to protect the oceans from oil pollution by bulk carriers, by creating a system of liability and compensation for harm caused by oil spills. This law stands for the proposition that the world community gives no one the right to spill oil into the *res communis* of the sea with impunity.[70]

(3) *Agreement on Cooperation in the Field of Environmental Protection Between the United States of America and the Union of Soviet Socialist Republics.*[71] This 1972 bilateral agreement between the world's preeminent space powers is a significant declaration of the environmental values of both countries. Both parties agree to cooperate to prevent pollution, develop the basis for controlling the impact of human activities on nature, and develop new

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68. Antarctic Treaty, Dec. 1, 1959, 12 U.S.T. 794, T.I.A.S. No. 4780. The treaty was signed by 13 nations, including seven space powers: the United States, the U.S.S.R., the United Kingdom, Ireland, Belgium, France and Japan. Although this treaty divided the use of the Antarctic up among the 13 signatories, it still has a flavor of viewing the Antarctic as *res communis* (though admittedly for a *communis* of 13), and as such, deserving of some environmental protections.

69. International Convention on Civil Liability for Oil Pollution Damage, Nov. 29, 1969, 9 I.L.M. 45, 64 AM. J. INT'L L. 481. The treaty requires adequate insurance by carriers, and creates a trust fund to pay claims, if an incident has occurred and the carrier wants to limit its liability to treaty-based monetary limits. This agreement has been signed by all of the space powers.

70. *Id.* at art. XI.

71. Agreement on Cooperation in the Field of Environmental Protection, May 23, 1972, United States-USSR, 23 U.S.T. 845, T.I.A.S. No. 7345, *reprinted in* 1 INTERNATIONAL PROTECTION OF THE ENVIRONMENT: TREATIES AND RELATED DOCUMENTS 50-57 (B. Ruster & B. Simma eds. 1975).

technologies which do not pollute the environment.[72]

(4) *Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter.*[73] Signed in 1972, this multilateral agreement is undoubtedly one of the most significant expressions of the world's practice and opinion on the environmental protection of the sea. This treaty requires contracting parties to prohibit the dumping of wastes in the oceans by vessels and aircraft, unless the dumping is authorized by a domestically-created permit program.[74]

(5) *Convention on the Prohibition of Military or Other Hostile Use of Environmental Modification Techniques.*[75] This 1973 multilateral treaty stresses, in Article III, the need to cooperate "[i]n the preservation, improvement, and peaceful utilization of the environment . . . ."[76] Its main thrust is to prohibit the "[m]ilitary or other hostile use of environmental modification techniques having widespread, long-lasting or severe effects as the means of destruction, damage, or injury to another State party . . . ."[77]

(6) *Agreement Governing the Activities of States on the Moon and other Celestial Bodies.*[78] Known as the Moon Treaty, this 1979 agreement has been signed by only two of the world's space powers—the Netherlands and France. Nonetheless, it is a treaty open for signature to the world's nations, and eleven have chosen to do so.[79] Aside from referring to the moon and other celestial bodies as the common heritage of mankind, this treaty reflects a state of the

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72. *Id.* at art. 2. A Joint Committee on Cooperation in the Field of Environmental Protection was established to further these goals. *See id.* at art. 5. This treaty is a clear sign of the environmental practices of these two significant countries.

73. Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, Dec. 29, 1972, 26 U.S.T. 2403, T.I.A.S. No. 8165.

74. *Id.* at art. IV & VI. Specific lists of wastes and the parameters which govern when, where and how these wastes are to be dumped are detailed in annexes to this treaty. *Id.* at art. I, II & III. Although the Convention does not apply to vessels or aircraft entitled to sovereign immunity, it does require contracting parties to conduct dumping activities in a manner consistent with the purposes of the Convention. *Id.* at art. VII. The purpose of this Convention is to conduct dumping so as to minimize the likelihood of damage to human and marine life. *Id.* at art. V. This agreement has been signed by all the space powers.

75. Convention on the Prohibition of Military or Other Hostile Use of Environmental Modification Techniques, May 18, 1977, 31 U.S.T. 333, T.I.A.S. No. 9614.

76. *Id.* at art. III.

77. *Id.* at art. I. A loose interpretation of this treaty would prohibit wanton and reckless pollution of outer space if such activity were to modify the environment of another country, and such a degree of recklessness were exhibited that the act could be termed "hostile." With such an interpretation, this treaty could be viewed as a limitation of the kind of behavior that will be tolerated when it comes to pollution in space. All of the space powers have signed this agreement.

78. *Agreement Governing the Activities of States on the Moon and Other Celestial Bodies*, Dec. 5, 1979, G.A. Res. 34/68, 34 U.N. GAOR Supp. (No. 46) at 77, U.N. Doc. A/Res/34/68 [hereinafter *Moon Treaty*].

79. C. CHRISTOL, *supra* note 15, at 912.

art appreciation for the need to protect the environment of the moon and celestial bodies.[80]

### b. International Declarations

(1) *Stockholm Declaration Of The United Nations Conference On The Human Environment.*[81] In 1972, a new United Nations organization was established—the United Nations Environmental Programme (UNEP). At a conference in Stockholm, 113 States adopted a declaration containing 26 principles relating to the protection and enhancement of the world's environment.[82] Principle 6

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80. *Moon Treaty*, *supra* note 78, art. VII. Article VII states:

1. 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 such environment, its harmful contamination through the introduction of extra-environmental matter or otherwise. States parties shall also take measures to prevent harmfully affecting the environment of the earth through the introduction of extraterrestrial matter or otherwise.
2. States parties shall inform the Secretary-General of the United Nations of the measures being adopted by them in accordance with paragraph 1 of this article and shall to the maximum extent feasible notify him in advance of all placements by them of radioactive materials on the moon and of the purposes of such placements.
3. States parties shall report to other States parties and to the Secretary-General concerning areas of the moon having special scientific interest in order that, without prejudice to the rights of other States parties, consideration may be given to the designation of such areas as international scientific preserves for which special protective arrangements are to be agreed in consultation with the competent organs of the United Nations.

These words reflect a deep concern for the ecosystem of space bodies. In contrast to the OST, there is a sophistication here which reflects the growth of environmental awareness in the world. Here there is an affirmative duty to report the environmental protective measures taken. There is even the possibility of creating "wilderness areas" on space bodies, similar to those created in the US. This deference accorded environmental protection of the moon, a concededly sterile object in space, is perhaps a reflection about the care to be afforded outer space itself, an equally sterile environment.

