INTERNATIONAL AND DOMESTIC LEGAL ISSUES FACING SPACE ELEVATOR DEPLOYMENT AND OPERATION

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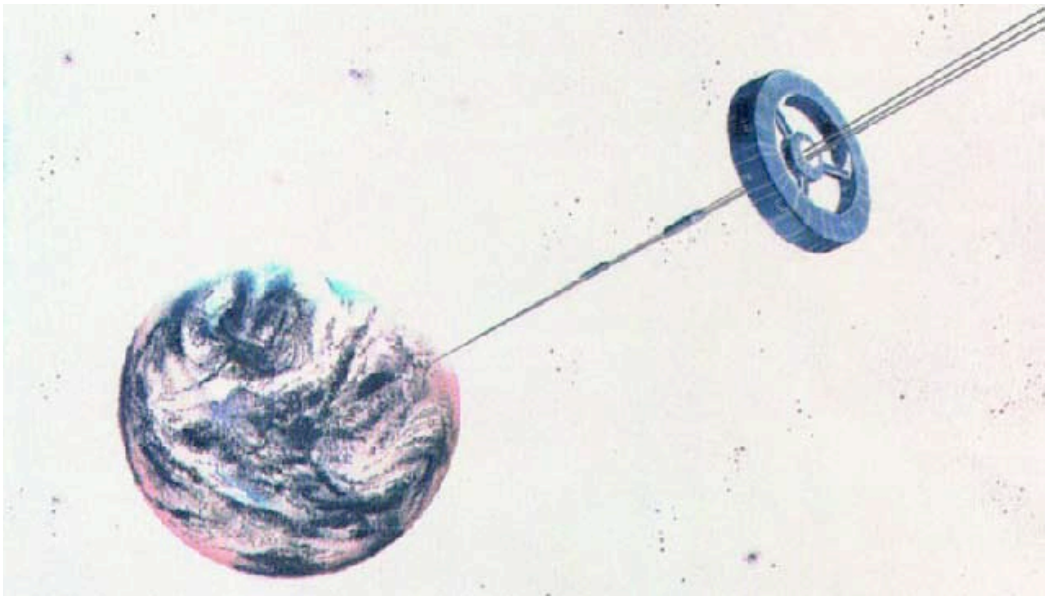

I. Introduction to the Space Elevator Concept

A space elevator is an earth-to-space transportation system that will, if deployed, provide routine, low cost access to outer space. As currently proposed, the structure consists of an anchor on earth, a counterweight in space, and a immensely strong ribbon composed of carbon nanotubes strung between, extending from a point on the earth's surface to a counterweight 62,000 miles in space—roughly twice the distance of a geosynchronous orbit. The competing

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centrifugal and gravitational forces from the ends of the structure above and below the geosynchronous point negate each other, pulling the cable taut and supporting the device; because the structure's center of mass is in geosynchronous orbit, most of the elevator is a free-floating orbiting object, with one end dipping into the atmosphere and tethered to an anchor station on Earth. The term space elevator is potentially misleading, because the device does not pull or hoist cargo up and down the length of the structure. Instead, robotic cars called "lifters" will travel up and down the length of the structure, and in that sense a "space elevator" is more analogous to a "space railroad" or "space highway."

The idea for an 'orbital tower' was first conceived as a theoretical structure by Russian scientist Konstantin Tsiolkovsky in 1895. The idea lay dormant for decades until the latter part of the 20th century when Russian engineer Yuri Artsutanov reconsidered it, and even later when American scientists revived work on the concept.

The idea left the laboratory and received wider attention when science fiction author Sir Arthur C. Clarke featured a space elevator in his 1978 novel *The Fountains of Paradise*; the idea has been a prominent feature in much science fiction literature since. Sir Clarke notoriously joked that "the first Space Elevator will be built 50 years after everyone has stopped laughing."[1] However, as with many imagined science fiction concepts that were later implemented by engineers, the idea of a space elevator has quickly moved from the conceptual to the concrete. In 1999, NASA convened a workshop titled "An Advanced Earth-Space Infrastructure for the New Millennium" at Marshall Space Flight Center in Huntsville, Alabama.[2] At the same time, Los Alamos National Laboratory scientist Dr. Bradley Edwards was pursuing the concept, and was commissioned by NASA's Institute for Advanced Concepts ("NIAC") to study the idea.[3] Edwards' report to NIAC radically scaled down the scope and cost of the project, estimating that an elevator could be deployed within a few decades, with existing technology, and at a cost of around $10 billion dollars or less – a hefty price tag, but reasonable in comparison to many

[1] *See* Sir Arthur C. Clarke, *foreword to* BRADLEY C. EDWARDS & PHILIP RAGAN, LEAVING THE PLANET BY SPACE ELEVATOR ix (Lulu.com 2006) [hereinafter Clarke, *forward*].

[2] *Id*. at 27.

[3] *Id*. at 27-28.

government infrastructure projects.[4]

In 2006, Sir Clarke summarized the progress of the space elevator as follows: "In 1995, it was entirely in the realm of science fiction. By 2000, it was becoming accepted as a theoretical possibility. Now, in 2006, it is an established engineering project, where the details are being planned for construction – maybe by the 2020s."[5] Indeed, two companies dedicated to constructing a space elevator have published roadmaps postulating the deployment of a working elevator by 2031 at the latest. Black Line Ascension is one such company, positing an operational date of 2029; LiftPort Group intends to be operational by October, 2031.[6] Whether these audacious deadlines will be met remains to be seen, but the fact that two separate commercial enterprises are willing to aim for an operational elevator within 25 years underscores the feasibility of the concept and the determination with which it is being pursued.

A space elevator is an appealing undertaking for many reasons, some fairly speculative, and some fairly certain. First and foremost, a space elevator makes economic sense. Although the initial capital outlay would be large, the return on that initial investment should offset the cost. Present day launch costs for liquid fueled rockets can range from thousands of dollars per kilogram for private commercial enterprises to tens of thousands of dollars per kilogram when considering the embedded costs associated with launches by space-faring governments. Current estimates show that the first primitive yet operational space elevator could immediately lower 'launch'[7] costs from tens of thousands of dollars per kilogram to mere hundreds of

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[4] BRADLEY C. EDWARDS & ERIC A. WESTLING, THE SPACE ELEVATOR: A REVOLUTIONARY EARTH-TO-SPACE TRANSPORTATION SYSTEM 18 (BC Edwards 2003) (2002) [hereinafter EDWARDS, THE SPACE ELEVATOR].

[5] *See* Clarke, *forward*, *supra* note 2, at x.

