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COMMENT

One Giant Heap for Mankind: The Need for National Legislation or Agency Action to Regulate Private Sector Contributions to Orbital Debris

CHARLES MOTTIER

I. INTRODUCTION

Space exploration and utilization has been a steady and permanent industry ever since the launch of Sputnik I in 1957.[1] The development of space soon after that launch was based primarily on defense necessity and competition in connection with the Cold War.[2] This competition led to the realization that space could have many uses other than simply a forum for semi-passive saber-rattling and defense systems experimentation.[3] With increased use, the value of Earth's orbit as a locus for communications and peaceful scientific experimentation has become readily apparent to developed countries.[4] In the late 1950s a total of twenty-one objects were successfully launched from Earth, but by the end of the Cold War, a space launch

1. *Space Launch Totals by Decade*, SPACE LAUNCH REPORT, http://www.spacelaunchreport.com/logdec.html#1990s (last updated Jan. 24, 2013).

2. Rod Paschall, *Coding and Decoding, in* THE OXFORD COMPANION TO AMERICAN MILITARY HISTORY 147, 146-47 (John Whiteclay Chambers II ed., 2000).

3. *See, e.g.*, FREDRIC A. GODSHALL ET AL., NASA, EXAMPLES OF THE USEFULNESS OF SATELLITE DATA IN GENERAL ATMOSPHERIC CIRCULATION RESEARCH 6 (1969).

4. *See* Michael Griffin, *The Real Reasons We Explore Space*, AIR & SPACE MAGAZINE (July 2007), *available at* http://www.airspacemag.com/space-exploration/Uncommentary.html?c=y&page=1.

occurred nearly twice weekly.[5] This trend has continued into the twenty-first century with between fifty and ninety orbital launches per year, and the occupation of space shows no signs of diminishing.[6]

Beginning in the mid-1980s, it became clear that private use of outer space would comprise an ever-growing component of space activities.[7] Private development spurred by legislation aimed at allowing private use of space was slow at first, but is now a sector of significant economic importance.[8] The National Aeronautics and Space Administration ("NASA") is committed to using private sector launch vehicles to the maximum extent practical.[9] For example, a private sector launch vehicle delivered cargo to the International Space Station in March 2013.[10] Private usage of space is increasing, and its effects on the orbital environment ought to be given serious consideration.

A direct effect of space usage in the past fifty years has been the accumulation of tons of space debris, commonly referred to as orbital debris or "space junk."[11] Space junk is composed of the relics of past exploratory missions and civilian satellite operations.[12] Every time a rocket stage from a vehicle is depleted or a capsule separates, pieces of the vehicle break off of the assembly (by design) and are jettisoned into space with the intention that they will remain in orbit indeterminately or return to Earth via a calculated procedure to harmlessly burn up on

5. *See* Gunter Dirk Grebs, *Chronology of Space Launches*, GUNTER'S SPACE PAGE, http://space.skyrocket.de/directories/chronology.htm (last updated Dec. 27 2013).

6. *See id*.

7. *See* Commercial Space Launch Act, Pub. L. No. 98-575, § 2, 98 Stat. 3055 (1984) (codified as amended at 49 U.S.C.A. § 70101 et seq.).

8. *See Office of Commercial Space Transportation: Recently Completed/Historical Launches*, FED. AVIATION ADMIN., http://www.faa.gov/about/office_org/headquarters_offices/ast/launch_license/licensed_launches/historical_launch/ (last modified Oct. 24, 2013, 1:24 PM).

9. 51 U.S.C. § 20301(b)(2) (2010).

10. *See Dragon Delivers*, SPACEX.COM (Mar. 3, 2013), http://www.spacex.com/news/2013/03/03/happy-berth-day.

11. *See Orbital Objects*, NAT'L GEOGRAPHIC, http://science.nationalgeographic.co.uk/science/space/solar-system/orbital/ (last visited Feb. 3, 2013).

12. *Id.*

reentry into the atmosphere.[13] Needless to say, with procedures and machinery as complicated as those used in the space industry, these intentions are not always realized.[14]

By current estimates there are that more than 21,000 pieces of orbital debris larger than ten centimeters in diameter surrounding the Earth, approximately 500,000 pieces between one and ten centimeters in diameter, and more than 100 million pieces smaller than one centimeter.[15] Though Earth's orbit is concededly a large place, this debris poses a very serious danger to the continued use of outer space.[16] NASA's greatest fear regarding sustained occupation of space is a collision between an occupied or operationally critical manmade object and a piece of space debris.[17] Not only does this have the potential to cripple communications and even prevent the launch of future missions, it may threaten the lives of astronauts through destruction of their spacecraft.[18]

The current body of international law on space debris is sparse, though still somewhat beneficial to the cause. The only relevant international agreement regarding the phenomenon of space debris concerns the assignments of liability in the event of a celestial collision, or for objects falling from space and striking the Earth.[19] There are no binding international documents concerning the control of space debris or the need to design objects launched into space to minimize debris. Some countries have recognized the threat of orbital debris and have unilaterally implemented their own controls on prospective space activities

13. NASA, *Orbital Debris Reentry*, NASA ORBITAL DEBRIS PROGRAM OFFICE, http://orbitaldebris.jsc.nasa.gov/reentry/reentry.html (last updated Aug. 21, 2009).

14. *See Orbital Objects*, *supra* note 16.

15. NASA, *Orbital Debris Frequently Asked Questions*, NASA ORBITAL DEBRIS PROGRAM OFFICE, http://orbitaldebris.jsc.nasa.gov/faqs.html#3 (last updated Mar. 2012).

16. *See generally* NASA, *Another Debris Avoidance Maneuver for the ISS*, 17 ORBITAL DEBRIS Q. NEWS, no. 1, January 2013, at 3.

17. *Id.*

18. *See* Clara Moskowitz, *Space Junk Problem is More Threatening Than Ever, Report Warns*, SPACE (Sep. 1, 2011, 11:01 AM), http://www.space.com/12801-space-junk-threat-orbital-debris-report.html.

19. Convention on International Liability for Damage Caused by Space Objects, Mar. 29, 1972, 24 U.S.T. 2389, 961 U.N.T.S. 187 [hereinafter "Space Liability Convention"].

within their respective jurisdictions in order to slow the growth of the threat.[20] Some national and multinational space agencies have even joined forces and created guideline statements concerning space debris.[21]

One considerable drawback of these multilateral efforts to curb the debris problem is that these guideline statements are non-binding; potentially more problematic is the fact that the existing self-adopted rules made pursuant to those guidelines may be inapplicable to private sector launches.[22] In order to protect current space installations and ensure that outer space may be utilized by posterity, it is essential that regulations be developed which limit the amount, type, and size of space debris that may be released in Earth's orbit from private sector activities.