81. *Stockholm Declaration of the United Nations Conference on the Human Environment*, June 16, 1972, U.N. Doc. A/Conf. 48/14, 11 I.L.M. 1416 (1972).

82. Christol, *supra* note 13, at 29. Some of the more significant principles were:

Principle 6. The discharge of toxic substances or of other substances and the release of heat, in such quantities or concentrations as to exceed the capacity of the environment to render them harmless, must be halted in order to ensure that serious or irreversible damage is not inflicted upon ecosystems. The just struggle of the problems of all countries against pollution should be supported.

Principle 7. States shall take all possible steps to prevent pollution of the seas by substances that are liable to create hazards to human health, to harm living resources and marine life, to damage amenities or to interfere with other legitimate uses of the sea.

Principle 21. States have, in accordance with the Charter of the United Nations and the principles of international law, the sovereign right to exploit their own resources pursuant to their own environmental policies, and the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction.

Principle 22. States shall cooperate to develop further the international law regarding liability and compensation for the victims of pollution and other environmental

bolsters the sea treaties by stressing the undesirability of dumping substances that the environment cannot handle. Principle 7, viewing the sea as *res communis*, forbids pollution of the sea because of the harm it causes other legitimate users. Principle 24 refers to eliminating "adverse environmental effects resulting from activities conducted in all spheres," and could be interpreted as meaning activities in space. In total, this Declaration is a significant indication of the position of the vast majority of the international community on the issue of environmental protection.

(2) *United Nations General Assembly Resolution 3281: Charter of Economic Rights and Duties of States.*[83] Article 29 of the resolution accords the seas CHOM status, which was previously conferred on space. This again helps tie in the issue of pollution in space to the issue of pollution in the seas. Article 30 is another

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damage caused by activities within the jurisdiction or control of such States to areas beyond their jurisdiction.

Principle 24. International matters concerning the protection and improvement of the environment should be handled in a cooperative spirit by all countries, big and small, on an equal footing. Cooperation through multilateral or bilateral arrangements or other appropriate means is essential to effectively control, prevent, reduce and eliminate adverse environmental effects resulting from activities conducted in all spheres, in such a way that due account is taken of the sovereignty and interests of all States.

Principle 25. States shall ensure that international organizations play a coordinated, efficient and dynamic role for the protection and improvement of the environment.

83. Charter of Economic Rights and Duties of States, G.A. Res. 832 (1975), *reprinted in* UNITED NATIONS RESOLUTIONS 300 (D. Djonovich ed. 1984). Adopted in 1974 by a vote of 120 in favor, 6 against and 10 abstentions, there are two significant articles which address environmental issues:

Article 29

The sea-bed and ocean floor and the subsoil thereof, beyond the limits of national jurisdiction, as well as the resources of the area, are the common heritage of mankind. On the basis of the principles adopted by the General Assembly in resolution 2749 (XXV) of 17 December 1970, all States shall ensure that the exploration of the area and exploitation of its resources are carried out exclusively for peaceful purposes and that the benefits derived therefrom are shared equitably by all States, taking into account the particular interests and needs of developing countries; an international regime applying to the area and its resources and including appropriate international machinery to give effect to its provisions shall be established by an international treaty of a universal character, generally agreed upon.

Article 30

The protection, preservation and enhancement of the environment for the present and future generations is the responsibility of all States. All States shall endeavour to establish their own environmental and developmental policies in conformity with such responsibility. The environmental policies of all States should enhance and not adversely affect the present and future development potential of developing countries. All States have the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction. All States should cooperate in evolving international norms and regulations in the field of the environment.

iteration of the general principle that States should prevent pollution, particularly pollution that causes damage to other States.

(3) *Resolutions of the Organization for Economic Cooperation and Development (OECD).* A confederation of European countries (with the exception of Turkey), the OECD is composed of all of the members of the ESA.[84] Of its numerous resolutions, three 1974 resolutions relating to the environment are cited here:

*Declaration on Environmental Policy*: "The protection and progressive improvement of the environment is a major objective of the OECD Member Countries."[85]

*Principles Concerning Transfrontier Pollution*: The OECD recommends that member countries should cooperate to develop international law applicable to transfrontier pollution.[86]

*The Polluter Pays Principle*: This is a "fundamental principle for allocating costs of pollution prevention and control measures."[87] It requires the polluter to bear the expenses of carrying out the necessary measures to ensure the environment is in an acceptable state.[88]

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84. 2 AIR WAR COLLEGE ASSOCIATE PROGRAMS, THE EUROPEAN COMMUNITIES ch. 14 (18th ed. 1984).

85. *Declaration on Environmental Policy*, Organization for Economic Cooperation and Development, Nov. 14, 1974, O.E.C.D. Doc. A (74) 47.

86. *Recommendations on Principles Concerning Transfrontier Pollution*, Organization for Economic Cooperation and Development, Nov. 14, 1974, O.E.C.D. Doc. C (74) 224, at preamble, para. 4. The O.E.C.D. states further: Countries should define a concerted long-term policy for the protection and improvement of the environment in zones liable to be affected by transfrontier pollution. *Id.* at tit. B, para. 1. In implementing this concerted policy, countries should among other things . . . draw up and maintain up-to-date lists of particularly dangerous substances regarding which efforts should be made to eliminate polluting discharges. *Id.* Countries should, individually and jointly, take all appropriate measures to prevent and control transfrontier pollution, and harmonize as far as possible their relevant policies. *Id.* at tit. B, para. 2. Polluters causing transfrontier pollution should be subject to legal or statutory provisions no less severe than those which would apply for any equivalent pollution occurring within their country. *Id.* at tit. C, para. 4a. Levels of transfrontier pollution entering into the zones liable to be affected by such pollution should not exceed those considered acceptable under comparable conditions and in comparable zones inside the country in which it originates. *Id.* at tit. C, para. 4b. Prior to the initiation in a country of works or undertakings which might create a significant risk of transfrontier pollution, this country should provide early information to other countries which are or may be affected. *Id.* at tit. E, para. 6. Countries should promptly warn other potentially affected countries of any situation which may cause any sudden increase in the level of pollution in areas outside the country of origin of the pollution, and take all appropriate steps to reduce the effects of any such sudden increases. *Id.* at tit. F, para. 9.

87. *Recommendation on the Implementation of the Polluter Pays Principle*, Organization for Economic Cooperation and Development, Nov. 14, 1974, O.E.C.D. Doc. C (74) 224, at art. I, para. 1.