[6] *See* BRADLEY C. EDWARDS & PHILIP RAGAN, LEAVING THE PLANET BY SPACE ELEVATOR (Lulu.com 2006) [hereinafter EDWARDS, LEAVING THE PLANET]; LIFTPORT GROUP, ROADMAP TO THE LIFTPORT SPACE ELEVATOR: VERSION 1.0.1 PUBLIC BETA 1 (2006), http://www.liftport.com/papers/SE_Roadmap_v1beta.pdf. Additional incentive has been provided by the Elevator 2010 Annual Space Elevator Games, in conjunction with the X-Prize Cup and NASA's Centennial Challenges Program, offering an escalating prize purse for American and international component manufacturers and engineering teams to work on the requisite lifter and tether technology. *See* Elevator 2010 Competition, http://www.elevator2010.org/competition.html (last visited March 20, 2007).

[7] In the context of a space elevator, it seems more appropriate to speak of "lift" costs.

dollars per kilogram or less.[8] Significantly lower costs would allow individuals and entities that could never justify the cost otherwise to access outer space. Developing nations, universities, commercial enterprises, and private individuals would all have low cost access to space in a manner that had never been feasible before.

More speculatively, cheap and routine lift capacity could make possible ambitious projects on a scale that would have been prohibitively expensive, and thus practically impossible, prior to a space elevator.[9] On-orbit manufacturing could allow space stations and other orbital habitats to be built from materials cheaply lifted out of Earth's gravity well. Large solar arrays could be deployed to cheaply facilitate the beaming of clean, renewable energy to remote areas of the globe, using a technology similar to the one that would power the space elevator lifters. Likewise, large vehicles for travel within the solar system could be manufactured on-orbit without regard for the design constraints required to survive being blasted out of the atmosphere on a tank of combustible hydrocarbons.[10] In addition, the angular momentum present at the top of the cable will allow the elevator to "throw" objects at a high speed nearly anywhere in the solar system, without the need for expensive and heavy fuel or an elaborate propulsion system, opening up the more remote parts of the solar system to human and robotic exploration and habitation.[11]

Despite the obvious benefits to be derived from a working space elevator, its construction is not a foregone conclusion. There are significant technical hurdles to overcome. The biggest technical obstacle is the unavailability of a composite carbon nanotube material with the requisite tensile strength to support the enormous physical stresses that the ribbon will experience.[12] Individual carbon nanotubes have demonstrated tensile strengths in excess of 150 gigapascals ("Gpa"), beyond what is required by the space elevator design.[13] The difficulty lies in producing nanotubes, or a carbon

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[8] *See* EDWARDS, THE SPACE ELEVATOR, *supra* note 4, at 159 (cost estimates range from 1154 dollars/kg to 51 dollars/kg depending on operational factors).

[9] *See* EDWARDS, LEAVING THE PLANET, *supra* note 6, at 147-166.

[10] *Id.* at 195.

[11] *Id.*

[12] *See id.* at 27.

[13] *Id.* Theoretically, 150 GPa is sufficient to create a 1-millimeter thread capable of supporting a 20-ton weight, and would be capable of supporting the weight of a space

nanotube composite, of sufficient length or in such an arrangement that the space elevator ribbon will withstand the tensile and gravitational forces that such a large structure will endure.

Assuming the engineering problems can be addressed, failure to address the numerous political, legal, and administrative hurdles could still preclude a space elevator from ever being built. Much of the skepticism towards the deployment and operation of a space elevator has focused on the technical hurdles, but the feasibility of a space elevator is also contingent on it attaining favorable legal status on both a domestic and international level. This article will attempt to address a few of the many regulatory and public international law issues relevant to space elevator construction and deployment.

II. Federal Regulation of Space Elevator Activities

To date, firms located in the United States have conducted much of the research and planning undertaken for the purpose of constructing and deploying a functioning space elevator.[14] It is likely that any firm or entity that attempts to deploy a space elevator will have at least a partial American interest, sufficient for the United States to assert jurisdiction over the project and require conformity with its laws and regulations, including international treaty obligations. The example of the multinational space launch enterprise 'Sea Launch,' in which the American corporation Boeing's 40% interest in the project was considered sufficient for the United States to assert jurisdiction under the Commercial Space Launch Act, is instructive but not dispositive on the issue of whether a space elevator would be subject to United States jurisdiction.[15] For the purpose of analyzing the following federal regulatory regimes, it will be assumed that the United States can assert jurisdiction over the project.

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elevator ribbon.

[14] *See supra* notes 6-7 and accompanying text.

[15] *See* Keil J. Ritterpusch & Mark J. Fiekers, *Legal Issues Affecting the Erection and Operation of the LiftPort Space Elevator System*, *in* LIFTPORT- THE SPACE ELEVATOR: OPENING SPACE TO EVERYONE 210 (Michael J Laine et al. eds., Meisha Merlin Publishing 2006).

A discussion of every federal regulation applicable to a space elevator would be a massive undertaking and would far exceed the scope of this article. However, at the outset of a project as ambitious as the construction of a space elevator, four regulatory regimes seem particularly germane. Again assuming that the space elevator falls under United States jurisdiction and is built by a private entity, licensing for the preliminary tests and the actual deployment of the elevator would fall under the regulatory scheme articulated by the Commercial Space Launch Act ("CSLA").[16] Because the space elevator will be located outside of the United States' territory, deployment of space elevator components will be governed by a complex web of export regulations, overseen by the United States Department of Commerce and the United States State Department. Ordinarily, technology exports are regulated by the Commerce Department's Bureau of Industry and Security's Export Administration Regulations ("EAR");[17] however, national security concerns compel the State Department to regulate most space launch technology through the International Traffic in Arms Regulations ("ITAR").[18] It is likely that some of the component parts of the space elevator system will fall under EAR. Furthermore, because one of the primary consumers of space launch services in the United States is the Federal Government, it will be necessary to determine to what degree ITAR will hinder the commercial use of the space elevator by other countries. Finally, because the construction of the space elevator will very likely be facilitated, at least in part by federal agencies, it will be important to note whether compliance with the procedural requirements of the National Environmental Policy Act ("NEPA")[19] will be a prerequisite to space elevator construction and deployment.

A. LICENSING AND REGULATION UNDER THE COMMERCIAL SPACE LAUNCH ACT

The primary instrument the United States has used to regulate private activity in outer space is the Commercial Space Launch Act of 1984, recently amended by the Commercial Space Launch

[16] Commercial Space Launch Act (CSLA), 49 U.S.C. §§ 70101-70121 (2006).

[17] Export Administration Regulations, 15 C.F.R. §§ 730-774 (2007).

[18] International Traffic in Arms Regulations, 22 C.F.R. §§ 120-130 (2006).

[19] National Environmental Policy Act of 1969, 42 U.S.C. §§ 4321-4347 (2006).

