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Falling Stars and Sinking Ships: How Article VII of the Outer Space Treaty Needs Maritime Law

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FALLING STARS AND SINKING SHIPS: HOW ARTICLE VII OF THE OUTER SPACE TREATY NEEDS MARITIME LAW

McKenzie Franck*

ABSTRACT

The urge to go where no man has gone before has led to great leaps in space technology that only seemed real in cinema. As more private companies, such as private asteroid mining companies in China, attempt to take this leap, it has become clear that there are significant gaps in international space law regarding liability with private parties. Within Article VII of the Outer Space Treaty, there is a laid-out structure on how states can be held liable for damages caused by celestial bodies. However, the Outer Space Treaty ignores what happens if a private company causes injuries in another country or to another space craft. While there has yet to be an example of a private company causing damages from negligence under space law, we know what may happen through Maritime Law. With multiple similarities between maritime and space law, already established maritime regulations can easily be used as a supplementation for space law. In part I of this article, there will be a discussion of the history of space law and modern-day technology done by private Chinese companies. Part II will then examine maritime law concepts and outer space collisions. Part III, IV, and V will move to an in-depth analysis on limitations of liability, vessel insurance, and employees' insurance. Part VI will finalize, discussing how limitations of liability, vessel insurance, and employee's insurance create a stable supplement for Article VII of the Outer Space Treaty.

KEYWORDS

Outer space treaty, maritime law, limited liability, asteroid mining, China, international, international space law.

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I. INTRODUCTION

To go where no man has gone before led to great leaps in space technology that only seemed real in cinema. State governments and private companies throughout the globe have been progressive in their innovations, hoping that their technological advancements will lead to new resources that are limited on earth.¹ As a rising superpower in space innovation, China has entered the scene, allowing its private companies to create and launch asteroid mining robots into space with the hope of extracting minerals from otherworldly resources.² As competing companies expand on their want for more natural resources, they will likely copy China by trying to create space technology to gather rare minerals from the galaxy.³ While this increase in innovation will eventually lead to significant economic advances in China and other countries that follow suit, these new technologies also show holes within current space law.⁴

The Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, also known as the "Outer Space Treaty," was based on the legal principles governing countries' activities in their exploration and use of outer space.⁵ Specifically, Article VII of the

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¹ See, e.g., Dylan Taylor, *Space Technologies Can Help Solve Earth's challenges*, SPACE.COM (May 11, 2020), <https://www.space.com/space-technologies-help-solve-earth-challenges.html> (explaining how certain technologies adapted from space use have benefitted our environment).

² Mai Tao, *China Launches Robot to Collect Space Debris and Mine Asteroids*, ROBOTICS & AUTOMATION NEWS (Apr. 28, 2021), <https://roboticsandautomationnews.com/2021/04/28/china-launches-robot-to-collect-space-debris-and-mine-asteroids/42822/>.

³ See, e.g., Andrew Jones, *Chinese Space Resource Utilization Firm Origin Space Signs Deal for Space Telescope*, SPACE NEWS (Apr. 23, 2020), <https://space-news.com/chinese-space-resource-utilization-firm-origin-space-signs-deal-for-space-telescope/> (discussing China's recent increase in exploration and use of space technology and resources).

⁴ See generally Samuel Stockwell, *Legal 'Black Holes' in Outer Space: The Regulation of Private Space Companies*, E-INT'L REL. (July 20, 2020), <https://www.e-ir.info/2020/07/20/legal-black-holes-in-outer-space-the-regulation-of-private-space-companies/> (providing examples of recent criticism respecting the new space exploration).

⁵ Loren Grush, *How an International Treaty Signed 50 Years Ago Became the Backbone for Space Law/Happy Anniversary, Outer Space Treaty*, VERGE (Jan. 27,

Outer Space Treaty states that a country is internationally liable for damages to other countries that are party to the Treaty.⁶ While Article VII of the Outer Space Treaty discusses countries' liability in the event of damage done to a different country, there is no discussion as to what happens if a private company causes injuries in another country.⁷ With private companies, such as the ones in China, creating and sending asteroid mining robots to outer space, there becomes an issue of who will be liable if materials from privately-owned companies cause damage in different territories.⁸ There also becomes the issue of how much private companies will be responsible for in collision cases.⁹ While there has yet to be an example of a private company causing damages from negligence under space law, we know what may happen through Maritime Law.¹⁰

This article will argue that maritime laws, limited liability, and insurance practices should be adopted when dealing with private companies' negligence under international outer space law. It will further argue that practices surrounding limited liability, vessel insurance, and employment insurance must be implemented to fully supplement Article VII of the Outer Space Treaty. This analysis will start with the evolution of space law and its current effect on private companies' space innovations. The conversation will then shift to existing private companies' asteroid mining robot innovations and how they are changing the technological landscape. This article will conclude by analyzing how maritime law would best supplement the outer space treaty to hold private companies liable for their

2017), <https://www.theverge.com/2017/1/27/14398492/outer-space-treaty-50-anniversary-exploration-guidelines>.

⁶ See 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), art. VII, Jan. 27, 1967, 18 U.S.T. 2410, 610 U.N.T.S. 205 [hereinafter Outer Space Treaty] (stating that international countries may hold the either accountable for violation of the Treaty).

⁷ *Id.*

⁸ See, e.g., Tao, *supra* note 2 (explaining that when various satellites become obsolete, they end up floating in space with no way of recovering, recycling, or disposing them in a clean way).

⁹ See generally Rachel Rogers, *The Sea of the Universe: How Maritime Law's Limitation on Liability Gets it Right, and Why Space Law Should Follow By Example*, 26 IND. J. GLOB. LEGAL STUD. 741, 757 (Aug. 1, 2019) (explaining how "it is highly unlikely that even a minority of the same budget as NASA, let alone the impending doom of costs for full liability damages if anything were to go wrong due to inexperience").

¹⁰ *Id.* at 748.

space innovations. This discussion includes the struggle to agree between strict and limited liability for private companies. Furthermore, it will emphasize the need for outer space insurance regulations that reflect different states' maritime codes for outer space vessels, cargo, and employees.