In furtherance of this goal, this article will explain the dynamics of the space environment, examine current space law and its shortcomings both internationally and nationally, and present reasoned resolutions to the issue at hand including the use of petitions for action by United States government agencies and the encouragement of legislative action. This article will also address certain positive and negative aspects of adopting debris-regulating law. Above all, the United States government and the American people should be made aware of the serious issues concerning the continued use of space by the private sector, and this article seeks to facilitate that conversation. Through this awareness, the United States can address the current legal deficiencies and provide an example of the focus that should be given to space debris law.

20. NASA, *Orbital Debris Mitigation*, NASA ORBITAL DEBRIS PROGRAM OFFICE, http://orbitaldebris.jsc.nasa.gov/mitigate/mitigation.html (last updated Jan. 8, 2013); *e.g.*, 47 C.F.R. § 25.114(d)(14) (2014) (requiring applicants for space station authorization to submit a statement on design and operation of said space station for the purpose of mitigating orbital debris).

21. *See Inter-Agency Debris Coordination Committee,* IADC, http://www.iadc-online.org (last visited Mar. 27, 2013).

22. NASA & DEP'T OF DEF., U.S. GOVERNMENT ORBITAL DEBRIS MITIGATION STANDARD PRACTICES (1997), *available at* http://orbitaldebris.jsc.nasa.gov/library/USG_OD_Standard_Practices.pdf; NASA, *supra* note 24 (under the "Additional Information" header).

II. BACKGROUND OF SCIENTIFIC PRINCIPLES UNIQUE TO OUTER SPACE

In order to understand why space debris needs to be regulated at all, the physical aspects of outer space, which account for the danger of the debris, need to be understood. The danger is a result of the combination of outer space's lack of gravity, the speeds at which objects in space are travelling in orbit, and the lengthy presence of many space objects.[23] It is clear that the most notable characteristic of the outer space environment is the lack of gravity. Aside from the appeal of extraterrestrial perspective for monitoring and communications purposes, the absence of gravity is among the central appeals of exploring the near Earth environment. Taking advantage of this feature, many experimental chemical processes and observations are conducted which are only possible in low gravity.[24]

The characteristic effect of low gravity is that objects in motion tend to stay in that motion; this is the central tenet of Newton's first law of motion, and the basis of orbital science.[25] As a result, objects that are released in space tend to continue on the trajectory of their release until acted upon by another force.[26] The predominant "other" force in this equation is the gravity of the Earth, which eventually corrals nearby objects and forces them to fall into the atmosphere.[27] This process may take decades and, as a result, there are pieces of space junk floating in Earth's orbit dating back to the genesis of spaceflight with no indication that they may soon collide with the atmosphere.[28] Consequently, objects in space have a semi-persistent presence

23. Lawrence D. Roberts, *Addressing the Problem of Orbital Space Debris: Combining International Regulatory and Liability Regimes*, 15 B.C. INT'L & COMP. L. REV. 51, 55 (1992).

24. *See e.g.*, Lawrence J. DeLucas et al., *Protein Crystal Growth in Space, Past and Future*, 237 J. OF CRYSTAL GROWTH 1646, 1646-1650 (2002); Andrei Markin et al., *The Dynamics of Blood Biochemical Parameters in Cosmonauts During Long-Term Space Flights*, 42 ACTA ASTRONAUTICA 247, 247-253 (1998).

25. STEVEN HOLZNER, PHYSICS FOR DUMMIES 64-73 (2006) (explaining Isaac Newton's famous three laws of motion remedially).

26. *Id.*

27. *See* OLIVER MONTENBRUCK & EBERHARD GILL, SATELLITE ORBITS: MODELS, METHODS, AND APPLICATIONS 2-4 (2000).

28. *Id.*; NASA & DEP'T OF DEF., *supra* note 27.

and are thus liable to accumulate, rather than diminish, as space activity goes on.

The other central characteristic of orbital space is the extreme speed at which objects are travelling. In order to maintain an orbit around the Earth, as persistent space objects do, objects must be travelling at a tangential speed (with respect to the Earth) sufficient to negate the force of Earth's pull.[29] This speed varies depending on the distance of the orbit from Earth; an object's orbital speed in near Earth orbit is generally in excess of 18,000 miles per hour, whereas an object in geostationary orbit may travel in excess of 67,000 miles per hour.[30] Therefore, any collision of objects in space, even if only glancing, carries a high risk of complete catastrophe for the objects involved. Some objects have been documented colliding in space in recent years, resulting in their complete destruction and the release of yet more debris.[31]

Due to these unique aspects of space, there is a real danger of a chain-reaction event known as "Kessler Syndrome."[32] Scientists fear that if a sufficient number of collisions occurs in orbit, a run-away reaction may prevent future use of space.[33] They theorize that when two space objects collide, that collision will result in more pieces of space debris than were involved in the original collision; those new fragments of debris would then cause more collisions and so forth indefinitely.[34] The end result of such a reaction is the transformation of Earth's orbital environment into a minefield that is no longer safe for manned or unmanned space activities; this would essentially trap mankind on the Earth, severely limit our ability to study our planet, and reduce our ability to communicate with each other.[35] Outer space physics create an extremely hostile environment, and necessitate

29. MONTENBRUCK, *supra* note 32.

30. *See Orbital Speed*, FREEMARS, http://www.freemars.org/jeff/speed/index.htm (last visited Feb. 3, 2013) (showing orbital speed calculations and speed estimates for space objects at various altitudes).

31. *See* NASA, *Satellite Collision Leaves Significant Debris Clouds*, 13 ORBITAL DEBRIS Q. NEWS, no. 2, April 2009, at 1.

32. KESSLER ET AL., *supra* note 2.

33. *See id.*

34. *Id.*

35. *Id.* at 10.

regulation in order to maximize the safety of current missions and reduce the possibility of a reduction in spacefaring activities in the future.