Amendments Act of 2004.[20] The Commercial Space Launch Act was designed to encourage private sector development of launch infrastructure.[21] The CSLA regulates launches performed by nationals of the United States outside of United States territory and states that "[a] license. . .or permit, is required. . .for a citizen of the United States (as defined in section 70102(1)(C) of this title) to launch a launch vehicle or to operate a launch or reentry site, or to reenter a reentry vehicle, outside the United States and outside the territory of a foreign country. . . ."[22] However, the applicability of this section depends on whether a space elevator firm or its operators qualify as a citizen under the statute, whether the elevator and its component parts would be considered launch or reentry vehicles or a launch and reentry site, and whether lifting payloads into orbit would constitute a launch.[23]

The first step in this analysis is determining whether the space elevator firm constitutes a United States citizen under the Act. The CSLA defines a "Citizen of the United States" as "an entity organized or existing under the laws of the United States" or "an entity organized or existing under the laws of a foreign country if the controlling interest. . .is held by an individual or entity" that otherwise qualifies as a citizen.[24] Regardless of whether the space elevator is constructed by an entity organized domestically or whether it is a multinational conglomerate where the controlling interest is held domestically, the CSLA would apply.[25] However, if the space elevator firm was organized in a foreign jurisdiction and the controlling interest was held by a foreign entity, the CSLA would be inapplicable.

The second step is determining whether the various components of a space elevator would qualify as launch and reentry vehicles. The CSLA defines a launch vehicle as "a vehicle built to

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[20] CSLA §§ 70101-70121.

[21] *Id.* § 70101(b)(2).

[22] *Id.* § 70104(a).

[23] *See generally* Ritterpusch, *supra* note 14 (examining in more depth the applicability of these provisions).

[24] CSLA § 70102(1)(A)-(C).

[25] *See* Ritterpusch, *supra* note 14, at 212 (Examining why the extraterritorial activities of "Sea Launch, a foreign entity, were subject to United States jurisdiction").

operate in, or place a payload or human beings in outer space."[26] Similarly, the definition or "reentry vehicle" includes vehicles "designed to return from Earth orbit or outer space to Earth, or a reusable launch vehicle designed to return from Earth orbit or outer space to Earth, substantially intact."[27] The lifters designed to traverse the space elevator should qualify as both launch vehicles and reentry vehicles under this definition. They are intended to place payloads into outer space, and are intended to return substantially intact. The language does not limit its applicability to a particular manner of placing payloads into orbit, consequently a space elevator system would not be precluded.

The third step is to determine whether space elevator activities constitute a launch under the statute. Launch is defined in the CSLA to mean "to place or try to place a launch vehicle or reentry vehicle and any payload, crew, or space flight participant from Earth—in a suborbital trajectory; in Earth orbit or outer space; or otherwise in outer space."[28] The purpose of a space elevator is to do all of these things, and because the lifters qualify as launch and reentry vehicles, utilizing the space elevator for these purposes would constitute a launch under the CSLA.

A few collateral issues involve "launch services" and "launch and reentry sites." Launch services are defined to include the activities engaged in preparation of a launch.[29] Launch and reentry sites are defined to mean "the location on Earth from which a launch takes place,"[30] and "the location to which a reentry vehicle is intended to return,"[31] respectively. Under these definitions, the activities surrounding the anchor station would also fall under the CSLA.

It is likely that all of the components of a space elevator would fall under the CSLA. However, this analysis will also need to be done for the initial stages of space elevator deployment, including the launches that deploy the initial seed cable and activities for installation of the anchor station. A preliminary review of the

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[26] CSLA § 70102(8)(a); *See generally* Ritterpusch, *supra* note 14.

[27] CSLA § 70102(16).

[28] *Id.* § 70102(4); *See generally* Ritterpusch, *supra* note 14.

[29] CSLA § 70102(6).

[30] *Id.* § 70102(7).

[31] *Id.* § 70102(15).

provisions discussed here seems to indicate that these activities would similarly fall under the CSLA.

In order to actually perform a launch under the CSLA, the operators of the space elevator must apply to the Office of the Associate Administrator for Commercial Space Transportation ("AST") within the Federal Aviation Administration ("FAA") for required licenses and permits.[32] The CSLA also calls for the Secretary to promulgate regulations pertaining to license applications.[33] The regulations are voluminous and far more specific than is relevant here.

I. LIABILITY INSURANCE REQUIRED UNDER THE CSLA

A licensee must demonstrate liability insurance or the ability to self-insure for the maximum probable loss that could be realized from the launch, as determined by the Secretary of Transportation, as a condition precedent to the issuance of a launch permit.[34] However, the statute places a monetary cap on the total amount of insurance that can be required.[35] The requisite amount of insurance for any one launch must not exceed $500 million dollars for third party death, bodily injury, or property damage claims or $100 million dollars for claims by the U.S. Government for damage or loss to Government property.[36] Alternatively, if the maximum insurance reasonably available on the world market covers less liability, the required insurance must not exceed those amounts.[37] This insurance coverage essentially protects three categories of people: the government and its agents, the customer of the licensee,[38] and the contractors and subcontractors of the licensee and the licensee's customer.[39] The language of the statute does not provide for protection of the "launching party."[40] As such, the operators of the space elevator must

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[32] *See generally* CSLA §§ 70101-21.

[33] Authority is given under the CSLA to promulgate the rules found in the Commercial Space Transportation Regulations, 14 C.F.R. §§ 400-460. *See* CSLA §§ 70101-21.

[34] CSLA § 70112(a)(1)-(2).

[35] *Id.* § 70112(a)(3).

[36] *Id.* § 70112(a)(1)(A)-(B), (a)(3).

[37] *Id.* § 70112(a)(3)(B).

[38] In this instance, the operator of the space elevator.

[39] CSLA § 70112(a)(4)(A)-(D).

[40] *See id.* § 70112.

obtain separate insurance in order to protect their interests, to whatever extent possible.

Once the insurance requirements are met, the Secretary of Transportation will pay for claims up to 1.5 billion dollars above the statutory coverage, valuing total coverage at 2 billion dollars.[41] This government subsidized insurance offers an important degree of protection because, as the later analysis of protections afforded by the Liability Convention will show, enforcement on an international level is subject to the voluntary cooperation of the offending party and offers little significant protection. Under this scheme, the licensee remains liable for any claims exceeding the cumulative 2 billion dollar coverage.[42] Because the minimum projected budget for a space elevator is 10 billion dollars, it will be important for the operators of an elevator to obtain insurance in excess of the 2 billion dollar coverage under the CSLA.

B. THE EXPORT ADMINISTRATION REGULATIONS

The Export Administration Regulations govern commercial exports, including items that are considered "dual-use" because they are applicable to both civilian and military or proliferation uses.[43] The EAR applies to acts that might not typically be considered exports. "Export" under the EAR is defined as "an actual shipment or transmission of items subject to the EAR out of the United States, or release of technology or software subject to the EAR to a foreign national in the United States. . ."[44] Under this definition, the issue governing applicability is whether the item is leaving the United States; the destination— be it a foreign country, the space elevator anchor station in the middle of the Pacific Ocean, or ultimately outer space— does not affect the applicability of the EAR.