II. HISTORY OF SPACE LAW AND MODERN TECHNOLOGY

A. *Evolution Of Space Law*

The Outer Space Treaty of 1967 was the cornerstone of creating orderly conduct within outer space.¹¹ At the beginning of the 1950s, the need for outer space law began due to the "space race" between the United States and the Soviet Union during the International Geophysical Year.¹² In particular, nations were worried about outer space being exploited for military advantage and nuclear weapons.¹³ Between 1959 and 1962, western powers attempted to make a series of proposals to prevent military use within outer space.¹⁴ During negotiations for new outer space laws, the Cold War took place, and western countries were concerned about space being militarized with nuclear weapons by the Soviet Union.¹⁵ In 1966, the Soviet Union and the United States submitted a draft treaty to create a United Nations resolution.¹⁶ The Soviet Union covered the outer space environment, and the United States accepted the Soviet Union's position.¹⁷ Further negotiations between the Soviet Union and western powers led to the Outer Space Treaty and our current

¹¹ Alla Podznakova, *Outer Space Law*, U. OSLO (Nov. 28, 2019, 11:43 AM), <https://www.jus.uio.no/nifs/english/research/areas/outer-space-law/>.

¹² Bailey DeSimone, *How the Antarctic Treaty of 1959 Influenced the Outer Space Treaty of 1967*, LIBR. CONG. (Jan. 28, 2022), <https://blogs.loc.gov/law/2022/01/how-the-antarctic-treaty-of-1959-influenced-the-outer-space-treaty-of-1967/>.

¹³ *Id.*

¹⁴ *Outer Space Treaty*, ATOMICARCHIVE.COM [hereinafter *Outer Space Treaty, Narrative*], <https://www.atomicarchive.com/resources/treaties/outer-space.html> (last visited Feb. 6, 2023).

¹⁵ *Nuclear Test Ban Treaty*, JOHN F. KENNEDY PRESIDENTIAL LIBR. & MUSEUM, <https://www.jfklibrary.org/learn/about-jfk/jfk-in-history/nuclear-test-ban-treaty> (last visited Feb. 22, 2023).

¹⁶ *Outer Space Treaty, Narrative*, *supra* note 14.

¹⁷ *Id.*

understanding of outer space laws.¹⁸ While current outer space laws have given countries a solid starting point, they were mainly created with only warfare in mind.¹⁹ However, with private companies now having the same resources to make outer space technology, outer space is seen as a source of resources rather than a war source.²⁰

As known today, the Outer Space Treaty allows for the freedom of exploration and use of space so long as it benefits all countries' interests.²¹ Moreover, the Treaty disallows the appropriation of outer space by any country and bans weapons of mass destruction in outer space.²² Overall, five major space treaties and other related instruments led to the development of current space law.²³ In addition to these treaties, there were four framework pieces: the Rescue Agreement of 1968, Liability Convention of 1972, Registration Convention of 1975, and Moon Agreement of 1979.²⁴ These framework pieces, and the original treaty, ultimately created the following nine principles: (1) exploration and use of outer space will be carried out for the benefit and interest of all countries, (2) outer space will be free for exploration by all states, (3) outer space is not subject to national appropriation by claim of sovereignty, (4) States shall not place nuclear weapons or weapons of mass destruction in outer space or orbit, (5) the moon and other celestial bodies shall be used exclusively for peaceful purposes, (6) astronauts shall be regarded as the envoys of humanity, (7) states shall be responsible for national space activities, whether they are carried out by government or non-government entities, (8) states shall be liable for damages

¹⁸ *Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies*, U.N. OFF. OUTER SPACE AFFS. (1996) [hereinafter U.N. Office for Outer Space Affairs], <https://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/introouter-spacetreaty.html>.

¹⁹ *Id.*

²⁰ Kristin Houser, *Private Companies, Not Governments, Are Shaping the Future of Space Exploration*, FUTURISM (June 12, 2017), <https://futurism.com/private-companies-not-governments-are-shaping-the-future-of-space-exploration>.

²¹ Jason Krause, *The Outer Space Treaty Turns 50. Can it Survive a New Space Race?*, ABA J. (Apr. 1, 2017, 5:00 AM) [hereinafter, *The Outer Space Treaty Turns 50*], https://www.abajournal.com/magazine/article/outer_space_treaty.

²² *Id.*

²³ Podznakova, *supra* note 11.

²⁴ Jason Krause, *5 United Nations Treaties in Outer Space*, ABA J. (Apr. 1, 2017, 4:45 AM), https://www.abajournal.com/magazine/article/space_law.

caused by space objects, and (9) states shall avoid harmful contamination of space.²⁵

Space law's general history has been seen as very similar to maritime law, where the main objective is a peaceful passage through unowned areas from vessels of all nations.²⁶ Additionally, the Outer Space Treaty is also seen as being comparable to the Antarctic Treaty system because of multiple international agreements holding up a non-militarized environment.²⁷ The Antarctic Treaty specifically recognized that the interest of mankind was for the Antarctic to be exclusively for peace and not become a scene or object of international discord.²⁸ While there is a solid baseline for the Outer Space Treaty, the issue arises concerning commercial activity by private companies.²⁹ When the Outer Space Treaty was created, it specifically regulated warfare, politics, and scientific discovery.³⁰ The Outer Space Treaty did not address the future of commerce within space.³¹ However, with companies increasing commercial and economic incentives for exploring outer space, there is a significant gap in the space laws currently being made.³²

While specifically looking at Article VI of the Outer Space Treaty, it states that a country party to the Treaty will have international responsibility for national activities within outer space.³³ Article VII adds to this by saying that state parties to this Treaty that launch objects into outer space are internationally liable for damages done to a separate state party.³⁴ While Article VI and VII appear to show how liability would work in the realm of space, these articles do not address what happens when private entities cause damage to another state.³⁵ Moreover, it is unclear if the state itself would be liable for any actions taken by its private citizens causing damage or if private citizens would themselves be held

²⁵ U.N. Office for Outer Space Affairs, *supra* note 18.

²⁶ *The Outer Space Treaty Turns 50*, *supra* note 21.

²⁷ *Id.*

²⁸ The Antarctic Treaty, Dec. 1, 1959, 12 U.S.T. 794, 402 U.N.T.S. 71.

²⁹ *The Outer Space Treaty Turns 50*, *supra* note 21.

³⁰ *See id.* (emphasizing the purpose of the treaty to be tailored towards military, science, and political questions).

³¹ *See id.* (indicating a lack of recognition on the management of commercial activity and actors in space).

³² *See id.* (explaining the reasons for the gaps in space law).

³³ Outer Space Treaty, *supra* note 6, art. VI.

³⁴ *Id.* art. VII.