III. RELEVANT INTERNATIONAL SPACE LAW

The current body of space law is largely implemented by individual nations through their space agencies.[36] Apart from such independent, domestically-centered regulations, international agreements on the use of space are few in number and lacking in substance. The first substantial contribution to international space law was the "Outer Space Treaty"[37] created in 1967 to address the growing concerns over mankind's increasing, multilateral use of outer space.[38] This is the most influential international agreement concerning space law, and among the most widely ratified.[39]

Chief among the guiding principles of the Outer Space Treaty are that space exploration be for the "benefit of all mankind" and that international laws should govern activities in outer space.[40] The Outer Space Treaty addresses liability assignment for space activities by making clear that the nation responsible for the launch retains ownership of and responsibility for the object.[41] Consequently, any resulting conflict arising on account of the activities of that object is attributable to the nation that launched it.[42] The treaty also states that party nations are to convene and consult with one another in the event that one nation's space activities may endanger those of another nation or the peaceful use of outer space as a whole.[43] With the addition of more space debris with every launch, it is now apparent that any launch has the potential to endanger the space activities of another spacefaring nation; while the immediate likelihood of such a

36. *See* IADC, *supra* note 25.

37. Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, Jan. 27, 1967, 18 U.S.T. 2410, 610 U.N.T.S. 205 [hereinafter "Outer Space Treaty"].

38. *Id.* pmbl.

39. *See id*. (signatories number over one hundred nations).

40. *Id.* art. I, III., *supra* note 42.

41. *Id*. art. VII.

42. *Id*. art. VI-VIII.

43. Outer Space Treaty at art. IX.

collision is slim, there is recognition of the growing danger.[44] It logically follows that nations participating in the Outer Space Treaty are compelled to resolve the issue of how to minimize the likelihood of an orbital collision and the theorized run-away chain reaction.[45]

In 1972, and in furtherance of the controlled exploration of outer space, the United Nations General Assembly presented a treaty colloquially called the "Space Liability Convention."[46] Article III of this convention provided that when two objects collided, whatever party is at fault is liable for damages resulting from the collision.[47] The most significant limitation of this treaty is that it would only apply to situations where fault could be determined. Because many pieces of space debris are no larger than a bolt or screw (and in most cases much smaller) it is relatively impossible to assign liability and causation.[48] To further complicate the assignment of liability, much debris is not catalogued, the launching state is often unsure whether it has released debris, debris is difficult to track, and existing debris may be decades old.[49] Thus, the problem of liability is complex. At least for liability, there are situations where no redress is feasible due to one or more of these complications; in such situations, a precautionary/remedial approach to debris control is warranted.[50]

In order to fulfill the limited purposes of the Space Liability Convention, a proper registry of space activities was necessary.

44. *See.supra*, Part II.

45. *See generally* Outer Space Treaty (Although this problem is not specifically addressed in the Outer Space Treaty, it is a logical outgrowth of the treaty's application that the problem be confronted).

46. *See generally* Space Liability Convention, *supra* note 23.

47. *Id.*

48. *See supra*, Part II.

49. Debris is tracked through observation efforts on the ground, while agencies like NASA are conscious that their craft may release a certain amount of debris, total omniscience as to what piece came from which craft when is infeasible to determine. *See NASA*, *supra* note 19.

50. *Cf. Massachusetts v. EPA,* 549 U.S. 497 (2007). (The global issue of carbon dioxide contributions resulting in climate change was recognized; while it was generally known from where much of the gas came, the effects of the releases had not yet been realized and liability was not assigned. Knowledge of the potential and inevitable effects of releasing carbon dioxide justified imposing rules for limitation on that release).

In 1974, the United Nations opened a treaty for signature to address this concern, the Convention on Registration of Launched Objects into Outer Space (Registration Convention).[51] The treaty required that any "space object" or its component parts that are intended to travel into outer space be registered with the Secretary General of the United Nations.[52] However, the convention failed to take into account the incidental expulsion of objects into space, a significant contributing factor to the problem of orbital debris.[53] While it is clear that a habitation capsule or the booster stage of a rocket would qualify as a "space object," it is impractical or impossible to register a loose rivet or an insulation foam shard incidental to the separation of vehicles, especially if the releases are unknown. While the Registration Convention does provide a list of possible sources of space debris, it has no provisions that explicitly or implicitly limit the release of small and incidental debris objects into orbit.

The foregoing treaties are low on substantive solutions for the present problem, mainly because they are non-self-executing, were created with domestic implementation in mind, and do not address all of the complexities of spacefaring activities. Nonetheless, these treaties have been ratified by all major participants in outer space utilization.[54] While they have addressed some of the concerns related to orbital debris, the domestic implementation of the agreements has resulted in incomplete regulation of orbital debris, especially in the United States.

IV. UNITED STATES' REGULATION OF ORBITAL DEBRIS

Outer space is an international environment that requires multilateral cooperation in order to secure its utility and

51. Convention on Registration of Objects Launched into Outer Space, Nov. 12, 1974, 28 U.S.T. 695, 1023 U.N.T.S. 15 [hereinafter "Registration Convention"].

52. *Id.* art. I, II.

53. U.S. CONGRESS, OFFICE OF TECHNOLOGY ASSESSMENT 18 (1990).

54. *See generally* Comm. on the Peaceful Uses of Outer Space, Legal Subcomm, Rep. on its 52nd Sess., Apr. 8-Apr. 19, 2013, U.N. Doc. A/AC.105/C.2/2013/CRP.5 (Mar. 28, 2013) *available at* http://www.oosa.unvienna.org/pdf/limited/c2/AC105_C2_2013_CRP05E.pdf.

preservation. This can only be achieved by improving implementation of international agreements at the national level.[55] While there is no barrier to nations creating supplementary bilateral or multilateral treaties to implement major international agreements, it is more practical for a nation to address the particulars of its own spacefaring activities and create domestically binding regulations, as the United States has. In addition to United Nations treaties, domestic regulations may be inspired by alternative international guidance and cooperation. Several nations have taken the initiative, through their respective space agencies, to promulgate cooperative non-binding guidelines addressing mitigation of space debris.[56]

The Inter-Agency Space Debris Coordination Committee ("IADC") worked with several space agencies to create the most comprehensive and influential guidelines on the subject.[57] The guidelines' most pertinent provisions require a participating agency to limit space debris release during normal operations to the extent feasible, to dispose of potential orbital debris after the conclusion of a mission, and to plan missions with the express purpose of minimizing the possibility of orbital collisions.[58] Each space agency is therefore responsible for implementing these practices. Recognizing the urgency of the space debris problem, President Barack Obama issued a statement revising United States space policy with specific emphasis on the preservation of the orbital environment in keeping with the spirit of the IADC guidelines as well as previous international agreements.[59] Congress has likewise taken initiative and incorporated the principles of the IADC guidelines and the new executive policy

55. *See generally* Space Liability Convention *supra* note 23*, see also* Outer Space Treaty*, supra* note 41.