It is unlikely that the EAR will apply to a space elevator as a whole, or even to the bulk of its component parts. However, this is

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[41] *See* CSLA § 70113.

[42] *See id*. § 70113.

[43] U.S. DEPARTMENT OF COMMERCE, BUREAU OF INDUSTRY AND SECURITY, *Introduction to Commerce Department Export Controls*, May 8, 2003, http://www.bis.doc.gov/licensing/exportingbasics.htm [hereinafter D.O.C., *Introduction to Export Controls*].

[44] 15 C.F.R. § 734.2(b)(1).

contingent on how the entire system is viewed by the Department of State and the Department of Commerce. Category 9 of the Commerce Control List ("CCL"), which regulates "Propulsion Systems, Space Vehicles, and Related Equipment," indicates that all space launch vehicles, satellites and all other vehicles are subject to the Department of State and ITAR.[45] However, the Department of State retains complete export licensing authority over "[a]ll other 'spacecraft,'" which is defined broadly to include "payloads, and specifically designed or modified components, parts, accessories, attachments, and associated equipment, including ground support equipment."[46] This definition indicates that most of the space elevator system will be subject to State Department jurisdiction and ITAR, rather than EAR. Despite this broad definition it is unlikely that every item 'exported' to a space elevator would be considered a "spacecraft." For instance, a space elevator system includes a substantial marine anchor station component,[47] and it seems unlikely that boats and other parts of that ocean-based system could fit under the definition of a spacecraft and escape ITAR regulation.

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[45] Commerce Control List, Space launch vehicles and "spacecraft," 15 C.F.R. § 774, Supp. No. 1, at 9A004(2)-(4) (2007), provides:

> (2.) Space launch vehicles are under the jurisdiction of the Department of State.
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> (3.) Effective March 15, 1999, all satellites, including commercial communications satellites, are subject to the ITAR. . . . [A]ll license applications for the export of commercial communications satellites will be processed by the State Department. . . . Commercial communications satellites licensed by the Department of Commerce, including those already exported, remain subject to the EAR and all terms and conditions of issued export licenses until their stated expiration date. All licenses issued by the Department of Commerce for commercial communications satellites, including licenses issued after March 15, 1999, remain subject to SI controls throughout the validity of the license. . . . Transferring registration or operational control to any foreign person of any item controlled by this entry must be authorized on a license issued by the Department of State. . . . This requirement applies whether the item is physically located in the United States or abroad.
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> (4.) All other "spacecraft" not controlled under 9A004 and their payloads, and specifically designed or modified components, parts, accessories, attachments, and associated equipment, including ground support equipment, are subject to the export licensing authority of the Department of State unless otherwise transferred to the Department of Commerce via a commodity jurisdiction determination by the Department of State.

See ITAR discussed *infra* Part II.C.

[46] 15 C.F.R. § 774, Supp. No. 1, at 9A004(4).

[47] *See* Elevator 2010 FAQ, http://www.elevator2010.org/faq.html?general#moreWebInfo (Last visited July 1, 2007).

Furthermore, the State Department can use a commodity jurisdiction procedure to specifically exclude certain items from ITAR jurisdiction.[48]

Items subject to the EAR are listed in the CCL,[49] which is divided into ten categories.[50] Each category is further divided into five specific product groups, and specific items listed in each product group are given an Export Control Classification Number ("ECCN").[51] Any space elevator items or components that escape ITAR jurisdiction and fall under an existing ECCN will be subject to the regulatory provisions specified within that ECNN. Items that do not fall under an existing ECNN are given an 'EAR99' designation; EAR99 items are typically consumer goods, and don't usually require an export license.[52] However, they are still subject to restrictions related to embargoes, prohibited end-uses, and end-users of concern.[53] Regardless of whether an exported item falls under an existing ECNN or is designated EAR99, the operators of a space elevator will need to ensure that they have obtained any necessary export licenses and have otherwise complied with the EAR before engaging in any 'export'

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[48] 22 C.F.R. § 120.4 (2006). See also 15 C.F.R. § 774, Supp. No. 1, at 9A004(5)(b), which provides:

> Exporters requesting a license from the Department of Commerce for "spacecraft" and their associated parts and components . . . must provide a statement from the Department of State . . . verifying that the item intended for export is under the licensing jurisdiction of the Department of Commerce. All specially designed or modified components, parts, accessories, attachments, and associated equipment for "spacecraft" that have been determined by the Department of State through the commodity jurisdiction process to be under the licensing jurisdiction of the Department of Commerce and that are not controlled by any other ECCN on the Commerce Control List will be assigned a classification under this ECCN 9A004.

[49] 15 C.F.R. § 774.1 (2007); 15 C.F.R. § 774, Supp. No. 1-3.

[50] Most of the CCL categories are germane in some way to different components of a space elevator system: Category 0-Nuclear materials, facilities and equipment (and miscellaneous items), Category 1-Materials, Chemicals, Microorganisms, and Toxins, Category 2-Materials Processing, Category 3-Electronics, Category 4-Computers, Category 5, (Part 1)-Telecommunications, Category 6-Sensors and Lasers, Category 7-Navigation and Avionics, Category 8-Marine, Category 9- Propulsion Systems, Space Vehicles, and related equipment. 15 C.F.R. § 774, Supp. No. 1. However, each item or component part will have to be evaluated separately to see if it is regulated by an ECCN, or whether it is an unregulated EAR99 item. *See* D.O.C., *Introduction to Export Controls*, *supra* note 43, at 13.

[51] *Id*.

[52] *Id*.

[53] *Id*.

activity with foreign partners or customers.

C. INTERNATIONAL TRAFFIC IN ARMS REGULATIONS

The International Traffic in Arms Regulations are regulations issued by the United States State Department that limit the export and import of defense-related items and services. ITAR regulation of 'defense articles' includes more than just weaponry and military hardware; it includes spacecraft, ground control stations for tracking and telemetry of spacecraft, and a number of other space-related components that would presumably exist in a space elevator system.[54] Furthermore, ITAR regulates more than the simple export of particular items; it regulates the provision of 'defense services' to foreign nationals- this makes very difficult, and in some cases prohibits, both the transfer of intellectual property related to articles falling under the regulations, and the provision of the article for use by foreign nationals.[55] It is very possible that a space elevator will ultimately be run by a multinational conglomerate or consortium, and if one is ever built it will almost certainly furnish lift services to an international client-base.[56] Economically, it will be important for the operators of a space elevator to ensure that they are not prohibited from providing services by export regulations like ITAR.

ITAR does establish a procedure for when there is doubt as to whether a particular item is covered by the United States Munitions List. A request for a determination requires that significant technical details be provided, and the decision will weigh factors such as the predominance of civil applications versus the nature and function of

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[54] *See* International Traffic in Arms Regulations, The United States Munitions List, 22 C.F.R. § 121.1 (2007).