³⁵ *Id.* arts. VI, VII.

responsible.³⁶ While some have suggested that the state should take the liability burden of private entities' negligence, this may not be plausible with the current increases in technology.³⁷ Furthermore, private companies from different countries may all have a stake in commercial outer space dealings.³⁸ Thus, Article VII of the Outer Space Treaty needs to be supplemented to understand how liability will be delegated.³⁹

B. Article VII Of the Outer Space Treaty in Action

The most significant international liability issue concerning Article VII of the Outer Space Treaty was the 1978 Soviet nuclear satellite crash in North Canada.⁴⁰ The Soviet satellite Cosmos 954 (also referred to as "Kosmos"), crashed near Great Slave Lake and scattered radioactive waste across 124,000 square kilometers.⁴¹ The areas within reach of this radioactive waste were the Northwestern territories of Alberta and Saskatchewan.⁴² Before the crash, maritime surveillance satellites noticed decay in the satellite's orbit almost immediately.⁴³ Cosmos 954 was powered by a nuclear reactor, which eventually led the Soviets to admit the satellite was out of control due to the radiation risk.⁴⁴ While the atomic reactor core was designed to be ejected into a higher orbit in emergency cases, the feature malfunctioned.⁴⁵ Though the Soviets admitted the satellite was out of control, they falsely claimed that Cosmos 954 had

³⁶ *Id.*

³⁷ *The Future*, NASA, <https://www.nasa.gov/specials/60counting/future.html> (last visited Apr. 16, 2022).

³⁸ See, e.g., Michael Sheetz, *Elon Musk, Defending the Value of Space Travel, Presents SpaceX's Starship as the 'Holy Grail'*, CNBC (Feb. 11, 2022, 11:44 AM), <https://www.cnbc.com/2022/02/11/elon-musk-spacexs-starship-is-solution-to-efficient-space-travel.html> (explaining how Musk claims the SpaceX program is necessary for "establishing security for life itself and . . . inspiring kids about the future").

³⁹ *Outer Space Treaty*, *supra* note 6, art. VII.

⁴⁰ See Craig Baird, *Kosmos 954*, CAN. HIST. EHX (Jan. 2, 2021), <https://canadaehx.com/2021/01/02/kosmos-954/> (reporting on the 1978 Russian Kosmos 954 satellite crash in North America which cost Canada \$14M to clean up and left radioactive fragments strewn about, killing at least one person and threatening thousands of others. The Soviet Union was billed \$6 million but only paid \$3 million).

⁴¹ *Id.*

⁴² *Id.*

⁴³ *Id.*

⁴⁴ *Id.*

⁴⁵ *Id.*

been destroyed from the “dense layers of the atmosphere” over Canada and that any satellite remains would pose a minimal radiation hazard.⁴⁶ In reality, some of the fragments from the satellite “proved to be of lethal radioactivity.”⁴⁷ This disaster ultimately led to a multiyear cleanup operation known as Operation Morning Light.⁴⁸ Luckily, the Morning Light team members concluded that they recovered ten percent of Cosmos 954 and kept the surrounding environment and community of the northwest territory from nuclear danger.⁴⁹ The clean-up led to the Canadian government requisitioning the Soviet Union to pay six million Canadian dollars for the clean-up.⁵⁰

This tragedy led to settlement claims between Canada and the Soviet Union of Soviet Socialist Republics for damages caused by Cosmos 954.⁵¹ Canada’s argument was under the liability convention, which was an elaboration of Article VII of the Outer Space Treaty.⁵² Canada claimed that based on the relevant international agreement of the 1972 Convention on International Liability for Damage Caused by Space Objects, to which both Canada and the Soviet Union were parties, the Soviet Union was liable.⁵³ Originally, the Soviets fought the claim made against them, but there was ultimately a settlement between the two countries that established a precedent for liability damage done by a spacecraft.⁵⁴ The ultimate

⁴⁶ Alexander F. Cohen, *Cosmos 954 and the International Law of Satellite Accidents*, 10 YALE J. INT’L L. 78, 81 (1984).

⁴⁷ *Id.*

⁴⁸ Steve Weintz, *Operation Morning Light: The Nuclear Satellite That Almost Decimated America*, NAT’L INT. (Nov. 23, 2015), <https://nationalinterest.org/feature/operation-morning-light-the-nuclear-satellite-almost-14411>.

⁴⁹ *Id.*

⁵⁰ *See id.* (explaining how Canada sought compensation for damages from the Soviet Union); *see also* Bryan Schwartz & Mark L. Berlin, *After the Fall: An Analysis of Canadian Legal Claims for Damage Caused by Cosmos 954*, 27 MCGILL L. J. 676, 678 (1982) (stating that while \$14 million in costs were incurred, only about \$6 million were collected by Canada from the Soviet Union for the clean-up).

⁵¹ Settlement of Claim between Canada and the Union of Soviet Socialist Republics for Damage Caused by ‘Cosmos 954’, Communiqué No. 27 Canadian Department of External Affairs (April 2, 1981) *reprinted in* SPACE LAW: BASIC LEGAL DOCUMENTS (Dr. Karl-Heins Bockstiegel et. al. eds, 8th ed. vol. 1 2005) [hereinafter SPACE LAW].

⁵² *Id.*; Convention on International Liability for Damage Caused by Space Objects, Mar. 29, 1972, 24 U.S.T. 2389, 1023 U.N.T.S. 15 [hereinafter Convention on Liability for Damage].

⁵³ *See* SPACE LAW, *supra* note 51.

⁵⁴ *See* Weintz, *supra* note 48.

settlement agreement was for three million Canadian dollars.⁵⁵ The protocol was ultimately signed by Canada's Ambassador Geoffrey Pearson and the USSR Deputy Minister N.S. Ryzhov.⁵⁶

The Outer Space Treaty eventually led to a settlement between Russia and Canada.⁵⁷ This was due to the well-laid-out provision within Article VII and its following conventions.⁵⁸ While the Outer Space Treaty was laid out well concerning government action, it is still questionable how liability issues with private companies would go in cases of disasters. For example, would the Chinese government be held accountable if one of China's private companies' robots were to crash back into Earth like Cosmos 954? What type of liability, if any, should private companies have? By examining the current maritime concepts against past space law concepts, we can see that maritime law is the perfect supplement for gaps in Article VII of the Outer Space Treaty.

C. *China And Asteroid Mining Robots*

Within the twenty-first century, China's innovation in space technology has become one of the strongest in the world.⁵⁹ China's plans for space exploration have included outlined priorities within space science, technology, and exploration.⁶⁰ The increase in space exploration comes with the hope of boosting innovation and supporting economic development.⁶¹ There is also increased pressure and ambition pushing China and other countries to create new technology to improve financial and commercial resources.⁶² For

⁵⁵ See SPACE LAW, *supra* note 51.