88. *Id.* at art. I, para. 2. "In other words, the cost of these measures should be reflected in the cost of goods and services which cause pollution in production and/or consumption." *Id.* "[T]herefore, as a general rule [Member Countries] should not assist the polluter in bearing the costs of pollution control whether by means of subsidies, tax advantages, or

Although these principles are intended to guide the conduct of the nations within the OECD, these nations are nonetheless influential members of both the international community and the space community. These principles also provide a logical approach to the problem of transfrontier pollution. They can be looked to as empirical evidence of the norm against pollution—particularly transfrontier pollution. Any pollution in space can involve transfrontier pollution effects. There can be either back pollution onto the surface of the earth, or forward pollution if a nation's space object or experiment is disrupted by pollution emanating from another nation's space activities. If pollution occurs, these principles have great utility in determining how space activities should be judged.

### c. International Organizations

The activities of three international organizations involved in environmental affairs indicate how the world perceives the issue of pollution. It should come as no surprise that pollution is not condoned by these groups, and that their membership includes the major space powers. All three are affiliated with the United Nations.

(1) *The International Law Commission (ILC).* Established in 1947, the commission encourages the progressive development and codification of international law.[89] Of the various topics it explores, several involve international environmental law. One topic, the Law of Non-Navigational Uses of International Watercourses, explores the prevention of conflicts between States that share a single watercourse system.[90] In the area of environmental protection, the ILC believes that as a principle of international law, States should refrain from "activities that may cause harm to the interests of other States in the use of such a watercourse, and that States have an obligation not to pollute such streams."[91] The work of the ILC is viewed with interest because it carries weight as a statement of general international law.[92]

(2) *The International Atomic Energy Agency (IAEA).* Established in 1956, the IAEA is an autonomous, intergovernmental agency, with over 100 members. Its purpose is "to accelerate and

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other measures." *Id.* at art. III, para. 1.

89. McCaffrey, *The Work of the International Law Commission Relating to the Environment*, 11 ECOLOGY L.Q. 189, 190 (1983).

90. *Id.* at 192.

91. *Id.* at 201, 205.

92. *Id.* at 191.

enlarge the contributions of atomic energy to peace, health, and prosperity throughout the world."[93] The IAEA, in terms of environmental protection, is primarily concerned with the safe operation of nuclear devices and disposal of radioactive wastes on earth. However, it does have an interest and programs in the area of nuclear safety in space. One of its programs concerns the possibility of contamination of the space environment by the escape of radioactive power supplies.

(3) *The United Nations Environmental Program (UNEP).* Established in 1972 by a United Nations resolution, UNEP is the preeminent international environmental protection body.[94] It is funded by voluntary contributions separate from contributions to the UN. All of the world's space powers are contributors, with the exception of Belgium and Spain.[95] The UNEP charter is the Stockholm Declaration,[96] and under it UNEP is active in many programs to monitor environmental problems of worldwide concern, and to coordinate international cooperation in dealing with these problems. Although it funds environmental protection programs on its own, UNEP acts more as a coordinating clearinghouse, relying on individual States to remedy most of the specific environmental threats.[97] All of the proclamations made by UNEP on the issue of pollution would be too numerous to mention. It is fair to characterize what it has said and done as being against any kind of right to pollute, and in favor of environmental protection.

### d. International Cases

The resolution of international cases or disputes can provide principles of international law. The four cases discussed below are cited for the international environmental law principles they establish, which can be easily applied to space activities.

(1) *The Trail Smelter Case.* This was an arbitration decision rendered in two parts, in 1938 and 1941.[98] The case involved trans-

93. *International Cooperation in Outer Space: A Symposium Prepared for the Committee on Aeronautical and Space Sciences*, S. Doc. No. 92-57, 92d Cong., 1st Sess. 426 (1971).

94. Smith, Lopatkiewicz & Rothblatt, *Legal Implications of a Permanent Manned Presence in Space*, 85 W. VA. L. REV. 857 (1980).

95. 1983 U.N.Y.B. 775, U.N. Sales No. E.86.I.1.

96. *See supra* notes 81-82 and accompanying text.

97. Buckley, *The United Nations Environment Programme: A Ten-Year Perspective*, Quarterly Newsletter of the Standing Committee on Environmental Law 4-6 (Winter 1982-83).

98. Trail Smelter (Can. v. U.S.), 3 R. Int'l Arb. Awards 1905 (1949).

frontier air pollution from a Canadian smelting operation into the United States. The tribunal held Canada liable for damages, stating that "no State has a right to use or permit the use of its territory in such a manner as to cause injury to the territory of another or the persons or property therein when the case is of serious consequence and the injury is established by clear and convincing evidence."[99]

(2) *The Corfu Channel Case.* This 1946 International Court of Justice (ICJ) case involved the laying of mines by Albania within its territorial waters, which caused damage to British vessels that came in contact with the mines.[100] Albania had not announced the presence of the mines, and as a result the court found Albania at fault. The ICJ held that it "is every State's obligation not to knowingly allow its territory to be used for acts contrary to the rights of other States."[101]

(3) *The Lake Lanoux Case.* This was an arbitrated decision made in 1957. It involved a lake located in France which discharged into a river and continued for twenty-five kilometers to Spain where it was used for irrigation and drinking water purposes. Although it upheld France's plan to alter the flow of the river for a hydroelectric project on the basis that its project included plans to continue the water flow to Spain by an alternate route, the tribunal noted in passing that "there exists a principle prohibiting the upstream State from changing the waters of a river in their natural condition to the serious injury of a downstream State."[102] As applied to outer space, the case can be cited as meaning that at the very least, no one can foul the sector of space they are operating within if it will impact to the injury of other nations in their use of space.

(4) *The Cosmos 954 Case.* This was a claim made by Canada against the USSR for the expenses it incurred in searching for and cleaning up the debris of a Soviet satellite which made an uncontrolled reentry into the atmosphere in 1978.[103] The debris included

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99. *See* Wetstone & Rosencranz, *Transboundary Air Pollution: The Search for an International Response*, 8 HARV. ENVTL. L. REV. 89, 121 (1984).

100. Corfu Channel (U.K. v. Albania), 1949 I.C.J. 4, *reprinted in* MCDOUGAL & REISMAN, INTERNATIONAL LAW IN CONTEMPORARY PERSPECTIVE 524 (1981).

101. *Id.*; *see also* Wetstone & Rosencranz, *supra* note 99, at 121.