[55] A defense service is defined as

> The furnishing of assistance (including training) to foreign persons, whether in the United States or abroad in the design, development, engineering, manufacture, production, assembly, testing, repair, maintenance, modification, operation, demilitarization, destruction, processing or use of defense articles; [and t]he furnishing to foreign persons of any technical data controlled under this subchapter.

22 C.F.R. § 120.9 (2007).

[56] LiftPort Group has proclaimed that it will operate under a policy of international inclusion. *See* Piotr Jagodzinski, *Why International Public Inclusion is Important*, *in* LIFTPORT- THE SPACE ELEVATOR: OPENING SPACE TO EVERYONE 210 (Michael J Laine et al. eds., Meisha Merlin Publishing 2006).

the article in civil and military contexts.[57] It will also determine whether the article has a sufficiently significant military or intelligence application that justifies controlling its export as a defense article.[58]

One of the first instances of a private space flight company having to face ITAR involved Burt Rutan's license of the intellectual property to his SpaceShipOne spacecraft to Sir Richard Branson's British-based Virgin Galactic. The deal required the two companies to overcome the regulatory obstacle posed by ITAR. The State Department's Directorate of Defense Trade Controls ("DDTC") weighed the civilian nature of the project against the potential military uses in favor of the two companies, and allowed the two companies to exchange information pursuant to the project.59 This bodes well for other international civilian endeavors in outer space. Hopefully, the DDTC would weigh in favor of the primarily civilian applications of a space elevator.

D. COMPLIANCE WITH THE NATIONAL ENVIRONMENTAL POLICY ACT

The National Environmental Policy Act (NEPA) is a procedural act that outlines the United States' national environmental policy and imposes significant procedural steps on federal agencies for all "major federal actions significantly affecting the quality of the human environment."[60] When applicable, NEPA imposes significant procedural duties on the federal actor, most notably the preparation of an Environmental Assessment (EA)[61] and an Environmental Impact Statement (EIS).[62] If the project as planned is found to be environmentally deficient, alternative proposals and designs must be considered. Failure to do so can expose the project to costly and time-consuming judicial review.

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[57] 22 C.F.R. §120.4(d)(1)(i-iii).

[58] *Id.* § 120.4(d)(3).

[59] Leonard David, *U.S. Gives Okay for SpaceShip Two Dealings,* http://www.msnbc.msn.com/id/8963138/ (last visited July 1, 2007).

[60] National Environmental Policy Act (NEPA), 42 U.S.C. § 4321(2)(c).

[61] An EA is an abbreviated report outlining the environmental impact of the project. If there is a "finding of no significant impact" then there is no need to do anything further, such as prepare an EIS. *See* Council on Environmental Quality Regulations, 40 C.F.R. § 1508.9 (2007).

[62] *See id.* § 1502.1 (1978).

The procedural requirements of NEPA are applicable to "major federal actions."[63] Because NEPA only applies to federal agencies, it may seem that the actions of private firms, such as a privately owned firm dedicated to the construction of a space elevator, would be exempt. However, courts have interpreted this language broadly, such that even private projects that are supported by the actions of federal agencies have been deemed to require NEPA compliance.[64] NEPA applies to "nonfederal activities that are entirely or partially financed, assisted, authorized, permitted, or otherwise approved by a federal agency," with some exceptions for instances where there is a "small federal handle."[65] Generally, federal involvement "federalizes" the entire action, but in cases where the federal involvement is not significant, only the federal component need comply with NEPA.[66] Considering the role federal agencies play in most space elevator proposals, the likelihood of United States jurisdiction for the purposes of securing compliance with international obligations, the possibility of the United States military securing the anchor station, possible public-private financing, probable lift/launch contracts with the Department of Defense and NASA, and compliance with other federal regulatory schemes, it is likely that there would be sufficient interplay between a privately held space elevator firm and numerous federal actors to require NEPA compliance for the entire project. In fact, the FAA Commercial Space Flight Regulations 14 C.F.R. § 415.201 make issuance of a launch license contingent on compliance with NEPA and other environmental statutes.[67]

The application of NEPA to a space elevator outside of United States territory is a more complex question. Some early decisions in cases involving the extraterritorial application of NEPA decided collateral issues without ever addressing the issue of whether NEPA was actually applicable extraterritorially.[68] At the time, it could be

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[63] NEPA § 4332(2)(c).

[64] Scientists Inst. for Pub. Info., Inc. v. Atomic Energy Commission, 481 F.2d 1079, 1088-1089 (D.C. Cir. 1973). *See also* ROBERT L. GLICKSMAN ET AL., ENVIRONMENTAL PROTECTION: LAW AND POLICY p. 166 (4th ed.166, 2003).

[65] RONALD E. BASS ET AL., THE NEPA BOOK: A STEP-BY-STEP GUIDE ON HOW TO COMPLY WITH THE NATIONAL ENVIRONMENTAL POLICY ACT, p 30. (2nd ed. 2001). *See also* 40 C.F.R. § 1508.18(b)(4) (2007).

[66] GLICKSMAN, *supra* note 64.

[67] 14 C.F.R. § 415.201.

[68] *See* ROBERT V. PERCIVAL ET AL., ENVIRONMENTAL REGULATION: LAW, SCIENCE, AND POLICY, pp 1343-44 (2nd ed. 1996). *See also* Sierra Club v. Adams, 578 F.2d 389 (D.C.

assumed that because the courts did not immediately dismiss these cases for lack of subject matter jurisdiction, NEPA could be applied to extraterritorial actions of federal agencies. Since that time however, NEPA has been affirmatively held to extend to activities outside of the United States' domestic territory in certain circumstances.

In *Environmental Defense Fund v. Massey,*[69] in which the National Science Foundation's decision to incinerate food waste at McMurdo Station in Antarctica was contested for failure to prepare an EIS in compliance with NEPA, the United States Court of Appeals reversed the lower court's decision to dismiss for lack of subject matter jurisdiction, and found that although NEPA is primarily intended to guide agency decision-making domestically, the mere fact that the effect of domestic agency decision-making would be felt extra-territorially was insufficient to trigger the presumption against the extraterritorial application of statutes.[70] This seems to imply that merely locating a space elevator outside of the United States' territory and in a non-sovereign global commons would not be enough to escape the need to comply with NEPA. Agency actions related to the space elevator would be decided domestically, but like the *Massey* case it would have an extraterritorial impact in a region designated *res communis* or global commons.[71] Thus, any federal agency that were to participate in a space elevator project would probably be required to prepare an EIS to assess the environmental impact of its participation.

The *Massey* court discussed the unique nature of Antarctica as

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Cir. 1978), NORM v. United States Dep't of State, 452 F. Supp 1226, 1233 (D.D.C. 1978), Greenpeace USA v. Stone, 748 F. Supp. 749, 761 (D. Haw. 1990).