56. IADC, *supra* note 25 (showing that international guidelines for the mitigation of space debris have been agreed upon by space agencies from: Italy, France, China, Canada, Germany, the European Union, India, Japan, the United States, Russia, Ukraine, and the United Kingdom); *see* IADC, IADC SPACE DEBRIS MITIGATION GUIDELINES (Sept. 2007), *available at* http://www.iadc-online.org/index.cgi?item=docs_pub.

57. IADC, SPACE DEBRIS MITIGATION GUIDELINES (Sept. 2007), *available at* http://www.iadc-online.org/index.cgi?item=docs_pub.

58. *Id.* § 5.

59. NATIONAL SPACE POLICY OF THE UNITED STATES OF AMERICA, (June 28, 2010), *available at* http://www.whitehouse.gov/sites/default/files/national_space_policy_6-28-10.pdf.

into its latest authorizing statute for NASA in 2010, and NASA has in turn incorporated the guidelines into its regulations for the governance of its space activities.[60]

Unfortunately, existing United States law regarding space debris is not comprehensive with respect to all United States space activities. While the United States has taken appreciable steps toward limiting the country's contribution to the orbital debris problem, the guidelines and agency regulations apply primarily to government activities and are silent, inapplicable, or avoidable as to the space activities of the private sector. Consequently, there is no legally binding regulation on the private sector forcing it to reduce its release of certain debris into orbit.

As it stands, the private sector is poised to expand its current operations in Earth's orbit and eventually assume many historically governmental aspects of space activity.[61] NASA has planned for this expansion to a limited extent and has committed to utilizing private sector launch vehicles and technology to the extent practical.[62] NASA, however, is not the governing agency that licenses and regulates the launch of private sector space objects; that duty falls on the Department of Transportation through the Federal Aviation Administration, specifically the Office of Commercial Space Transportation ("AST").[63] AST was established to regulate and promote commercial space transportation, recommend regulatory changes to commercial space transportation laws, and bolster the United States' space

60. *See* 51 U.S.C. §§ 10101-71302 (2012); 14 C.F.R. §§ 1200-1299 (2013); NASA, NASA TECHNICAL STANDARD 8719.14A: PROCESS FOR LIMITING ORBITAL DEBRIS (2012), *available at* https://standards.nasa.gov/documents/detail/3315680.

61. *See* Adam Mann, *The Year's Most Audacious Private Space Plans*, WIRED.COM (Dec. 27, 2012, 6:30AM), http://www.wired.com/wiredscience/2012/12/audacious-space-companies-2012/; *see also* Emi Kolawole, *NASA Awards Multi-Million Dollar Contracts to Boeing SpaceX and Sierra Nevada for Human Spaceflight*, WASH. POST (Aug. 3, 2012), http://www.washingtonpost.com/blogs/innovations/post/nasa-awards-multimillion-dollar-contracts-to-boeing-spacex-and-sierra-nevada-for-human-spaceflight/2012/08/03/a40938c0-dd89-11e1-af1d-753c613ff6d8_blog.html.

62. 51 U.S.C. § 20301(b)(2) (2012).

63. FAA, OFFICE OF COMMERCIAL SPACE TRANSPORTATION: ABOUT THE OFFICE, http://www.faa.gov/about/office_org/headquarters_offices/ast/about/ (last visited Mar. 27, 2013).

transportation infrastructure.[64] Although operating in the same field as NASA, AST differs significantly in that it regulates private entities. This difference may explain the disparity in regulations between private and government projects.

Entry into outer space by commercial entities is not a new phenomenon; it was anticipated and lauded by President Reagan and the 98th Congress.[65] The Commercial Space Launch Act, enacted in 1984, not only created AST and the licensing procedures and requirements for private sector space activities, but it also included a purposive provision that suggested a major difference between the private and public sector space industries: the promotion of economic growth.[66] While NASA is a participant in the economic exploitation of space,[67] private space companies are able to more easily profit from space due to their efficiency.[68] It is reasonable to think that the Congress, in enacting the Commercial Space Launch Act, was more interested in spurring the national economy and broadening American companies' extraterrestrial participation than protecting space orbits from debris incidental to private sector launches.[69] Forcing a private sector business to implement controls on debris would be costly, and in an industry with such a high monetary barrier[70] to entry as space exploration, every penny counts. However, the Commercial Space Launch Act was passed with the 1980's private sector environment in mind – that is, it was concerned with growing the private space industry. Now that the industry has developed, the Commercial Space Launch Act is outdated.

64. *Id.*

65. Commercial Space Launch Act, Pub. L. No. 98-575, 98 Stat. 3055 (1984).

66. *Id.* § 3(1).

67. Stephen J. Dubner, *Is Space Exploration Worth the Cost? A Freakonomics Quorum*, FREAKONOMICS.COM (Jan. 11, 2008), http://www.freakonomics.com/2008/01/11/is-space-exploration-worth-the-cost-a-freakonomics-quorum/ (quoting G. Scott Hubbard, former director of the NASA Ames Research Center, "It is true that, for every dollar we spend on the space program, the U.S. economy receives about $8 of economic benefit.").

68. Phoenix McLaughlin, *SpaceX Spends 320 Times Less on Building the Dragon Than NASA Does on the Orion*, POLICYMIC (July 2012), http://www.policymic.com/articles/11354/spacex-spends-320-times-less-on-building-the-dragon-than-nasa-does-on-the-orion.

69. S. REP. NO. 98-656 at *6 (1984).

70. *See Why the US Can Beat China: The Facts About SpaceX Costs,* SPACEREF (May 4, 2011), http://www.spaceref.com/news/viewpr.html?pid=33457.