⁵⁶ Protocol between the Gov. of Can. and the Gov. of the Union of Soviet Socialist Republics, Can.-U.S.S.R. April 2, 1981, 20 I.L.M. 689.

⁵⁷ See Outer Space Treaty, *supra* note 6; see also SPACE LAW, *supra* note 51.

⁵⁸ See Outer Space Treaty, *supra* note 6, art. VII (establishing strict international liability for damages caused by launching objects into space).

⁵⁹ See Theresa Hitchens, *China Sprinting Ahead as a Space Power While US Lacks 'Urgency,' New Report Frets*, BREAKING DEF. (Aug. 25, 2022, 12:02 PM), <https://breakingdefense.com/2022/08/china-sprinting-ahead-as-a-space-power-while-us-lacks-urgency-new-report-frets/> (explaining that "China is now on track to outpace the United States as the leading space power by 2045").

⁶⁰ See Jones, *supra* note 3 (describing China's recent space exploration initiatives and projects).

⁶¹ See Hitchens, *supra* note 59 (referring to space as "an economic domain that is resource and opportunity rich").

⁶² See Rachel Riederer, *Silicon Valley Says Space Mining is Awesome and Will Change Life on Earth. That's Only Half Right.*, NEW REPUBLIC (May 19, 2014),

example, China's President Xi Jinping recently stated that China's "Space Dream" is to overtake other nations and become the leading space power by 2045.⁶³ China appears to have a specific interest in gaining more space power because, in the past, it was seen as weak in developing space technology.⁶⁴ However, China also has a goal that goes beyond achieving prestige and reputation.⁶⁵ China aims to establish a permanent space presence that would offer long-term economic advantages for the region.⁶⁶ Additionally, other countries have started expanding their space technology capacity to compete with more prominent countries that have historically had extensive space programs.⁶⁷

China has recently put its support behind asteroid mining.⁶⁸ Asteroid mining involves obtaining critical elements from asteroids.⁶⁹ These elements can include rare metals and common elements.⁷⁰ Asteroid mining is done through robots, where a robot is

<https://newrepublic.com/article/117815/space-mining-will-not-solve-earths-conflict-over-natural-resources> (suggesting that countries must look beyond land and water for resources, and rather into space, but only through technology and capital is that possible).

⁶³ Arjun Kharpal, *China Once Said it Couldn't Put a Potato in Space. Now it's Eyeing Mars*, CNBC (Jun. 29, 2021, 8:09 PM), <https://www.cnbc.com/2021/06/30/china-space-goals-ccp-100th-anniversary.html>.

⁶⁴ See *id.* (stating that China was not involved when the Soviets launched Sputnik).

⁶⁵ Namrata Goswami, *What China Wants in Outer Space*, *Global Forum*, CAIRO REV. GLOB. AFFAIRS (Apr. 23, 2019), <https://www.thecairoreview.com/global-forum/what-china-wants-in-outer-space/>.

⁶⁶ *Id.*

⁶⁷ See Kharpal, *supra* note 63 (outlining how the competition in space between China and the United States has caused Australia, Canada, Italy, Japan, Luxembourg, the United Arab Emirates, and the UK to get involved in space programs and agreements).

⁶⁸ See Ariel Cohen, *China's Space Mining Industry is Prepping for Launch – But What About the US?*, FORBES (Oct. 26, 2021, 11:40 AM), <https://www.forbes.com/sites/arielcohen/2021/10/26/chinas-space-mining-in-dustry-is-prepping-for-launch—but-what-about-the-us/?sh=368d83ac2ae0> (stating in April 2021, "China's Shenzhen Original Space Technology Co. Ltd. launched the NEO-1, the first commercial spacecraft dedicated to the mining of space resources").

⁶⁹ *Asteroid Mining, Mission 2016: The Future of Strategic Natural Resources*, MASS. INST. TECHN. [hereinafter *Asteroid Mining Mission*], <https://web.mit.edu/12.000/www/m2016/finalwebsite/solutions/asteroids.html> (last visited Jan. 21, 2023).

⁷⁰ *Id.*

sent into outer space and catches minerals with either a net or magnet.⁷¹ Asteroid mining has been chiefly seen within the private sector due to governments having difficulty safely investing in the technology.⁷² Origin Space is a leading example of the future with asteroid mining.⁷³ As a private Chinese company, Origin Space has shown that the potential for asteroid mining is within the future range.⁷⁴ Launching the first asteroid mining robot prototype, Origin Space has also created hope of mining for minerals outside of earth's atmosphere.⁷⁵

The hope of collecting minerals within outer space has raised issues about how outer space laws will apply. As private companies in China become more innovative, it is looking like China is becoming the next space superpower that will be subject to more technology competition from other countries.⁷⁶ With an increased number of robots in outer space comes the increased likelihood of an accident.⁷⁷ Moreover, the more private companies that send out asteroid mining robots, the less likely government agencies will have meaningful oversight of private projects.⁷⁸ Furthermore, this leads to the issue of whether government entities will be held liable for

⁷¹ Liangping Gao & Ryan Woo, *China Launches Robot Prototype Capable of Catching Space Debris with Net*, REUTERS (Apr. 27, 2021, 05:47 AM), <https://www.reuters.com/lifestyle/science/china-launches-robot-prototype-capable-catching-space-debris-with-net-2021-04-27/> (discussing how China launched the NEO-01 robot that scoops up debris left by other spacecraft with a net).

⁷² See *Asteroid Mining Mission*, *supra* note 69 (concluding the high start-up costs, risk, and long time-scales on investment returns makes it difficult for the government to invest in asteroid mining, therefore requiring funding from the private sector).

⁷³ Jones, *supra* note 3.

⁷⁴ Gao & Woo, *supra* note 71.

⁷⁵ See *id.* (noting that Origin Space hopes to achieve the first commercial mining of asteroids outside of Earth's atmosphere by 2045).

⁷⁶ Charlie Campbell, *From Satellites to the Moon and Mars, China is Quickly Becoming a Space Superpower*, TIME (July 17, 2019, 12:53 PM), <https://time.com/5623537/china-space/> (describing how China is close behind the U.S. and Russia, the leading space superpower countries, in developing private space companies).

⁷⁷ See *Space Debris and Human Spacecraft*, NASA (May 27, 2021), https://www.nasa.gov/mission_pages/station/news/orbital_debris.html.