102. Lake Lanoux (Fr. v. Spain), Arbitrated Decision of Nov. 16, 1957, *reprinted in* 24 INTERNATIONAL LAW REPORTS 101 (E. Lauterpacht ed. 1961); 53 AM. J. INT'L L. 156 (1959).

103. Dept. of External Affairs, Canada's Claim Against the U.S.S.R. Arising Out of the Cosmos 954 Incident and the Claim's Settlement, Note No. FLA-268 (Jan. 23, 1979).

highly radioactive Uranium 235 particles from the satellite's nuclear reactor. Canada's claim was eventually settled by the USSR in the amount of $3,000,000 Canadian dollars. The settlement agreement does not reflect exactly what damages the USSR paid for and this is still a matter of conjecture. Nonetheless, the Soviets were willing to pay.[104] Canada based its claim on the Liability Convention,[105] the Outer Space Treaty,[106] and customary international law. This is the first successful utilization of these treaties to deal with the issue of space pollution (though admittedly of the back pollution variety), and demonstrates the impropriety of pollution in general, even if from a space based source.

To summarize the first three cases: in the realm of earth-based pollution, it is clear that international environmental law establishes the responsibility of States to control their pollution activities in order to avoid damage to other States. Nations must consider the transfrontier impacts of pollution which arise within their borders.[107] Comparing this principle to the result in the Cosmos 954 incident, it can be concluded that the principle also applies to govern the conduct of States in outer space—whether that conduct causes harm to a State's territory on earth, or its "territory" in space. In light of the jurisdictional rights States exercise over their space objects, these objects are in effect a State's territory. Therefore, States have an obligation not to engage in polluting activities via their space objects, if such activities would harm the space activities and objects (i.e., territory) of other States.

### e. Domestic Practice

Independent of the conduct of the world's nations in the international arena, what are the domestic practices of these nations when it comes to environmental protection and pollution control? Looking at such practices gives an insight into the world's "uniform practices" as a basis for finding customary international law.

(1) *The United States.* The United States is heavily regulated by a host of domestic laws that attempt to control pollution and protect the environment. Laws such as the CAA, NCA, FWPCA, SDWA, RCRA, CERCLA, TOSCA, and NEPA, attempt to maintain the purity of America's air, water, and soil, all with the goal of

104. Gorove, *Cosmos 934: Issues of Law and Policy*, 6 J. SPACE L. 137, 138 (1978).
105. *See supra* notes 53-57 and accompanying text.
106. *See supra* notes 44-49 and accompanying text.
107. Wetstone & Rosencranz, *supra* note 99, at 121.

protecting human health and the environment.[108] This body of law is mirrored repeatedly on state levels. It is correct to say that the U.S. position on pollution is to avoid and prevent it, and to clean it up when it occurs. The U.S. domestic practice mirrors its involvement in the United Nations Environmental Programme,[109] and its participation in the various international environmental protection treaties discussed earlier.

(2) *The Union of Soviet Socialist Republics*. The Soviet Union's domestic practice is a reflection of its political system. Since all of the land and natural resources are owned by the State, it is the national government's responsibility to protect the environment. The Soviet Union's environmental protection laws are geared towards controlling the extent and manner to which the environment can be exploited. Of these laws, the Fundamentals of the Legislation of the USSR and Union Republics on Protection of Health (1969) most closely approximates those of the United States. This law contains a provision very similar to NEPA in its requirement to evaluate the environmental effects of activities:

> Managers of enterprises, institutions, design and construction organizations, and management boards of collective farms, must envisage and prevent air, water bodies, underground waters and soil from pollution while planning, constructing, reconstructing and exploiting enterprises. In case they fail to perform their duties they bear the responsibility determined by the legislation of the USSR and the Union Republics.[110]

Actually, this law appears to be more far reaching than NEPA, since NEPA deals only with major federal government actions. This Soviet law also places controls on the "production, application, storage and transportation, of radioactive, poisonous, and powerful substances."[111] Environmental protection laws are, for the most part, managed on a national level by the Ministry of Health Regu-

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108. CAA: Clean Air Act, 42 U.S.C. §§ 7401-7642 (1982).
NCA: Noise Control Act, 42 U.S.C. §§ 4901-18 (1982).
FWPCA: Federal Water Pollution Control Act, 33 U.S.C. §§ 1251-1376 (1982).
SDWA: Safe Drinking Water Act, 42 U.S.C. §§ 300f-j (1982).
RCRA: Resource Conservation and Recovery Act, 42 U.S.C. §§ 6901-87 (1982).
CERCLA: Comprehensive Environmental Response, Compensation, and Liability Act, 42 U.S.C. §§ 9601-57 (1982).
NEPA: National Environmental Policy Act, 42 U.S.C. §§ 4321-70 (1982).
TOSCA: Toxic Substances Control Act, 15 U.S.C. §§ 2601-29 (1982).

109. *See supra* notes 94-97 and accompanying text.

110. Kolbasov, *Legal Protection of the Environment in the USSR*, 1 EARTH L.J. 51 (1975).

111. *Id.*

lation.[112] It is clear that on the domestic front, the Soviet Union does engage in pollution control and environmental activities, following the uniform practice of States to avoid contamination of the environment.

(3) *The Nations of the ESA.* The domestic positions of the European Space Agency (ESA) countries on environmental protection are reflected to a certain extent by the OECD's declarations on the environment. Further evidence is found in the regulations, directives, and decisions of the European Community (EC) formerly called the European Economic Community (EEC). These three categories of rules are binding upon member States pursuant to Article 189 of the EEC Treaty.[113] Through these means, the EC "has taken formal action in the areas of air, water, and noise pollution; control of toxic chemical substances; solid and liquid waste disposal; land and natural resource management; protection of flora and fauna; nuclear safety; and international environmental problems."[114] As of March 1, 1984, fifty-eight environmentally related directives were in existence. Pursuant to the EEC Treaty, the EC has the power to serve notices on member States for noncompliance with these directives, issue opinions on the failure of the member States to fully comply with the directives, and bring cases before the International Court of Justice for a member State's failure to fulfill its obligations under these directives. As of March 1, 1984, the EC served 119 notices, rendered 55 opinions, and brought suit on 22 cases.[115]

It is clear from the EC's enforcement of its environmental directives that the ESA States are aware of the need to protect the environment. This desire to pursue environmental quality is shared by the European populace, as revealed in a 1983 survey of EC citizens. The poll showed environmental protection rated second behind unemployment as the most important "socio-political problem" in five of nine member States.[116]

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112. *Id.* On a local level, more than 3,000 standing committees on nature conservation help influence the implementation of these laws. On a private level, there are various environmental awareness groups. Of note is the All-Russia Society for the Conservation of Nature, which has more than 20 million members, and has as its creed: "For the Leninist attitude towards nature." *Id.*

113. Kelly, *International Regulation of Transfrontier Hazardous Waste Shipments: A New EEC Environmental Directive*, 21 TEX. INT'L L.J. 85, 90 (1985). The member States of the EC include all of the ESA States, except Switzerland and Sweden.