[69] Envtl. Def. Fund v. Massey, 986 F.2d 528 (D.C. Cir. 1993).

[70] *Id.* at *529.*

[71] Grotius explains that "the sea is called indifferently the property of no one (*res nullius*), or a common possession (*res communis*), or public property (*res publica*)." Grotius, *Mare Liberum* (1633). According to Grotius, the sea should be open to everyone, belong to everyone, and be incapable of appropriation by anyone. *Id.* The global commons he argued extended right up to the shoreline. *Id.* The United Nations Convention on the Law of the Sea has adopted a similar principle and specifically stating "[n]o State may validly purport to subject any part of the high seas to its sovereignty." Third United Nations Convention on the Law of the Sea art. 89, Nov. 16, 1994, 1833 U.N.T.S. 397, 432 [hereinafter UNCLOS]. *See* Discussion *infra* sect. III.A. For additional information on the philosophy of *res communis* and an argument for the adoption of international law to govern extrateritorial matters see David Tan, *Towards a New Regime for the Protection of Outer Space as the "Province of All Mankind,"* 25 YALE J. INT'L. L. 145, 161-65 (2000).

a sovereign-less global commons (analogizing it to outer space) and considered as an important factor the United States' significant measure of control over the continent.[72] This discussion is pertinent to the construction of a space elevator, because such a structure would span three other global commons- the high seas, international airspace, and outer space. According to most space elevator proposals, it is likely that the United States' government would exercise some degree of control over a space elevator by providing for, at the very least, its security.

It is worth quickly noting however, that high-altitude tether tests, carbon nanotube manufacturing, and other domestic activities of a space elevator firm and its subsidiary corporations would not present any issues of extraterritoriality. Because of the licensing and other federal requirements of those activities, to whatever extent those activities involved a federal actor they would almost certainly fall under NEPA jurisdiction.

III. International Law Issues

Regardless of the national status of a space elevator company, a functional space elevator will necessarily possess a unique legal status on the world stage, because it will simultaneously occupy space in three distinct geographical regions, of which the legal status is that of a global commons: the high seas, international airspace, and outer space. The space elevator's anchor station will most likely be located in the high seas, outside of any territorial waters, and at a point within two degrees of the equator – between the Earth's Hadley Cells where there is very little violent weather. Although mobile enough to move the elevator to avoid orbiting satellites and debris, the space elevator anchor station will be a somewhat permanent structure, and the space elevator ribbon will extend from the ocean's surface into all of the airspace directly above the anchor. The general customary rules regarding the global commons are that they are free for use by all, and not subject to claims of ownership or appropriation by any person or nation.[73] There is precedent in international law relating to the

[72] *Massey*, 986 F.2d at 533-34.

[73] *See* discussion *supra* note 71.

high seas and to outer space, to which some components of a space elevator can be analogized. The space elevator anchor station will not be the first semi-permanent installation on the high seas, nor will the elevator be the first man-made object to occupy a region of space on a semi-permanent basis. Accordingly, these areas will be discussed first. However, to this author's knowledge, there exists absolutely no precedent for any man made structure permanently occupying international airspace, and as such, it presents a problem with a less precise answer.

A. INTERNATIONAL LAW OF THE SEA

Much of the "International Law of the Sea" is customary and has its basis in ancient maritime traditions. One customary issue in particular is important for the purposes of a space elevator— the internationally recognized principal of freedom of the seas- *mare liberum*.[74] It will be important for any entity operating a space elevator to avoid any attempt to assert ownership of its operating area. This does not mean, however, that a space elevator could not enjoy any protected status in its operating area.

The primary treaties regarding international waters are the treaties drafted by the United Nations Convention on the Law of the Seas (UNCLOS). These treaties have a great deal to say about the rights of ships on the high seas, however they might not be considered authoritative for the purposes of a space elevator operated under the jurisdiction of the United States, because the United States has refused to ratify UNCLOS. However, the United States has since withdrawn its primary objections, and although it has still not ratified the treaty, it expressed agreement with the principles outlined in the treaty as forming a body of international customary law.[75]

The UNCLOS III Treaty may offer the best foundation for legitimizing a space elevator anchor station in international waters. Part VII of the treaty, outlining the provisions relating to the high seas, states:

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[74] A sea or other body of navigable water that is open to all nations. BLACK'S LAW DICTIONARY, 986 (8th ed. 2004).

[75] *See generally* Candace L. Bates, *U.S. Ratification of the United Nations Convention of the Law of the Sea: Passive Acceptance is Not Enough to Protect U.S. Property Interests*, 31 N.C. J. Int'l L. & Com. Reg. 745 (2006).

> The high seas are open to all States, whether coastal or land-locked. Freedom of the high seas is exercised under the conditions laid down by this Convention and by other rules of international law. It comprises, inter alia, both for coastal and land-locked States: . . . (d) freedom to construct artificial islands and other installations permitted under international law, subject to Part VI.[76]

The applicable provision is Article 80, which states: "Article 60 applies *mutatis mutandis*[77] to artificial islands, installations and structures on the continental shelf."[78] Article 60 outlines the rules pertaining to the construction of an artificial island or installation.[79] The article allows for the construction or establishment of "installations"[80] as long as certain prerequisites are met: that notice be given regarding the construction of an installation, that permanent safety zones are established, that the installation will not interfere with established shipping lanes, and that the installation be removed when no longer in use.[81] None of these rules should represent a problem for a space-elevator anchor station as currently proposed-notice is easily given, the plans specifically call for the establishment of safety zones and for the anchor location to be far removed from shipping traffic.

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[76] UNCLOS, *supra* note 71, at art. 87.1(d).

[77] *Mutatis Mutandis* means: "all necessary changes having been made." BLACK'S LAW DICTIONARY, 1044 (8th ed. 2004). This term essentially incorporates the terms of a previous provision, with the understanding that some changes being understood. In this case, whereas art. 60 outlines the rules pertaining to the construction of an artificial island or installations in a coastal states' Extended Economic Zone, while art. 80 refers to the construction of an artificial island or installations on the continental shelf, and art. 87, § 1(d) refers to the construction of an artificial island or installations on the high seas.

[78] UNCLOS, *supra* note 71, at art. 80.

[79] *Id.* art. 60 (details the requirements for establishing an artificial island or installation).

[80] The space elevator anchor station would most likely qualify as an installation. Article 60, §1(b) allows for "installations and structures for the purposes provided for in Article 56 and other economic purposes." Article 56 outlines the legitimate uses of a coastal state's Exclusive Economic Zone. It can be assumed that per the doctrine of *mutatis mutandis*, what is acceptable in territorial waters would be acceptable on the high seas.

[81] UNCLOS, *supra* note 71, at art. 60.