⁷⁸ See generally Beatrice Copeland, *Question: Do You Need Permission to Launch a Rocket?*, DEKOOKTIPS (Apr. 7, 2022), <https://www.dekooktips.com/guide/question-do-you-need-permission-to-launch-a-rocket.html> (explaining how sending objects, such as a rocket, into outer space is not illegal; however, countries still have strict laws that require a permit to launch rockets into space).

private companies' negligence in outer space. Thus, an analysis is needed to figure out how to supplement the outer space treaty to ensure a clear distinction on how liability in space should be handled.

III. OUTER SPACE COLLISIONS AND MARITIME LAW

A. *Similarities Between the Ocean and Outer Space*

States should look at liability under maritime law to supplement Article VII of the Outer Space Treaty. Maritime law is a body of laws related to commerce and navigation at the high sea.⁷⁹ Maritime law would supplement Article VII of the Outer Space Treaty because of the similarities. Like the sea, outer space is unowned by any country and has its own laws that govern the area.⁸⁰ Moreover, the primary interaction likely to happen in space is through aircrafts meeting one another.⁸¹ Like a ship sailing through the sea, an aircraft will not come across any owned property or set of laws that govern the area.⁸² Instead, they will only have to navigate around other aircraft while reaching their destination safely.⁸³ Thus, privately owned aircrafts getting into collisions in space should be treated similarly to privately owned ships that get into collisions at sea.⁸⁴

⁷⁹ *Maritime Law: Introduction*, LOY. UNIV. NEW ORLEANS COLL. L., <https://lib-guides.law.loyno.edu/maritime> (last visited Apr. 17, 2022).

⁸⁰ See GlobalPost Writer, *No Man's Land: 3 Territories That are Still Unclaimed*, WORLD (June 26, 2013, 12:53 PM), <https://theworld.org/stories/2013-06-26/no-man-s-land-3-territories-are-still-unclaimed> (demonstrating that no country owns the moon according to the 1967 Outer Space Treaty).

⁸¹ But see Kashyap Vyas, *Is it Already Time to Have Laws for Outer Space?*, INTERESTING ENG'G (July 20, 2019, 2:41 AM), <https://interestingengineering.com/is-it-already-time-to-have-laws-for-outer-space> (explaining how spacecrafts are going to be interacting with one another).

⁸² But see *id.* (generalizing how outerspace is common property for everyone by using the moon as an example).

⁸³ See *generally id.* (comparing similar interactions of maritime life and spacecraft interactions).

⁸⁴ See *id.* (questioning whether the "collision in the Sea" law under maritime law is sufficient enough to be implemented in regards to outer space).

B. Private Party Negligence Overseas

Private party negligence overseas needs to be examined to understand how liability would work for private entities in space. Under maritime law, a party of a ship is only held liable for damages to another boat if a deficiency causes a vessel to collide with another or if there is a willful act on the part of the navigator.⁸⁵ Moreover, there is a presumption of fault when a moving ship collides with another fixed or properly moored vessel.⁸⁶ The burden of proving fault will usually lie with the moving boat.⁸⁷ When applying this definition of maritime liability to Article VII of the Outer Space Treaty, space ships owned by private entities could be held liable for negligence caused by their space vessel colliding with another.⁸⁸

While looking at private companies sending asteroid mining robots into space, implementing maritime law allows a better understanding of their potential liability.⁸⁹ For example, if an asteroid mining robot were to crash into a vessel due to negligence, then the navigator of that asteroid mining robot could be held liable.⁹⁰ Additionally, if an asteroid mining robot were to crash into a stationary area, there could be a presumption of liability towards the owner of the asteroid mining robot.⁹¹ Thus, maritime law concepts can easily supplement liability for private outer space vessels.

⁸⁵ *Limitation of Liability*, BRITANNICA [hereinafter *Limitation of Liability*], <https://www.britannica.com/topic/maritime-law/Limitation-of-liability#ref39242> (last visited Jan. 30, 2023) .

⁸⁶ *Id.*

⁸⁷ *Id.*

⁸⁸ See Outer Space Treaty, *supra* note 6, art. VII (explaining the distinctive features of limitations of liability for shipowners in cases of tort and contract claims and the consequences of implementing those features to private companies in the space industry since both industries are not controlled by any State).

⁸⁹ *Id.*

⁹⁰ See *Limitation of Liability*, *supra* note 85 (stating that a moving boat is held liable for their negligence in hitting a moored vessel); see also Outer Space Treaty, *supra* note 6, art. VII (comparing the liability of a moving boat under maritime law to a moving space vessel).

⁹¹ *Limitation of Liability*, *supra* note 85; see Outer Space Treaty, *supra* note 6, art. VII (providing another example of comparing maritime law to a moving space vessel).

IV. EXAMINATION OF ABSOLUTE LIABILITY VS. LIMITED LIABILITY

A. *Absolute Liability*

It could be argued that jurisdiction for private parties was sufficiently laid out in the 1972 Liability Convention.⁹² Per the Liability Convention of 1972, contracting States agreed to create absolute liability for damage on the surface of the earth and fault-based liability for States' damage caused elsewhere than on the surface of the world caused by a space object.⁹³ Under the Liability Convention, absolute liability imposes full legal responsibility for damages or injuries on the government without proof and regardless of the degree of negligence.⁹⁴ While the Liability Convention helped expand the meaning of Article VII of the Outer Space Treaty, it still does not address whether private companies would be held to the same standard.⁹⁵ Like the rest of the Outer Space Treaty, the Liability Convention only talked about countries' liability in the event of an accident by the government.⁹⁶ Additionally, applying absolute liability to private parties instead of the government may cause issues that decrease incentives to explore technology in space.⁹⁷

Based on the assumption that the way Article VII is currently written should apply in cases with private companies, absolute liability may apply to two incidents within space law. The first is by holding governments absolutely liable for their citizens' actions. Applying absolute liability to governments for accidents caused by their own citizens' space technology could lead to higher

⁹² *Contra* Rogers, *supra* note 9, at 757 (arguing that there are issues with the Convention's stipulations as to how liability is treated throughout space travel).

⁹³ Timothy G. Nelson, *Regulating the Void: In-Orbit Collisions and Space Debris*, 40 J. SPACE L. 105, 115 (2016).