114. *Id.* at 89.

115. *Id.* at 98.

116. *Id.* at 90.

f. Summary

Various types of empirical evidence show that there is an international uniform practice to protect the earth and its atmosphere from pollution. The evidence indicates that States have a duty to avoid engaging in pollution activities. By interpretation and implication, this practice also applies to activities in outer space. This uniform practice by the world's States comprises the first element of a customary international law against pollution of space.

*2. Customary International Law: The Psychological Element*

The second element of customary law, the psychological element, or *opinio juris*, looks to the world's opinion of the law on a given subject. Evidence of this element can be initially established by looking once again at the evidence of the empirical element. The various treaties, declarations, and organizations reflect the opinion of those nations who are signatories or members, and are also proof of the psychological element. This means that the world's opinion is that nations should avoid pollution in general, and specifically pollution which can cause harm to another nation's interests. Furthermore, a nation which causes harm by its transfrontier pollution activities must provide compensation for the harm it causes.

A second form of evidence of *opinio juris* is the writings of experts in the space law field. The focus is to see if these experts agree that there is a norm, principle, custom or general concept in international space law against the pollution of outer space.

Most of these experts are members of the International Aeronautical Federation's International Institute on Space Law (IISL). Members of this private organization are considered the leading thinkers in the area of space law—most of the major treatises, texts, and law review articles on the issue of space law have been written by them. In a series of articles written for the 1971 Colloquium on the Law of Outer Space, the issue of environmental protection was addressed. Although primarily addressing the issue of back pollution, the principles of international space law discussed are nonetheless illuminating.

Ernest Fasan of Austria noted that international law forbids negligent acts in space which endanger the earth's environment or the life, health, and security of mankind or segments of mankind, inde-

pendent of the dictates of Article IX of the OST.[117]

Gunter B. Krauss-Ablass of the Federal Republic of Germany, noting the existence of an international principle against actions which "endanger the existence of the entire human race as well as the existence of individual persons of a foreign nation," and of "every State's obligation not to allow knowingly its territory to be used for acts contrary to the rights of other States,"[118] concluded that it is also a principle of international law that "any activities in outer space which cause harmful effects on the territory of another State must be avoided."[119]

Nicholas M. Poulantzas of Greece found that general international law allows a State to ask for compensation for the contamination of its territory caused by another State's activities in outer space. This principle includes the right of a State to demand the activities be stopped for self-preservation purposes, and includes the right of reprisal.[120]

Peter Sand of the Federal Republic of Germany noted that existing international law which protects against the contamination of earth's environment by space activities is very narrow. Nonetheless, he cited the Test Ban Treaty and the OST as evidence of at least some law in this area, although he questioned how well it had been honored by the world's space powers.[121]

The remaining three experts are all Americans. Andrew Ritholz noted the existence of an "internationally accepted ban against contamination of outer space."[122] He concluded that this ban could be construed as including nonfunctioning space debris.

Stephen Gorove, a member of the IISL, examining the meaning of the OST as it relates to space pollution, found the OST to be a reflection of "mankind's concern about the dangers of pollution and

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117. Fasan, *Legal Problems of the Terrestrial Environment*, in PROCEEDINGS OF THE FOURTEENTH COLLOQUIUM ON THE LAW OF OUTER SPACE 55 (M. Schwartz ed. 1972). Article IX of the OST is described *supra* notes 47-48 and accompanying text.

118. Krauss-Ablass, *Protection of the Terrestrial Environment in Outer Space: A Principle of International Law*, in PROCEEDINGS OF THE FOURTEENTH COLLOQUIUM ON THE LAW OF OUTER SPACE 72 (M. Schwartz ed. 1972).

119. *Id.* at 74.

120. Poulantzas, *Legal Problems Arising Out of Environmental Protection of the Earth*, in PROCEEDINGS OF THE FOURTEENTH COLLOQUIUM ON THE LAW OF OUTER SPACE 75 (M. Schwartz ed. 1972).

121. Sand, *Space Programs and International Environmental Protection*, in PROCEEDINGS OF THE FOURTEENTH COLLOQUIUM ON THE LAW OF OUTER SPACE 83 (M. Schwartz ed. 1972). The Test Ban Treaty and the OST are discussed *supra* notes 41-49 and accompanying text.

122. Ritholz, *International and Domestic Regulation of Private Launching Ventures*, 24 STAN. J. INT'L L. 135, 150 (1984).

contamination" in outer space.[123] He nonetheless recommended a strengthening of the OST via a new international code of conduct dealing with pollution in space.

Carl Christol, also a member of the IISL, examining nuclear power sources in outer space, stated that the general principles of international law prohibit a State from using radioactive materials in space in such a way as to cause harm to another State's interests.[124] In examining pollution in outer space in general, he concluded:

> Harms to the natural environment of outer space, per se, the Moon, and other celestial bodies can result from the intentional and unintentional conduct of juridical and natural persons. Such activities can produce the legal duty to provide compensation to those who have experienced detriment. Such detriment can be caused by physical debris. It can also be caused by non-physical or intangible contamination pollution.[125]
>
> On the basis of the 1967 Principles Treaty, as well as other relevant international law, the conclusion was reached that States have an affirmative duty to avoid allowing debris, and contaminants, from constituting harmful interferences in the beneficial and peaceful uses of the natural environment of outer space, per se, the Moon, and other celestial bodies.
>
> The consultative provisions of Article 9 of the 1967 Principles Treaty have particular relevance to a procedure whereby this duty can be implemented. Thus, the space environment cannot be treated as an area open to the wholly unregulated conduct of the space-resource States.[126]

Of these experts, Christol most clearly accepts the existence of an international principle against the pollution of outer space. His statements can be interpreted to mean that pollution in outer space includes pollution of space itself, without the need for a specific harm to another nation.

To summarize the psychological element: the opinions of the world's States and its experts oppose pollution in general, and pollution which causes harm in particular, both on earth and in outer space.

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123. Gorove, *supra* note 3, at 64. The OST is discussed *supra* notes 44-49 and accompanying text.