AST's licensing power is not entirely toothless regarding regulation of orbital debris. The Secretary of Transportation has the authority to impose restrictions, such as debris regulation, on a license applicant upon issuance of the license.[71] This restrictive power has yet to be exercised by AST, but AST's treatment of the National Environmental Policy Act ("NEPA") sheds light on how these restrictions may be imposed.[72]

As it currently stands, AST does not require consideration of the effects of debris on much of the orbital environment in order to comply with NEPA.[73] When preparing an application for licensing under the Commercial Space Launch Act, an applicant is encouraged to submit, along with the required application information, sufficient information concerning the environmental effects of the project such that the Secretary of Transportation can determine whether an Environmental Impact Statement is necessary in order to comply with NEPA.[74] The guidance document for this process requires a discussion of the *atmospheric* impact of orbital debris.[75] Any atmospheric impact to be considered by AST in an environmental assessment is limited to those impacts felt in the ionosphere, which has a maximum ceiling of roughly 960 kilometers.[76] Distinctly absent from the guidance document is any requirement for consideration of orbital debris[77] above 960 kilometers, a region which contains hundreds of satellites.[78] It appears that the Council on

71. 51 U.S.C. § 50905(b)(2) (2012).

72. 42 U.S.C. §§ 4321-4370h (2012).

73. 42 U.S.C. § 4332(2)(C)(i) (2012); 40 C.F.R. § 1501.3 (2013); 14 C.F.R. § 413.7 (2013); *see* AST, GUIDELINES FOR COMPLIANCE WITH THE NATIONAL ENVIRONMENTAL POLICY ACT AND RELATED ENVIRONMENTAL REVIEW STATUTES FOR THE LICENSING OF COMMERCIAL LAUNCHES AND LAUNCH SITES (2001), *available at* http://www.faa.gov/about/office_org/headquarters_offices/ast/licenses_permits/media/epa5dks.pdf [hereinafter "AST NEPA GUIDELINES"].

74. *Id*.

75. AST NEPA Guidelines, at App.. D (VII)(2).

76. AST NEPA Guidelines at 21; Rani C. Gran & Laura Layton, *Space Has Never Been Closer: NASA Instruments Document Contraction of the Boundary between the Earth's Ionosphere and Space*, NASA, http://www.nasa.gov/topics/earth/features/outer_atmosphere.html (last visited Feb. 25, 2014).

77. For the purposes of succinctness, "orbital debris" as referenced in this article shall refer to that debris which is beyond the ionosphere.

78. *List of Satellites in Geostationary Orbit*, SATELLITE SIGNALS, http://www.satsig.net/sslist.htm (last updated Feb. 21, 2014).

Environmental Quality ("CEQ"), the administrator of NEPA, and the AST have never considered the orbital surroundings of Earth beyond the ionosphere to be subject to NEPA.[79]

Additionally, NEPA's application to the area beyond the ionosphere is subject to two limitations. First, NEPA is only applicable to major federal actions which have the potential to significantly affect the "human environment."[80] Second, NEPA's extraterritorial application must be considered. This second issue was presented under similar factual circumstances in *Environmental Defense Fund v. Massey*, concerning extraterritorial application of NEPA in the "sovereignless" territory of Antarctica.[81] Among other considerations, the court held that when applying NEPA where all major decisions are made in United States territory and where conflict with another sovereign's law is not present, the presumption against extraterritoriality of a statute is inapplicable.[82] Concerning licensing private space launches, all licensing decisions are made domestically, and there is likewise no definite sovereign over the subject territory of outer space. It is therefore reasonable to conclude that upon a determination that orbital debris significantly affects the "human environment," NEPA's Environmental Impact Statement requirements should apply.

Even if orbital debris were to be considered in an Environmental Impact Statement pursuant to NEPA and an AST licensing procedure, there would still be no guarantee of substantive environmental protection from NEPA. NEPA is simply a procedural statute and does not force an agency to impose any measure of environmental protection so long as there

79. *See* 42 U.S.C. § 4332(2)(C)(i) (There is no explicit or implicit intention in the statute for orbital space beyond the ionosphere to be considered an "environment," but there is no preclusion of the Council on Environmental Quality on making that interpretation. Thus far there has been no action taken at any level in furtherance of making that interpretation, suggesting that it would be a novel legal issue to the agency.).

80. 42 U.S.C. 4332(2)(c) (2012). A discussion of the unregulated zone beyond the ionosphere affecting the "human environment" appears below in Part V.

81. *See* Envt'l Def. Fund. v. Massey, 986 F.2d 528, 534 (D.C. Cir. 1993).

82. *Id*.

has been an adequate identification and evaluation of the environmental impact of the action.[83]

Environmental protection against orbital debris currently exercised by AST has the potential to be inapplicable under a new administration. Since AST, an Executive agency under the Department of Transportation, adheres to President Obama's National Space Policy of the United States of America,[84] it must create its own orbital debris reduction procedures as NASA did.[85] However, this adherence is not required by the current version of the Commercial Space Launch Act, only by Executive policy.[86] If Executive policy were to change, by a change of the administration for example, the Secretary of Transportation could, under the Commercial Space Launch Act, waive any requirement pursuant to issuance of a license, even the need for a license itself, if he finds that such a waiver is in the public interest and will not jeopardize public health or safety, safety of property, and national security and foreign policy interests, unless a human is on board.[87] Consequently, President Obama's National Space Policy document does not offer the kind of permanent protection which would survive a change in administration.

Whether the Secretary would consider the addition of debris from a launch a danger is unclear. While the policy statement by the President recognizes the need to limit orbital debris for the sustainable use of the orbital environment, neither the President nor any relevant Executive agency has gone so far as to qualify any single, specific addition of debris as dangerous.[88] This interpretation is consistent with a preference for economic

83. *See* Vermont Yankee Nuclear Power Corp. v. Natural Res. Def. Council, 435 U.S. 519, 558 (1978); *see also* Strycker's Bay Neighborhood Council, Inc. v. Karlen, 444 U.S. 223, 227-28 (1980).

84. WHITE HOUSE, NAT'L SPACE POLICY OF THE U.S. (June 28, 2010), http://www.whitehouse.gov/sites/default/files/national_space_policy_6-28-10.pdf.

85. *See generally* FAA, *Office of Commercial Space Transportation: Legislation and Policies*, THE FEDERAL AVIATION ADMINISTRATION, http://www.faa.gov/about/office_org/headquarters_offices/ast/legislation_policies/ (last modified Sept. 10, 2013).

86. 51 U.S.C. § 50905(b)(3) (2011).

87. *Id.*

88. *See generally* NAT'L SPACE POLICY , *supra* note 88.

development of space, reminiscent of the Reagan era, as opposed to a concern for the safety of the space environment.