⁹⁴ Convention on Liability for Damage, *supra* note 50, art. 2; *see, e.g., Absolute Liability*, COLLINS, <https://www.collinsdictionary.com/us/dictionary/english/absolute-liability> (last visited Apr. 15, 2022) (providing a general legal definition of absolute liability).

⁹⁵ Joel A. Dennerley, *State Liability for Space Object Collisions: The Proper Interpretation of 'Fault' for the Purposes of International Space Law*, 29 EUR. J. INT'L L. 281, 282-83 (2018).

⁹⁶ Convention on Liability for Damage, *supra* note 52, art. 3.

⁹⁷ *See* Guoyu Wang & Chao Li, *Applicability of the Liability Convention For Private Spaceflight*, SPACE: SCI. & TECH. (2021), <https://spj.sciencemag.org/journals/space/2021/9860584/> (arguing that it may be burdensome to impose heavy regulations regarding liability).

governmental restrictions.⁹⁸ Restrictions may make it harder for citizens to be innovative with technology and decrease realistic timelines to compete with other nations already ahead in space innovation.⁹⁹ Even worse, the government could ban citizens from sending their technology into space out of fear that the government will be held liable if there is an accident.¹⁰⁰ The government can ban citizens from sending materials into outer space under Article VI of the Outer Space Treaty, which requires government supervision and authorization to send materials into outer space.¹⁰¹ Thus, holding the government accountable for private companies' space technology disasters could cause a decrease in innovation and space explorations.¹⁰²

The second option is applying absolute liability to private actors. Transferring absolute liability for damage on the surface of the earth and fault-based liability for state damage caused elsewhere to private companies may discourage advancements in space technology.¹⁰³ Moreover, if private companies get into an accident

⁹⁸ See generally Camino Kavanagh, *New Tech, New Threats, and New Governance Challenges: An Opportunity to Craft Smarter Responses?*, CARNEGIE ENDOWMENT INT'L PEACE (Aug. 28, 2019), <https://carnegieendowment.org/2019/08/28/new-tech-new-threats-and-new-governance-challenges-opportunity-to-craft-smarter-responses-pub-79736> (explaining that countries have adopted new legislation to authorize and supervise resource extraction in space).

⁹⁹ See generally *id.* (discussing how there are serious challenges with new technological advances that create a risk of public safety, which ultimately leads to government regulations).

¹⁰⁰ See generally Morgan Smith, *Lunar Parking Permits: Do You Need Special Permission to Land Something on the Moon?*, SLATE (Sep. 20, 2007, 2:43 PM), <https://slate.com/news-and-politics/2007/09/do-you-need-special-permission-to-land-something-on-the-moon.html> (discussing how private companies in the United States are required to use the FAA "[t]o get a launch license" and "a company must prove that it could take financial responsibility if anything went wrong, and that its activities won't threaten foreign policy or national security interests").

¹⁰¹ See *id.* (explaining how under Article VI of the Outer Space Treaty of 1967, nongovernmental entities in space "require authorization" and "continuing supervision" of civilian actions in launching space materials).

¹⁰² See generally Kavanagh, *supra* note 97 (discussing how there are serious challenges with new technological advances that create a risk of public safety, which ultimately leads to government regulations).

¹⁰³ See generally Pam Karlan & Jonathan Zittrain, *Absolute and Strict Liability*, HARVARD L. H2O, <https://h2o.law.harvard.edu/playlists/2007> (July 20, 2015) (explaining how strict liability imposes a high burden on parties subject to it because they must pay damages when certain harm occurs regardless of fault or their efforts to prevent harm).

under this policy, they may be financially ruined.¹⁰⁴ Private companies do not have the same amount of resources as the government and thus would be hampered by liability.¹⁰⁵ For example, if private Chinese companies were forced under an absolute liability or fault-based liability policy, then those companies may be discouraged from creating and implementing space technology.¹⁰⁶ This would ultimately go against China and other countries' goal to reap the benefits of space exploration.¹⁰⁷

From total liabilities hindrance of space exploration, other options need to supplement Article VII of the Outer Space Treaty. These options include creating a limited liability system based on maritime law, outer space insurance regulations, and employers' insurance. Using the maritime method of limited liability and liability insurance for space companies would allow for more protection and economic opportunity.¹⁰⁸ Moreover, creating liability regulations for vessels, cargo, and employees will ensure that private companies have a baseline system to follow that will allow for coverage of lost property and employee injuries.¹⁰⁹ Thus, Article VII of the Outer Space Treaty should be supplemented with these methods to protect innovation and increase earth's overarching goal of space commerce.

¹⁰⁴ See generally James A. Henderson Jr., *Torts v. Technology: Accommodating Disruptive Innovation*, 47 ARIZ. ST. L.J. 1145, 1159 (2016) (discussing how American tort law accommodates new technological innovation by refusing to impose strict liability due to the risk of crushing liability).

¹⁰⁵ See John Norris & John Podesta, *The Role of the U.S. Government in Promoting Private-Sector Development Solutions*, CTR. AM. PROGRESS (Aug. 14, 2013), <https://www.americanprogress.org/article/the-role-of-the-u-s-government-in-promoting-private-sector-development-solutions-2/> (discussing U.S. government assistance in the public sector versus in the private sector).

¹⁰⁶ See Van C. Ernest, *Third Party Liability of the Private Space Industry: To Pay What No One Has Paid Before*, 41 CASE W. RESV. L. REV. 503, 505-06 (1991) (arguing that requiring private companies to carry certain liability policies can adversely affect future developments in the space industry).

¹⁰⁷ See generally Norris & Podesta, *supra* note 105 (providing examples of how private sector companies have successfully contributed to public health in Africa and India while simultaneously benefitting from these contributions).

¹⁰⁸ See *Limitation of Liability*, *supra* note 85 (explaining the benefits and privileges of limited liability in maritime law).

¹⁰⁹ *Id.*

B. Limited Liability

Due to the considerable skepticism about absolute liability for space accidents, Article VII of the Outer Space Treaty should be supplemented with limitations of liability.¹¹⁰ Under the Doctrine of Limited Liability, a shipowner is restricted to only the shipowner's interest in the vessel.¹¹¹ Through this doctrine and under maritime law, shipowners can limit their liability in respect to tort and other contract claims.¹¹² For shipowners, limited liability extends to appurtenances, equipment, freightage, and insurance proceeds.¹¹³ Additionally, depending on the country, the liability is limited based on the value of the ship and the ship's earnings during the act of negligence.¹¹⁴ The concept of limited liability for vessels at sea comes from the extraordinary hazards of seaborne commerce.¹¹⁵ It also protects shipowners from liability that would otherwise limit their likelihood of venturing out and creating a prosperous livelihood.¹¹⁶ Moreover, limited liability protects the personal interest of an investor from any wrongdoing of a corporation.¹¹⁷ Applying limited liability to outer space law, countries could create limited liability opportunities to companies sending out ships.¹¹⁸

While analyzing limited liability opportunities to private companies' interest in space exploration, we see that maritime law would help protect and encourage private companies within space

¹¹⁰ See generally *Marine Insurance*, BRITANNICA [hereinafter *Marine Insurance*], <https://www.britannica.com/topic/maritime-law/Marine-insurance> (last visited Apr. 15, 2022) (outlining the basic information, concepts, and limitations of liability in Maritime Insurance Law).