B. INTERNATIONAL LAW OF OUTER SPACE

The United States is a party to four international treaties regarding the use of outer space: The Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies ("Outer Space Treaty") signed in 1967, The Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space ("Rescue Agreement,") signed in 1968, The Convention on International Liability for Damage Caused by Space Objects ("Liability Convention,") signed in 1972 and the Convention on Registration of Objects Launched into Outer Space ("Registration Convention") signed in 1975. Because these four treaties are only applicable to a space elevator in certain instances, it makes more sense to address their implication by the subject matter to which they apply.

1. OCCUPATION AND OWNERSHIP OF OUTER SPACE: "APPROPRIATION BY USE"

Because the bulk of a space elevator will occupy a portion of outer space on a more or less permanent basis, it will be important to delineate the legal status of the elevator under international law. Outer space, like the high seas and international airspace, is considered *res communis*.

The Outer Space Treaty was the first international treaty dealing with human presence in outer space. A pertinent provision on Article II of that treaty states: "Outer Space . . . is not subject to appropriation . . . by use or occupation, or by any other means."[82] The concept of 'appropriation by use or occupation' is particularly relevant in the space elevator context, as it is very likely that some observers will claim that in permanently occupying a large swath of outer space, to the exclusion of others, the operator of a space elevator will have appropriated it *de facto*.

The simplest defense to this assertion will be a contrary

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[82] Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon Celestial Bodies, The Outer Space Treaty art. II, opened for signature Jan. 27, 1967, 18 U.S.T. 2410, 610 U.N.T.S. 205 [hereinafter Outer Space Treaty].

assertion that no claim of ownership is made, and that the operator of the elevator is simply utilizing the free right of access to outer space afforded to all others by international law. There is significant international precedent for such an approach. International law[83] requires the registry of launched space objects, both with the United Nations Secretariat and with the appropriate registry in the launching state, and it offers a forum for disputes regarding conflicting uses.[84] However, no international body authorizes launches in any affirmative sense. Launching states, and non-governmental entities launching with the consent of state parties to the treaty, are more or less free to launch as they please under international law.[85] Violations of these treaty obligations by private actors are resolved through diplomatic channels by the 'launching state,' and punishment or indemnification by the launching state is a collateral issue.

Similarly, geosynchronous radio satellites permanently occupy an orbital slot, of which there are a finite number, on a semi-permanent basis. The International Telecommunications Union ("ITU") is an international body that has issued Radio Regulations that provide a legal mechanism governing the use of radio spectrum by these satellites, and the ITU assigns protected status to operators operating in conformity with the specifications of their registered satellite.[86] However, the ITU does not authorize use of spectrum, nor

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[83] *See* Convention on Registration of Objects Launched into Outer Space, *opened for signature* Jan. 14, 1975, 28 U.S.T. 695, 1023 U.N.T.S. 15 [hereinafter Registration Convention].

[84] *See id.* art. 1; Convention on International Liability for Damages Caused by Space Objects art. 1, opened for signature May 21, 1975, 24 U.S.T. 2389, 961 U.N.T.S. 187 [hereinafter Liability Convention]. Although use of a space elevator would constitute a launch under the language of the CSLA, it is unclear whether use of a space elevator would constitute such under international law. "Launching state" is defined as a state that "launches or procures the launch of a space object", "Space object" is defined to include "component parts of a space object as well as its launch vehicle and parts thereof", and "launch" is undefined. *See* Liability Treaty *supra*, at art. 1; Registration Convention *supra* note 83, at art. 1. As new methods for placing space objects into orbit arise — including "lift" by a space elevator system, and on-orbit assembly and deployment of satellites and other devices from space stations and installations on celestial bodies like the Moon—this ambiguity may ultimately require a revision of the language of the treaties, some new language, or some other documented understanding of what kinds of activities fall under the aegis of the treaties.

[85] This assertion presumes compliance with other relevant provisions of international law.

[86] For a more detailed discussion of the ITU's role in licensing orbital slots, see

does it license the use of particular orbital slots where geosynchronous radio satellites are located. These orbital slots are freely available on a first come, first served basis, but satellite operators must relinquish the use of an orbital slot when the satellite is no longer in service.[87] Because the ITU primarily registers geostationary telecommunications satellites and allocates spectrum, it may not have jurisdiction to register an object other than a telecommunications satellite. In defense of their operation, a space elevator company could argue by analogy that they are simply using a geosynchronous orbit in a manner comparable to a communications satellite, on a first-come basis, in accordance with international law.

C. INTERNATIONAL AIR LAW

As stated above, the legal status of the portion of the space elevator passing through international airspace presents a question that admits no precise answer in international law. It is generally recognized that the legal status of the airspace over the high seas is analogous to the high seas itself, under the principle of *res communis*.[88] Extant international airspace law deals primarily with over-flight rights and the relationships between state parties regarding airplanes.[89] Because all vehicles that navigate international airspace heretofore are in motion and eventually land, there has never been a need to regulate the permanent occupation of airspace. Despite the lack of any particularly applicable law, it is likely that we can have some assurance of the probable legal status of a space elevator in international airspace by referring to the treatment of similar structures or objects located in international waters and in outer space. As discussed above, both the high seas and outer space are *res communis* under international law. The international approach to the use of international airspace by airplanes has been much the same, guaranteeing the right to over-fly international waters in much the same manner as ships navigate the high sea.

Ritterpusch, *supra* note 15.

[87] Ritterpusch, *supra* note 15.

[88] *See* CENTER FOR RESEARCH OF AIR & SPACE LAW, MCGILL UNIVERSITY, SPACE ACTIVITIES AND EMERGING INTERNATIONAL LAW, p.167 (Nicolas Mateesco Matte, ed 1984) [hereinafter SPACE ACTIVITIES AND EMERGING INTERNATIONAL LAW] .

[89] *See* Convention on International Aviation, Dec. 7, 1944, 61 Stat. 1180, 15 U.N.T.S. 295.

It is possible that if and when it becomes necessary, either international law relating to airspace could be amended to explicitly accommodate the construction of a space elevator or it is possible that the space elevator firm could affirm the principles that have traditionally governed *res communis,* with respect to portion of the elevator that is in international airspace and hope that no one complains.

A third option might be to regard the portion of a space elevator in international airspace as insignificant, and simply pursue any necessary legal action under the applicable international laws of outer space. A space elevator will be an extremely large structure-extending 62,000 miles into space, or more. There is no absolute point at which the atmosphere ceases and outer space begins; the issue of delimitation has been the subject of fierce debate.[90] However, 100 kilometers (62 miles) is one traditionally accepted boundary. By this measure, the portion of the space elevator in the atmosphere is approximately 1/1000 of the length of the entire structure. In this respect, the space elevator is primarily an orbiting space object. From the standpoint of international obligations and the standpoint of international liability, it might be easier and more realistic to pursue legal remedies under the existing regime of outer space treaties, primarily the Outer Space Treaty and the Liability Convention, than to create a new regulatory regime or carve out a set of exceptions for one small class of objects. The language of the Liability Convention supports this approach; it defines "space object" to include the component parts of a space object and the component parts of its launch vehicle.[91] The anchor station, ribbon, and counterweight would all fall under one of those two categories.