It may also be argued that existing United States space law policies would adequately regulate private sector orbital debris. However, this argument is potentially flawed. United States governmental agencies, such as NASA and the Department of Transportation, rely heavily on the "U.S. Government Orbital Debris Mitigation Standard Practices," a document meant to guide agencies in creating regulations which restrict orbital debris[89] This document, developed by NASA and adopted by all United States government agencies by 2001, included meaningful purposive and practical mandates for the limitation and reduction of debris in Earth orbit.[90] Although the document itself purports to apply to "all operational orbit regimes" these guidelines have questionable application to private sector space activities.[91] The document is silent on which entities are to be regulated, and an external governmental description of the policy's applicability speaks only of "government operated or procured space systems."[92] Whether issuance of a license amounts to government operation or procurement of a private sector space system is unclear. Thus, the current United States Standard Practices document is potentially inapplicable to the private sector.

Even assuming that the Standard Practices document is applicable to the private sector, there is a glaring fault which has the potential to allow the release of copious amounts of orbital debris. The document does specify that spacecraft should be designed to minimize the release of debris; however, debris under five millimeters in any dimension is allowed to be jettisoned with no restriction, and debris larger than five millimeters may be jettisoned pending evaluation of cost effectiveness and mission requirements.[93] The second situation gives no attention to the environmental considerations attendant to release of orbital

89. *See generally NASA* & DEP'T OF DEF., U.S. GOV'T ORBITAL DEBRIS MITIGATION STANDARD PRACTICES (1997), http://orbitaldebris.jsc.nasa.gov/library/USG_OD_Standard_Practices.pdf.

90. *See id.*; NASA, *supra* note 24 (under the "Additional Information" header).

91. *See* ORBITAL DEBRIS MITIGATION STANDARD PRACTICES, *supra* note 93.

92. *Id*.

93. ORBITAL DEBRIS MITIGATION STANDARD PRACTICES, *supra* note 93.

debris and no guidance on what is cost effective or required by a mission. The Standard Practices document provides little assurance that orbital debris is effectively minimized.

To summarize, the regulatory body of law on private sector additions of orbital debris falls short. International treaties bind countries to use space for peaceful purposes and to allow for space exploitation for the benefit of the human race; domestic space agencies have followed the essence of these treaties, but fall short of effective regulation of the private sector.[94] The IADC provided guidelines to government agencies which, upon their adoption, became binding on the agencies, but not necessarily private space operations.[95] Congress, through its failure to address the private sector space industry in the latest NASA authorization statute and its effective exemption of private companies from environmental considerations in the Commercial Space Launch Act, has left the private sector, perhaps intentionally, environmentally unregulated.[96] The Secretary of Transportation may impose restrictions, such as an environmental restriction upon the grant of a license, but there is no requirement that he do so; even if there were, the Secretary may waive that requirement.[97] As a consequence, the only environmental protections against private sector orbital debris come from an Executive policy which is subject to change following a change in administration.[98] AST also fails to consider the effects of orbital debris released beyond the ionosphere when reviewing a license applicant's environmental assessment.[99] Additionally, NEPA fails to provide any substantive protection to the orbital environment as it is only a procedural statute. [100] If applicable, perhaps the most protective is the U.S. Government Orbital Debris Mitigation Standard Practices, which allows for widespread addition of debris below a certain size and also addition of larger debris pending evaluation of non-environmental

94. *See supra*, Part III.
95. *See supra*, Part IV.
96. 51 U.S.C. §§ 10101-71302 (2010).
97. 51 U.S.C. § 50905(b)(2)-(3) (2011).
98. AST NEPA Guidelines at Appx. D (VII)(2)(a)(5).
99. AST NEPA Guidelines at 21.
100. *See generally* 42 U.S.C. § 4332; *see also supra*, Part IV.

factors.[101] At best, regulation of orbital debris from private sector space launches depends on whether the Secretary sees fit to impose protective requirements; at worst, there is essentially no effective regulation of orbital debris for private sector space activities.

Interestingly, we find another approach to orbital debris mitigation in United States law, one that is not based on private or public identity, but on use. This approach is implemented by the Federal Communications Commission ("FCC"), which requires that any proposed communications satellite must include in its license application a plan for reduction of debris including disposal of the satellite after expiration of its useful life.[102] Nevertheless, the regulation falls short in that it only applies to communications satellites.[103] Given the limited scope of the FCC regulatory sphere, the regulation does not provide a proper platform upon which to base the industry-wide protection required to solve the problem of orbital debris.

V. REVISING THE CURRENT BODY OF UNITED STATES SPACE LAW

There are several routes that a revision of the current body of United States space law may take that would allow greater controls on the private sector's contribution to orbital debris. In order to mitigate debris not subject to IADC-derivative regulation, there must be an assurance that agencies, such as AST, will create legally binding rules on orbital debris for private companies, or at the very least ensure that procedural provisions such as NEPA apply to private activities in the region beyond the ionosphere.

First, the regulation of private space debris should be based on either a comprehensive agency rule or federal statute with clear standards controlling the discretion of the Secretary of Transportation to either impose certain restrictions or waive them. Of those two choices, an agency rule is the more practical approach. If upon its own volition, the agency does not undertake rulemaking, then members of the public might petition

101. ORBITAL DEBRIS MITIGATION STANDARD PRACTICES, *supra* note 93.
102. *See e.g.* 47 C.F.R. § 5.64 (2012).
103. *Id*.

for a rule. The Commercial Space Launch Act does not include a provision for the public to petition for the issuance of a rule; however, the Administrative Procedures Act ("APA"), which applicable to administrative procedures, does allow for petition by interested persons.[104] Who qualifies as an interested party in such situations can be complicated. A member of the regulated community would certainly meet the legal requirements, although such an entity might be unlikely to seek regulation. Petitions might more likely come from cell phone users or satellite television users, who receive benefits from an uncluttered space environment, particularly the uninterrupted use of satellites and the benefits of space innovations. Whether they would qualify as interested parties under the APA would depend on the specific facts of the case.