¹¹¹ *Doctrine of Limited Liability: Everything You Need to Know*, UPCOUNSEL [hereinafter *UPCOUNSEL*], <https://www.upcounsel.com/doctrine-of-limited-liability> (last visited Apr. 15, 2022).

¹¹² *Limitations of Liability*, *supra* note 85.

¹¹³ *UPCOUNSEL*, *supra* note 111.

¹¹⁴ *Limitations of Liability*, *supra* note 85.

¹¹⁵ See *Marine Insurance*, *supra* note 110 (explaining the various perils that are anticipated by hull and cargo insurance).

¹¹⁶ See *id.* (providing the downfalls and benefits of various types of Marine Insurances); see also Tereza Pultarova, *Do Space Tourists Really Understand the Risk They're Taking?*, SPACE.COM (Sep. 27, 2021), <https://www.space.com/space-tourism-risk-safety-regulations> (outlining the accountability and risks of the space tourism industry).

¹¹⁷ See *UPCOUNSEL*, *supra* note 111 (explaining the Doctrine of Limited Liability with respect to shipowner's interests).

¹¹⁸ See Rogers, *supra* note 9, at 756 (alluding to the notion that limited liability will encourage sea trade and travel participation).

exploration.¹¹⁹ For example, if China implemented limited liability opportunities for private asteroid mining robot companies, the private company would be less concerned about losing all its money due to an outer space accident.¹²⁰ This would allow outer space companies' assets to be protected and would encourage companies to send out more asteroid-mining robots.¹²¹ Moreover, creating limited liability opportunities for companies would allow for the protection of investors.¹²² Protection of investors for companies wanting to send out asteroid mining robots of other outer space vessels could increase investment for these technologies.¹²³ Thus, when analyzing the implementation of limited liability with China's private companies, we see an increased likelihood of innovation and investment that would help China reach its goal.¹²⁴

C. *The Unwarranted Skepticism on Limitations of Liability*

While limited liability would greatly supplement Article VII of the Outer Space Treaty, others have argued to the contrary. The unfortunate part about space flight is the hazards of space flight.¹²⁵ For example, if a mining robot were to crash from outer space and hit a metropolitan area, it could cost thousands of lives and millions of dollars' worth of damage. Additionally, critics against limited liability are concerned with who would be responsible in the case of

¹¹⁹ See *id.* (explaining how the application of maritime law will encourage private space exploration).

¹²⁰ See *Contracts 101: Limitation of Liability Clauses*, PROZIO, BROMBERG & NEWMAN (Nov. 29, 2021), <https://pbnlaw.com/contracts-101-limitation-of-liability-clauses>.

¹²¹ See *id.* (establishing that limiting liability for companies intending to mine asteroids could end up increasing asteroid-mining missions).

¹²² Adam Hayes, *Limited Liability Definition: How it Works in Corporations and Businesses*, INVESTOPEDIA (July 14, 2022), <https://www.investopedia.com/terms/l/limitedliability.asp>.

¹²³ Alex Gilbert, *Mining in Space is Coming*, MILKEN INST. REV. (Apr. 26, 2021), <https://www.milkenreview.org/articles/mining-in-space-is-coming>.

¹²⁴ Ariel Cohen, *China's Space Mining Industry Is Prepping For Launch – But What About The US?*, FORBES (Oct. 26, 2021), <https://www.forbes.com/sites/ariel-cohen/2021/10/26/chinas-space-mining-industry-is-prepping-for-launch—but-what-about-the-us/?sh=7b7c0ff62ae0> (establishing that the implementation of limited liability with Chinese companies could motivate them to innovate and invest in asteroid-mining missions).

¹²⁵ *Hazards of Space: How Satellite Missions can go Wrong*, CAPITOL (Sep. 25, 2018), <https://www.capttechu.edu/blog/hazards-of-space-how-satellite-missions-can-go-wrong>.

wrongdoing.¹²⁶ The blame under limited liability can be hard to place based on the corporate structure.¹²⁷ Moreover, the public may want a company to pay entirely for the damages done instead of being limited.¹²⁸ Although these concerns are warranted, the benefits of space exploration may outweigh potential accidents caused by a spacecraft.¹²⁹ The likelihood of a spacecraft causing significant damage at this point is still very minimal.¹³⁰ Additionally, the more innovation goes towards space exploration, the more likely the vessel will be safe.¹³¹ By hindering vessels through strict liability, companies will not be able to make the strides necessary to explore space and get minerals from other planets, as China plans to accomplish.¹³²

V. THE IMPORTANCE OF VESSEL AND CARGO INSURANCE

While the implementation of limited liability would be an asset to supplement Article VII of the Outer Space Treaty, insurance would also need to provide further protection to space vessels and cargo. Analyzing maritime law, insurance for cargo and containers can either further shield limited liability companies or supplement

¹²⁶ UPCOUNSEL, *supra* note 111.

¹²⁷ *Id.*

¹²⁸ See generally Western Bonime, *Should Companies Pay us When They Make Mistakes?*, MEDIUM (Mar. 6, 2019), https://medium.com/@contact_99928/should-companies-pay-us-when-they-make-mistakes-30dac8ab3f29 (discussing how the public wants companies to pay for mistakes made that could hurt consumers).

¹²⁹ See *Everyday Benefits of Space Exploration*, CAN. SPACE AGENCY, <https://www.asc-csa.gc.ca/eng/about/everyday-benefits-of-space-exploration/default.asp> (last visited Apr. 17) (linking to various articles on the benefits of space exploration).

¹³⁰ Stuart Clark, *Progress 59 Spacecraft: What are Your Chances of Being Hit by Falling Debris?*, GUARDIAN (May 17, 2015), <https://www.theguardian.com/science/across-the-universe/2015/may/07/progress-59-spacecraft-what-are-your-chances-of-being-hit-by-falling-debris>.