D. REGISTRATION OF SPACE OBJECTS AND LIABILITY ISSUES UNDER INTERNATIONAL LAW

Most space elevator designs endow the anchor station with the ability to move within a few kilometers so that the elevator cable can avoid space objects. There are so many satellites and other objects orbiting the earth that without this ability, a collision between an

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[90] *See* ANDRZEJ GORBIEL, OUTER SPACE IN INTERNATIONAL LAW 85-118. (Uniwersytet Lodzi 1981). *See also* U.N. General Assembly, Committee on the Peaceful Uses of Outer Space, sect. V, U.N. Doc. A/AC.105/871 (April 24, 2006).

[91] Liability Convention, *supra* note 84.

orbiting object and the elevator is inevitable. The operators of a space elevator will need to know with certainty what orbiting objects pose a threat.[92]

The Registration Convention requires multiple registries of launched space objects; every launching state must keep an appropriate registry of all launched objects, and all launching states must provide the Secretary General of the United Nations with data relevant to the launch: the date of the launch, the territory from which the launch will take place, the orbital parameters of the space object, and its function.[93]

If a collision does occur, liability issues will certainly arise. The Outer Space Treaty affixes international liability to the launching state, even for the activities of its nationals. In the case of a collision between a space elevator under United States jurisdiction and a space object launched by another state party to the treaty, both launching states would remain liable to each other on an international level, and the loser would have to indemnify itself by pursuing the offending party.[94]

The Liability Convention also affixes liability, but it does so to different degrees depending on the circumstances that surround the collision. Under Article II of the Convention, a launching state is absolutely liable for any damage incurred by its launch to person or property located on the earth, or to aircraft—although this liability can be mitigated if the damage is the result of malicious activity.[95]

In cases involving collisions between two space objects, a fault-based analysis applies rather than strict reliability.[96] This is extremely relevant to the operation of a space elevator, because once it has been deployed and registered, presumably other launching states would have constructive notice of its existence and location—

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[92] It should also be noted that in addition to the registries required by the Registration Convention, many government agencies like NASA and the Department of Defense maintain detailed records of orbiting space objects, including space debris that may not have been purposefully launched, but can still pose a threat.

[93] Liability Convention, *supra* note 84, art. II-IV.

[94] Presumably this would be facilitated, on the United States' side, by the insurance requirements of the CLSA, discussed *supra* Sect. II.A.i.

[95] Liability Convention, *supra* note 84, art. II, VI (1)(a).

[96] *Id.* art. III.

and the onus to avoid a collision would rest with subsequent launching states and to the operators of the space elevator to the degree they could avoid or mitigate a collision.

Objects already in orbit present a more serious problem in terms of liability. According to Dr. Edwards, "anything that is in orbit will eventually cross the equator" where the elevator is located."[97] The Liability Convention doesn't provide any absolute rules for how fault is determined, only that they are to be presented and resolved through diplomatic channels.[98] Presumably, the burden to avoid a collision with already orbiting objects would ultimately rest with the operators of the space elevator, unless the offending space object could be controlled by its launching state in such a way as to avoid or mitigate the collision.

The Liability Convention also assigns joint and several liability[99] to any joint-launches between state parties to the treaty.[100] Because of the global scale and likely international character of any space elevator, this provision will very likely have profound consequences to the operation of the device. The Liability Convention defines "launching state" as "any state which launches or procures the launching of a space object."[101] In the context of a space elevator, any country that "procured" lift services from the operators of a space elevator could become jointly and severally liable[102] for damages incurred by the elevator. Furthermore, because state parties to the Outer Space Treaty are absolutely liable internationally for the activities of their nationals, a country could be held liable simply because a company operating within its jurisdiction procured a launch. Any 'procuring state' would be able to indemnify itself against the actual offending party, but this may be little comfort to nations facing individual liability for claims in the billions of dollars simply

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[97] *See* BRADLEY C. EDWARDS, THE SPACE ELEVATOR- A REVOLUTIONARY EARTH-TO-SPACE TRANSPORTATION SYSTEM 112 (2002).

[98] Liability Convention, *supra* note 84, art. IX.

[99] *Id.* art. V.

[100] *Id.* art. IV(1).

[101] *Id.* art. I.

[102] Liability that may be apportioned either among two or more parties or to only one or a few select members of the group, at the adversary's discretion. Thus, each liable party is individually responsible for the entire obligation, but a paying party may have a right of contribution and indemnity from nonpaying parties. BLACKS LAW DICTIONARY, (8th Edition).

because one of its nationals procured the launch of a space object using the space elevator. Limiting the exposure of customers, including the international liability flowing to their states of origin, will be essential to the successful financial operation of any space elevator enterprise. As discussed earlier in this article, the United States' Commercial Space Launch Act requires some measure of insurance for commercial enterprises launching under its jurisdiction, but whether this would be enough to compensate for the catastrophic damage that could potentially arise in a space elevator incident is doubtful.

The historical record of claims arising under the Liability Convention is neither extensive nor encouraging. Only one claim has ever been presented under the Liability Convention, involving the 1978 crash of a nuclear-powered Soviet Cosmos 954 satellite in a remote area of Canada, in which the de-orbiting satellite spread its radioactive fuel over a 124,000 square-kilometer area.[103] Canada asserted that Russia was strictly liable under Article II of the Liability Convention, and presented a claim for fifteen million dollars in cleanup and remediation costs. Although Russia never admitted liability under the Convention, it did eventually pay some amount of money towards the cleanup, through diplomatic channels.[104] The failure of the Liability Convention to result in actual satisfaction of the claim presented under it emphasizes the need of any space elevator enterprise to self-insure to whatever extent possible, and to ensure that its customers can limit their liability and insure for their own loss.

IV. Conclusion

Navigating and overcoming the international obligations and domestic regulatory requirements that an engineering and construction project on the scale of a space elevator will face will be a daunting challenge. The issues discussed in this paper are significant, but while these issues are somewhat broad in scope, a

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[103] *See* SPACE ACTIVITIES AND EMERGING INTERNATIONAL LAW, *supra* note 88, at 101. *See also* Health Canada, *The Cosmos 954 Accident*, http://www.hc-sc.gc.ca/ed-ud/fedplan/cosmos_954_e.html.

[104] *See* Michael Bein, *Star Wars and Nuclear Reactors in Space, available at* http://www.animatedsoftware.com/spacedeb/canadapl.htm.

project of this sort will also face a multitude of legal and administrative particulars that will be no less important. Hopefully, like the engineering challenges that have yet to be overcome, the legal obstacles that face space elevator development will yield to a steadfast and consistent effort to resolve them.