Alternatively, Congress might amend the Commercial Space Launch Act to more stringently regulate private space debris and to require that environmental impact analyses include evaluation of space debris generated by the activity. Concerning environmental assessment, there is currently nothing in NEPA, the Commercial Space Launch Act, Council on Environmental Quality regulations, or Department of Transportation regulations classifying space beyond the ionosphere as a "human environment" that would require an environmental impact assessment on a proposed federal action, such as the grant of a license. Despite this lack of such a classification, the region beyond the ionosphere may still be subject to an environmental impact assessment under NEPA due to the fact that it does significantly affect the "human environment" which lies beneath it.[105]

Low Earth orbit can reasonably be interpreted as a "human environment" under NEPA based on the broad scope of the term "environment." The provision in NEPA concerning "major Federal actions affecting the quality of the human environment" is meant to be broadly interpreted and strictly imposed.[106] For example, "'[e]nvironment' means something more than rocks,

104. 51 U.S.C. §§ 50901-50923 (2011); 5 U.S.C. § 553(e) (2012).

105. 42 U.S.C. § 4332 (c) (2012).

106. Jones v. U.S. Dep't of Housing and Urban Dev., 390 F. Supp. 579, 591 (E.D. La. 1974) (*referencing* Calvert Cliffs' Coordinating Comm. v. Atomic Energy Comm'n, 449 F.2d 1109 (D.C. Cir. 1971)).

trees, and streams, or the amount of air pollution[;] [i]t encompasses all the factors that affect the quality of life: crowding, squalor, and crime are obviously adverse environmental factors."[107] This interpretation suggests that when a major United States federal action could have significant impact on an area with a human presence, NEPA may be applicable.[108] It then follows that low Earth orbit can be considered a "human environment" given that it has had and continues to have a human presence.[109] Orbital debris beyond the ionosphere does inevitably fall from its high altitude to the occupied region below it. The low Earth orbit "human environment" is thus clearly affected by debris released in regions beyond the ionosphere. Consequently, NEPA's environmental impact analysis should consider debris releases beyond the ionosphere.

Space beyond the ionosphere may be interpreted as a NEPA-protected environment in its own right in that its continued use "stimulate[s] the health and welfare of man . . . ."[110] The benefits to mankind in keeping space exploration uninhibited are innumerable. As previously mentioned, there are medical breakthroughs and scientific discoveries that only could have been made in orbit.[111] Likewise, the contribution to mankind's understanding of the Earth has resulted in substantial benefit and terrestrial technological advancement.[112] The continued exploration of space beyond the ionosphere can only serve to benefit the health and welfare of mankind.

Upon further examination of NEPA's purposive language, space beyond the ionosphere can reasonably be interpreted as an environment in the sense that it may produce resources important to the United States. One of NEPA's purposes is to

107. *Jones*, 390 F. Supp. at 591 (alteration in original).

108. *See id*.

109. *See International Space Station*, NASA, http://www.nasa.gov/mission_pages/station/expeditions/index.html (last visited Apr. 16, 2013) (showing a cumulative crew time on the International Space Station alone in excess of 4,500 days).

110. *See* 42 U.S.C. § 4321 (2012).

111. DELUCAS ET AL., *supra* note 28, at 1647; MARKIN ET AL., *supra* note 28, at 247.

112. *See Benefits of Space Exploration*, NASA HEADQUARTERS LIBRARY (Nov. 2010), http://www.hq.nasa.gov/office/hqlibrary/pathfinders/spinoff.htm.

"enrich the understanding of . . . natural resources important to the Nation."[113] A planned purpose of future space missions is harvesting natural resources present in asteroids and other small celestial bodies.[114] The harvest and exploitation of celestial compounds can only exist when access to such bodies is unimpeded by the dangers of a Kessler-type debris cloud. Since this potential boon of natural resources remains largely untouched or undiscovered, it would be pertinent for NEPA to encompass activities in regions that might limit mankind's ability to formulate an understanding of and explore those resources.

The region beyond the ionosphere has thus far not been considered in AST's licensing procedures despite the preceding arguments that NEPA ought to apply. AST should starting taking a hard look at significant environmental impacts that result from its licensing. To include significant impacts in space as "environmental" impacts, revisions could be made to NEPA or regulations that interpret NEPA. Revision of NEPA, to require environmental impact analysis for debris released beyond the ionosphere, is neither necessary nor wise, since lobbying to amend a statute concerning environmental protection may open that statute to less environmentally friendly modifications. Amendment of the Council of Environmental Quality's NEPA regulations would be adequate to make orbital debris releases beyond the ionosphere a consideration in environmental impact analyses. Alternatively, petition could be made for an AST regulation requiring such consideration in environmental assessments, or a petition could be made to directly require private license applicants to provide protections more stringent than those in the U.S. Government Orbital Debris Mitigation Standard Practices.

Interpreting space beyond the ionosphere as affecting the human-occupied region beneath it, or as an environment in its

113. 42 U.S.C. § 4321.

114. Cecilia Jamasmie, *Asteroid Mining to Dominate the Industry: Experts*, MINING.COM (Mar. 11, 2013), http://www.mining.com/asteroid-mining-to-dominate-the-industry-experts-69016/; Staff Writers, *Stott Space Aims to Mine Asteroids this Decade*, SPACEDAILY.COM (Mar. 1, 2013), http://www.spacedaily.com/reports/Stott_Space_Aims_to_Mine_Asteroids_this_Decade_999.html; *Asteroid Mining Plans Announced*, HAZARDEX (Mar. 12, 2013), http://www.hazardexonthenet.net/article/56880/Asteroid-mining-plans-announced.aspx.

own right, would allow for additional procedures and potential protections. Through the inclusion of the preceding concepts in American space regulation, the United States can set an example for intolerance of space debris which may be imitated worldwide to a beneficial effect.

VI. POTENTIAL EFFECTS OF NATIONAL DEBRIS REGULATION ON THE PRIVATE SECTOR

The private sector would understandably resist the imposition of a rule regulating the release of orbital debris beyond the ionosphere and even the consideration of such orbital debris in an environmental impact analysis. Assuming that some control does in fact occur through a scenario explored by this article, the impact on private launches would be largely predictable.

With a focus on debris reduction, companies would be compelled to invest in new research, engineering, and launch strategies in order to be granted a license to operate. While this would be a significant economic hurdle for companies wishing to enter the market, the greatest mitigation of future dangers could be better achieved at the infancy stages of private sector participation. As it stands, there are only seven private companies licensed to launch spacecraft.[115] Proactively addressing this problem could drastically reduce economic impact on the private sector if implemented now, rather than when there are substantially more licensees.