124. C. CHRISTOL, *supra* note 15, at 800.

125. *Id.* at 146.

126. *Id.* at 147.

### *3. Customary International Law: Combining The Elements*

When the empirical and psychological elements are combined, a customary international law against pollution can be perceived. The law is in favor of protecting the environment, prohibiting activities in space which cause back pollution, and activities in space which cause forward pollution of a type that causes direct harm to another State's interests (e.g., damage to a State's satellite).

There is also a strong case that this customary law extends to forward pollution where space activities cause contamination of the purity of the space environment, although no one in particular is presently harmed. Such pollution could be prohibited as a potential interference with other States' future use of space. It also amounts to appropriation of that particular area of space by the pollution, particularly in the case of a dumping site. Such conduct is a clear violation of the CHOM principle of space.[127] Independently, it is a violation of the overwhelmingly accepted practice on earth to condemn pollution and protect the environment for its own sake, and not purely for reasons of sovereignty.

Regardless of the parameters of the customary law against pollution in outer space, the area could benefit from clarification. The next section explores a suggested regime to address present and future space pollution.

## III. Suggested Controls on Outer Space Pollution

There are three significant flaws in the present system of international space pollution law. First, the rules primarily relate to pollution which causes harm to another State. Generally speaking, until a piece of space debris hurts somebody, it doesn't become a problem under the law—but by then it is too late. Second, unlike the sea where there is at least the chance for someone to catch the polluter doing its dirty work, the remoteness of space makes it far more difficult to police the waste-handling practices of space manufacturing industries. Third, although the system of compensation for harm caused by space activities is in place,[128] there may in the future be serious proof problems in establishing whose waste caused the harm.[129]

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127. The CHOM principle is developed in Articles I and IX of the OST. *See supra* notes 47-48 and accompanying text.

128. *See* Liability Convention, *supra* note 53.

129. Wetstone & Rosencranz, *supra* note 99, at 123.

These problems, as well as others, have been pointed out by other authors.[130] It is apparent that they will not be solved by creating some sort of supranational space environmental protection agency to which States would give their allegiance. Historically, States are reluctant to submit to binding arbitration to resolve disputes, so it is unlikely they will give up whatever measure of sovereignty it would take to make such an agency effective.[131] Also, while such an agency would prove of great utility in the realm of ordinary pollution on earth, one has never been created.

What is needed instead is an international agency in the mold of the International Atomic Energy Agency (IAEA),[132] dedicated to the singular issue of pollution in outer space. This agency would be within the United Nations Environmental Programme.[133] For illustration purposes it will be called the Office of Outer Space Environmental Protection (OOSEP). OOSEP would act as a clearinghouse for information relating to research and the space environmental protection activities of other nations; promulgate proposed model treaties, domestic laws, and regulations to establish controls on space pollution; perform inspections of space operations and receive notice from the States on their space activities which involve potential pollution; and perform clean-up activities in outer space of already existing pollution, and of future pollution in the case of accidental releases.

To boost its effectiveness, OOSEP would benefit from a formal declaration by the United Nations, similar to the Stockholm Declaration which initially gave rise to the Nations Environmental Programme.[134] This declaration would establish a world position that contamination of outer space should be regulated as much as the dumping of wastes in the oceans. The declaration would give OOSEP the charter to coordinate world activity to this end. The IAEA is cited as an example because of its somewhat activist approach to the issue of radioactive material safety. In fact, IAEA conducts inspections of nuclear facilities to ensure that minimal guidelines established by IAEA are met (although only at the request of the State who owns the facility).[135] IAEA was even called

130. *See, e.g.*, Sand, *supra* note 121, at 60; Gorove, *supra* note 3, at 64.

131. Beckstiegel, *Arbitration and Adjudication Regarding Activities in Outer Space*, 6 J. SPACE L. 3 (1978); Smith, Lopatkiewicz & Rothblatt, *supra* note 94, at 859.

132. *See supra* note 93 and accompanying text.

133. *See supra* notes 94-97 and accompanying text.

134. Sand, *supra* note 121, at 87.

135. 1957 U.N.Y.B. 420. The Stockholm Declaration is discussed *supra* notes 81-82

upon by the Soviet Union after the Chernobyl disaster to help evaluate Soviet handling of the situation, and it is presently considering developing an international convention to resolve damage claims for future nuclear accidents.[136]

OOSEP could benefit from IAEA's example. OOSEP's goal would be to create a regime of space environmental protection laws which the world would want to adhere to based on the scientific reliability of the rules, and the independence and neutrality of its creator. This section will describe the general nature of this regime, the specific regulations to control space pollution, and how clean-up operations should proceed.

### *A. The General Nature of the Space Environmental Protection Regime*

The proposed regime would have as its most basic principle that no waste created on earth could be put into space, and no waste generated in space could be returned to earth. The purpose of this principle is to prevent the destruction of a space craft either on launch or reentry, and to eliminate the risk of wastes (nonhazardous, hazardous, and radioactive) spreading into the atmosphere and onto the surface of the earth. In the future, such flights may become so reliable that this premise can be changed. However, in light of the Challenger disaster,[137] it may take years for this to occur. Another purpose of this principle is to force generators of waste to clean up pollution in the location that it is created, and prevent them from shipping the problem someplace else.

There are seven basic rules which would govern the control of space pollution:

1. Each State would regulate the activities of its governmental and nongovernmental entities. The model for this approach is the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter.[138] This convention envisions each State issuing permits to those who would dump wastes into the sea. As noted earlier, the annexes to the Convention list items which must be carefully reviewed before issuing a permit to dump. OOSEP, in its model treaty, would create the same kind of framework for

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and accompanying text.

136. Pincus, *Chernobyl Is Focus of IAEA Session*, Washington Post, Sept. 30, 1986, at A22.

137. *See supra* note 23.

138. *See supra* notes 73-74 and accompanying text.

items dumped in space.

2. The proposed convention on space pollution would limit liability for damage caused in space to a specific dollar amount (subject to upward revision due to inflation). This is similar to Article V of the International Convention on Civil Liability for Oil Pollution Damage.[139] As for back pollution damage to earth, liability limits would also be allowed, but the dollar limit would be higher to account for the greater extent of harm which might occur if an accident happened. As in the International Convention on Civil Liability for Oil Pollution Damage, the polluter would need to post a bond equal to the value of the liability limitation. Such a scheme would encourage prompt settlement of damage claims.

3. States would report the location and extent of the activities by the government and the nongovernmental entities to OOSEP. This would allow OOSEP, acting in its clearinghouse capacity, to provide information to victims of space pollution damage and to help pinpoint the source of harm.

4. OOSEP would inspect generators, transporters, and facilities that store and dispose wastes to ensure safe practices in handling wastes are followed. Although these inspections would be voluntary, it is hoped that OOSEP would command respect in the world community analogous to the IAEA, so that OOSEP inspections and assistance would be willingly sought.

5. Use of the earth and sun to dispose of wastes would not be permitted until OOSEP has an opportunity to determine if these methods are safe, and in what manner they are safe. In the meantime, wastes would be handled in space by treatment, storage, and disposal facilities, with the goal to render the substances harmless.

6. Funding for OOSEP would be voluntary, as is the case with the IAEA and UNEP. OOSEP would have no space resources of its own with the exception of a few spacecraft, already parked in space, to be used in conducting its inspections and research of the outer space environment. Instead it would rely on state support to put its personnel into space.

7. OOSEP would have a clean up function which is explained in detail below.

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139. *See supra* notes 69-70 and accompanying text.

### *B. Regulations of the Space Environmental Protection Regime*

Although each State would regulate its own activities in space, OOSEP would create a series of model regulations to help States maintain uniformity, and avoid the pitfalls of national subsidization of polluters which the OECD has recognized in its "Polluter-Pays Principle."[140] This would be consistent with Principles 21, 22, and 25, of the Stockholm Declaration, which holds each State responsible for the pollution activities of its nongovernment entities, and encourages States to allow international organizations like OOSEP to play a role in the protection of the environment.[141]

Under the model regulation of space pollution activities, OOSEP should propose the following rules:

1. Any nongovernment entity (hereinafter "industry") whose activities in space create waste, would be required to obtain insurance in advance, to indemnify the State.[142] This is a simple recognition of the State's continuing responsibility for the conduct of industry. The amount of liability coverage would vary depending on the type of waste being handled. Simple trash of a nonhazardous nature would require a small amount of coverage, while hazardous and radioactive waste would require greater coverage.

2. The current philosophy of the Environmental Protection Agency (EPA) on managing wastes would be adopted in a regulation to encourage industry to produce as little waste as possible; to reuse the waste that is produced; and to treat whatever waste is leftover after reuse to render it harmless.[143]

3. The basic model for the proposed space pollution regulation would be the Resource Conservation and Recovery Act (RCRA)[144] which is managed by the Environmental Protection Agency in the United States. This law was created to deal with the problem of how to safely dispose of solid and hazardous wastes.[145] Although it does not deal with wastes of a radioactive character, for purposes of space pollution it would be expanded to address these substances as well.

4. The proposed space pollution regulation (for illustration purposes, the Space Resource Conservation and Recovery Act (SR-

140. *See supra* notes 87-88 and accompanying text.
141. *See supra* notes 81-82 and accompanying text.
142. Esposito, *supra* note 49, at 26.
143. Pryor, *Getting Some Good Out of EDB*, 11 EPA J. 22 (1985).
144. 42 U.S.C. §§ 6901-87 (1982).
145. Hinds, *Liability Under Federal Law for Hazardous Waste Injuries*, 6 HARV. ENVTL. L. REV. 1, 15 (1982).

CRA)), would parallel RCRA's categorization of participants in the waste process, and the rules that govern their behavior.

The cast of characters includes:

(1) *Generators*: These are the individuals who place any type of substance into a space manufacturing facility, laboratory, or other activity, from which they will generate any type of waste material (solid, hazardous, or radioactive) as a by-product of their activity.

(2) *Transporters*: These are individuals who move wastes from the site of the manufacturing facility, laboratory, or other area to the site of the treatment, storage, or disposal facility which handles the particular type of waste involved.

(3) *Treatment, Storage, and Disposal Facility*: These are facilities where waste is treated to render it harmless, stored until it can be treated or disposed, or disposed in an environmentally acceptable manner (e.g., using the earth or sun once the safety parameters for doing so are established by OOSEP).

A facility could, of course, contain all three types of operations. Also, a given form of waste could conceivably receive all three forms of handling—it could be initially stored, then treated, and then disposed.

SRCRA would regulate these entities as follows:

(1) Generators, transporters, and treatment, storage, or disposal facilities would need a SRCRA permit to operate in space. A detailed list of substances subject to SRCRA controls would be established. This list would consist of substances whose unmanaged presence in outer space would pose a danger to earth if they were to migrate into its atmosphere (e.g., radioactive wastes and most of the wastes currently deemed hazardous by RCRA). If these substances are generated, transported, treated, stored, or disposed, then manifests would be required to trace the item from "cradle to grave."[146]

(2) Solid wastes would be less rigorously controlled. Solid wastes could not be casually dumped into space, however, if for no other reason than the navigational hazard they would pose to other States. Nonetheless, solid wastes which are celestially-biodegradable could be disposed of by injecting them into space. No report to

146. *See* OFFICE OF SOLID WASTE, ENVIRONMENTAL PROTECTION AGENCY, EPA ACTIVITIES AND ACCOMPLISHMENTS UNDER THE RESOURCE CONSERVATION AND RECOVERY ACT: FISCAL YEARS 1980-1985, July 1986, at 8-9. These manifests are required by RCRA. Corrigan, *Space-Age Speculators Plan Orbiting Industrial Parks with NASA's Help*, NAT'L J., Sept. 7, 1985, at 1986-87.

the state space agency administering the SRCRA regulation would be necessary, as long as OOSEP is certain that such waste could truly be assimilated.

(3) The basic scheme would call for generators who create controllable waste to either reuse the substance, or store it and then treat and/or dispose of it. The generator would have the option to send the items to a central treatment, storage, and disposal facility. The generator could also use the services of a transporter, whose job would be to move these substances in a safe manner to the treatment, storage, and disposal facility.

Under RCRA, generators can store wastes on site for up to ninety days, without a permit to function as a treatment, storage, or disposal facility.[147] SRCRA would also have time standards, but they would likely be longer. This concession would be due to the remoteness of space, where the risks from the accumulation of large quantities of waste would not be as great as they would be on earth.

Under RCRA there is also a category of small quantity generators, which is allowed to accumulate wastes for up to 180 days, if the amount of waste is less than 100 kilograms of waste per month.[148] In relation to the vastness of space, what constitutes a large amount of waste on earth will likely be a small amount in space. As a result, small quantity generators in space may be more numerous than they are on earth.