Private space companies are not struggling either. Space is a lucrative business and, as private companies contribute more to the development of space technologies, the industry as a whole is ripe to expand and reduce its relative costs.[116] Arguably, such expansion was the main impetus in passing the Commercial Space Launch Act in the first place. It is apparent with the growth of the private sector that economic considerations can no longer be the only source of regulatory inspiration; a

115. *Launch Data and Information: Active Licenses,* FED.AVIATION ADMIN., http://www.faa.gov/about/office_org/headquarters_offices/ast/launch_license/active_licenses/ (last visited Mar. 28, 2013).

116. *See Keep on Truckin': A Private Company Heads for the International Space Station*, ECONOMIST (May 5, 2012), http://www.economist.com/node/21554170; *see, e.g.*, SPACEREF, *supra* note 74.

consideration on the environmental impacts on outer space is also warranted.

VII. CONCLUSION

The use of outer space for human exploration and exploitation has been ongoing and expanding for more than half a century.[117] At first there was only government participation in space use,[118] and international agreements provided an outline of uses and purposes for which space ought to be utilized.[119] Subsequent adoption of international agreements provided the guidance necessary to preserve space for the benefit of all mankind.[120] Unfortunately, those provisions were shortsighted or intentionally not all-inclusive.

At least in the case of the United States, regulation of space debris beyond the ionosphere may currently be inapplicable to private sector space participants.[121] Private sector space activities are governed by a separate set of rules than public sector space activities and administered by a different agency altogether, making NASA's policy statements and guidelines concerning space debris inapplicable.[122] The Secretary of Transportation, the person in charge of commercial space access, is not bound to require a mitigation of orbital debris in his consideration of private space launch licensing applications beyond what is required in the U.S. Government Orbital Debris Mitigation Guidelines.[123] These guidelines provide inadequate protection because they do not concern materials below five millimeters, and for materials above that threshold, release may be allowed without an environmental consideration.[124] As a result, the private space industry has the potential to pollute the

117. *See* Gunter Dirk Grebs, *Chronology of Space Launches*, GUNTER'S SPACE PAGE, http://space.skyrocket.de/directories/chronology.htm (last updated Dec. 9, 2012).

118. *See id*.

119. *See generally* Outer Space Treaty, *supra* note 41, Space Liability Convention, *supra* note 23, Registration Convention, *supra* note 55.

120. *See generally* 51 U.S.C. §§10101-71302 (2012).

121. *See id*.

122. *Id*.

123. *AST NEPA Guidelines*, *supra* note 79 app.D(VII)(2)(a)(5); ORBITAL DEBRIS MITIGATION STANDARD PRACTICES, *supra* note 93.

124. ORBITAL DEBRIS MITIGATION STANDARD PRACTICES, *supra* note 93.

upper orbital environment of Earth with impunity unless the Secretary specifically assigns additional restrictions on the license. The Secretary also has the power to waive any restriction on a license given a finding of public benefit and the lack of a finding of danger.[125] Thus far, there is no indication that the addition of orbital debris has been regarded as a danger which might discourage the Secretary from granting a waiver.

Under current industry and agency practice, addition of orbital debris above the ionosphere is not considered in a NEPA-required environmental impact analysis.[126] NEPA arguably should be applicable to this region because the addition of debris in orbit significantly affects the "human environment."[127] Alternatively, the region beyond the ionosphere can be interpreted as an environment subject to NEPA in its own right, because it would "stimulate[] the health and welfare of man," and "enrich the understanding of . . . natural resources important to the Nation."[128] A revision of agency regulations is recommended to reinforce NEPA's application to the release of debris beyond the ionosphere.

It was Congress' intention when it passed the Commercial Space Launch Act to reduce as much as possible the barriers to entry into such an expensive industry.[129] The motivations present for the original legislation are now outdated given the fact that private space companies are having little trouble gaining footholds in the space industry and profiting.[130] The lack of regulation on orbital debris has the potential to render orbit around Earth inaccessible, unusable, reduce mankind's ability to

125. 51 U.S.C. § 50905(b)(3) (2012).

126. *See e.g.* FAA, ENVIRONMENTAL ASSESSMENT FOR PEGASUS LAUNCHES AT U.S. ARMY KWAJAELIN ATOLL RONALD REAGAN BALLISTIC MISSILE DEFENSE TEST SITE. (2009) *available at* http://www.faa.gov/about/office_org/headquarters_offices/ast/media/2009%20EA%20for%20Pegasus%20LLO%20Renewal%20USAKA.pdf.

127. 42 U.S.C. § 4332(c) (2012).

128. 42 U.S.C. § 4321(2012).

129. *See* Commercial Space Launch Act, Pub. L. No. 98-575, 98 Stat. 3055 (1984) (current version at 51 U.S.C. § 50901 (West 2010)).

130. *See* Ricardo Bilton, *SpaceX's Worth Skyrockets to $4.8B after Successful Mission*,VENTUREBEAT.COM (June 7, 2012), http://venturebeat.com/2012/06/07/privco-spacexs-worth-skyrockets-to-4-8-billion-after-successful-mission/.

transmit information and make scientific innovations, and could essentially trap humanity on Earth.[131]

The solution to excess debris is regulation of entrants into the extraterrestrial environment. Congress could amend the Commercial Space Launch Act with a specific requirement that private sector space activities must consider and mitigate their contribution to orbital debris beyond the ionosphere. Alternatively and somewhat more feasibly, interested persons should petition the Council on Environmental Quality, the Department of Transportation, or AST, to issue a regulation conditioning the grant of a license on the incorporation of an orbital debris mitigation program for releases beyond the ionosphere.

An alternative approach, which offers only procedural protection, would be a petition to the Council on Environmental Quality, the Department of Transportation, or AST, to recognize that the space beyond the ionosphere affects the "human environment" and should therefore be considered in an environmental impact analysis. Though procedural protection from NEPA would not require any actual regulation of debris, it would at least provide an additional procedural step which allows the contemplation of the issue.[132]

The current regulation of private sector space activities is in need of updating to cope with the realities of space economics and the very real dangers of unregulated and expanding usage of space by private companies. Short of notice and comment origin to such regulations, petitioning for issuance of a rule is the most apt alternative for producing the desired effect. Through implementation of private space activities controls, the United States can provide an effective international model in furtherance of the goal of the mitigation of space debris.

131. KESSLER ET AL., *supra* note 2.

132. *See* Vermont Yankee Nuclear Power Corp. v. Natural Res. Def. Council, 435 U.S. 519, 558 (1978); *see also* Strycker's Bay Neighborhood Council, Inc. v. Karlen, 444 U.S. 223, 227-28 (1980).