(4) If a generator is able to reuse its waste, it would still need a permit. However, it would not need a permit to operate as a treatment, storage, or disposal facility, unless it stored the wastes on site without reusing them beyond the storage standards established by SRCRA.

(5) Inspections conducted without notice under RCRA would need modification under SRCRA. If the inspections are conducted by the State's regulating space agency, then it should be easy to arrange, even in light of the practical need for approaching spacecraft to identify themselves before boarding a space station. If OOSEP conducted the inspection, advance coordination with the state space agency would be necessary to ensure that the facility would honor a request from OOSEP spacecraft to dock for an inspection. Such OOSEP inspections would occur only with the

147. *See* 42 U.S.C. §§ 6901-87 (1982).

148. Hinds, *supra* note 145. Macbeth, Superfund: Impact on Environmental Litigation, Quarterly Newsletter of the Standing Committee on Environmental Law, Winter 1982-83, 1-2, 6-7.

State's consent.

Examining these proposed SRCRA rules, it is apparent that there is little variation from the way RCRA is enforced on earth. This is because the RCRA regime is a fairly straightforward attempt to control the complex problem of solid and hazardous wastes. As such, it is worthy of emulation in the realm of space.

### *C. Clean-Up Operations in Outer Space*

In light of the debris which is presently in outer space and the hazards to navigation it poses, and the danger to space travelers posed by radioactive materials, OOSEP should be charged with responsibility for coordinating the resources of the world to clean up outer space. In addition, an international coordinating agency like OOSEP should be created to respond to accidental releases of wastes into outer space.

On earth, there are no concerted general environmental clean up operations (e.g., there has been no organized clean up of the seas). Clean ups occurred case-by-case as the result of specific incidents. And as to these, States have performed the necessary clean up operation either individually or in concert with the nation of the polluter or neighboring States.

But space, of course, is different. There are no territorial boundaries and no State has the same type of relationship with a region of space as it does to its territorial, contiguous, or continental shelf sea areas. That is why the need for a central agency like OOSEP is greater in the realm of space environmental pollution.

To perform this clean up function, OOSEP would draft an international treaty, modeled very loosely on the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)[149] administered by the Environmental Protection Agency in the United States. CERCLA enables the federal government to respond to abandoned or inactive hazardous waste sites. It creates a "Superfund" composed of taxes on industry and federal funds. This money is used by the EPA to hire contractors to perform the clean up.[150]

As for future accidental leaks, the OOSEP treaty would have each State perform its own clean up operations using its own resources. If a State refused, OOSEP would be permitted under the

149. 42 U.S.C. §§ 9601-57 (1982).
150. Hill, *supra* note 39.

treaty to clean up the waste itself. It would do this exclusively through contractors, and would have no space clean up resources of its own. Contractors would consist of other States or private industry. The big problem would be funding and indemnification of OOSEP by the recalcitrant State. Since OOSEP's funding will consist of voluntary contributions by the States, the amount of funding must be sufficient to accomplish such a clean up program, and indemnification would be critical to allow OOSEP to act again. It is hoped that the international opprobrium which would greet such a scofflaw State would force voluntary cleanup, or at least grudging compliance with an indemnification demand.

As for the debris presently in outer space, OOSEP would coordinate a one-time massive clean up effort of this thirty year accumulation of junk. Once this is accomplished, and the SRCRA regulations are in place, such an endeavor would theoretically never need to be repeated. Similar plans have been suggested by others.[151] Such a clean up would occur only after careful research, to ensure that only those objects which are no longer performing an active function are disposed of. Coordination with States of registry would be necessary to ensure appropriate removal. Funding for such a project would be secured by seeking contributions in proportion to the percentage of debris in space for which the State is responsible.

For purposes of a one-time clean up, this voluntary funding could be passed by the State onto private industry. However, the percentage of such contributions solicited from industry should take account of the great amount of debris resulting from purely governmental space operations. As for clean up efforts of accidental leakages, private industry contributions should be greater, but at the same time proportional to the amount of insurance coverage they are required to have for such contingencies.

In summary, a regime of treaties and regulations empowered to deal with present and future pollution in outer space is suggested. As with all similar suggestions dealing with the unknown demands of the future, scientific matters in general, and outer space in particular, a great deal of what has been presented can be viewed as fanciful conjecture. Nonetheless, this is the very nature of outer space law, and it is what makes it the unique area of study that it is.

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151. *See* Desaussure, *Manned Space Stations*, 21 SAN DIEGO L.J. 985, 1000 (1984).

## FINAL OBSERVATIONS

The comparison between those who derided the notion of protecting the deserts, and those who question the need to protect outer space, is useful in making another point. Basically, the treatment of the deserts is similar to the treatment of outer space. In both cases, a trail of trash was left in the wake of early explorers and travelers.

In the quest to tame the West, early settlers made the deserts true "wastelands" by casting off supplies, refuse, and unwanted items to lighten their load and ensure their survival. In space, items are also cast off when they become superfluous to the main objective of simple survival in this equally inhospitable region. Both the deserts and outer space were new and strange to their travelers, and in the end neatness did not amount for much, whereas expediency and survival did.

Today, we know the deserts have a fragile ecology. Clean up of the deserts has been relatively effortless, because most of the debris was biodegradable. Much of the debris presently in space is also reclaimable by nature, by the friction of earth's atmosphere and the sun. But we stand at a threshold in outer space that we did not face in the early years of our use of the deserts. The plans to begin manufacturing operations in outer space and the resulting wastes which cannot be assimilated by nature pose a threat to the space environment that the deserts did not have to face.

As noted earlier, several years will pass before these manufacturing operations pose such a threat. This time should be used by the world's States to ensure that the legacy of space can be preserved, just as humanity today is attempting to preserve the deserts and other areas. This should be done, if not to preserve the aesthetic quality of outer space, then for the sake of space safety and the protection of the earth.

A side benefit to developing an agency like OOSEP would be to help the world in dealing with terrestrial environmental catastrophes. Most of the environmental emergencies which have occurred in the world have been addressed by those States directly affected. Someday the world may be faced with an environmental problem of such tremendous international scope that no one country or group of countries will have the ability to address it. Only concerted international action could address such a problem—the kind of action that an agency like OOSEP will be designed to muster. An OOSEP prototype for the global environmental problem would save time and limit damages by providing ready access to the environmental

protection resources of the world.

OOSEP is an idea whose time has come, both to benefit humanity's future use of space, as well as to provide the earth with an extra measure of security from environmental catastrophes. The world community should work to make such an agency a reality while time is still available.

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