¹³¹ See, e.g., Daniel Oberhaus, *How NASA Certifies New Spacecraft Safe Enough for Humans*, WIRED (May 13, 2020, 7:00 AM), <https://www.wired.com/story/how-nasa-certifies-new-spacecraft-safe-enough-for-humans/> (explaining that innovation in space exploration encourages safer advancements).

¹³² See generally Henderson, *supra* note 103, at 1159 (explaining how some doctrines help to avoid discouraging innovation from crushing liability caused by strict scrutiny).

the Outer Space Treaty in itself.¹³³ While looking at maritime law, some countries have moved away from the limitation of liability and towards marine insurance.¹³⁴ Recognized as the earliest forms of insurance first created as early as the 14th century,¹³⁵ marine insurance covers damage and loss for ships, cargo, or any movable property while being transferred on the sea.¹³⁶ Like limitation of liability, marine insurance coverage protects ship owners and incentives them to continue doing commerce at sea.¹³⁷ Thus, if analogously applied to outer space vessels, private owners of space vessels would likely be protected and this protection could further encourage private companies to continue exploring space.

A. *English Marine Insurance Act*

The English Marine Insurance Act is an example of states implementing a comprehensive insurance code for vessels and their cargo.¹³⁸ Adopted in 1906, the Maritime Insurance Act was the first marine insurance code of its time.¹³⁹ The purpose of the Marine Insurance Act was to have insurance against maritime losses that were incident to marine adventure.¹⁴⁰ The Marine Insurance Act is also unique as it extends marine insurance to protect the insured against losses on inland waters or any land risks which may be incidental to a sea voyage.¹⁴¹ By making a comprehensive code for maritime losses, it allowed for more sea adventure due to having

¹³³ *Ocean Marine Insurance 101*, THIMBLE [hereinafter, THIMBLE], <https://www.thimble.com/small-business-insurance/ocean-marine-insurance> (last visited Feb. 22, 2023).

¹³⁴ *Admiralty & Maritime Law Guide*, BETANCOURT, VAN HEMMEN, GRECO & KENYON, <http://www.admiraltylawguide.com/insurance.html> (last visited Feb. 5, 2023).

¹³⁵ *Marine Insurance*, PERKINS COIE, <https://www.perkinscoie.com/en/insurance-recovery-resource-library-1/marine-insurance.html> (last visited Feb. 5, 2023).

¹³⁶ *Marine*, PRADHAN MANTRI FASAL BIMA YOJANA, <https://nationalinsurance.nic.co.in/en/marine> (last visited Feb. 5, 2023).

¹³⁷ THIMBLE, *supra* note 133.

¹³⁸ *The Outer Space Treaty Turns 50*, *supra* note 21.

¹³⁹ Graydon S. Staring & George L. Waddell, *Marine Insurance*, 73 TUL. L. REV. 1619, 1634 (1999).

¹⁴⁰ Marine Insurance Act, 1906 (Ch. 6 Edw 7 § 1) (U.K.) [hereinafter *Marine Insurance Act*].

¹⁴¹ *Id.* § 2.

more protection in the incidence of losses.¹⁴² Additionally, the English Marine Insurance Act encouraged other countries also to get their coverage to compete with English trade.¹⁴³

The history of the English Marine Insurance Act could ultimately help with the supplementation of Article VII of the Outer Space Treaty because it could give us background on how to properly create insurance codes that allow for protection not only while in outer space but also while outer space vessels are still within earth's atmosphere.¹⁴⁴ For example, if China had an outlined insurance code that allowed insurance agencies to cover damaged asteroid mining robots, companies could be more willing to send out more of this new technology into outer space.¹⁴⁵ Moreover, implementing an insurance code could allow for innovations created by companies to go into outer space with the promise of this new technology being covered in the event of an accident.¹⁴⁶ In addition, if China were to have a code, private companies' cargo could also be covered in cases of accidents.¹⁴⁷ This would mean that if a private company had retrieved valuable minerals and they were damaged on their way back to earth, the insurance could partially cover them.¹⁴⁸ Finally, suppose there was a code to supplement Article

¹⁴² See *id.* (discussing the extension of protection against risks incidental to sea voyage).

¹⁴³ See Leonidas Villigran, *The U.K. Insurance Act 2015: The Shift in Marine Insurance Warranties Regime*, VILAGRAN LARA ABOGADOS (Oct. 2, 2016), <http://www.villagranlara.com/the-uk-insurance-act-2015-the-shift-in-marine-insurance-warranties-regime/> (expressing the influence had on other countries by using the Marine Insurance Act as a guideline).

¹⁴⁴ See Grush, *supra* note 5 (expressing how the English Marine Act supports the Outer Space Treaty and its ability to provide protection through the liability associated with countries actions).

¹⁴⁵ See *generally Marine Insurance Act, supra* note 140 (arguing the willingness of companies to undergo activity protected by contracted insurance to indemnify the insured).

¹⁴⁶ See *generally id.* ("A contract of marine insurance is a contract whereby the insurer undertakes to indemnify the assured, in manner and to the extent thereby agreed, against marine losses, that is to say, the losses incidental to marine adventure").

¹⁴⁷ See *generally id.* ¶ 2 ("A contract of marine insurance may, by its express terms, or by usage of trade, be extended so as to protect the assured against losses on inland waters or on any land risk which may be incidental to any sea voyage").

¹⁴⁸ See *generally id.* ¶ 2 ("Where a ship in course of building, or the launch of a ship, or any adventure analogous to a marine adventure, is covered by a policy in the form of a marine policy, the provisions of this Act, in so far as applicable, shall apply thereto; but, except as by this section provided, nothing in this Act shall

VII of the Outer Space Treaty. In that case, it could help assure private Chinese companies that insurance agencies will not take advantage of them by outlining acceptable premium rates and outlining what insurance agencies are supposed to cover in the event of an accident.¹⁴⁹

B. Satellite Insurance

The English Marine Insurance Act is not the only indicator that an insurance code should be implemented to supplement Article VII of the Outer Space Treaty. Space insurance for satellites and vessels that orbit in earth's outermost sphere has been on the rise in multiple countries.¹⁵⁰ Space insurance has been rising due to increased space debris around the earth's orbit.¹⁵¹ This space debris is an issue, for it causes hazards for other companies' satellites and vessels that lay in earth orbit.¹⁵² While China and other countries who plan to send robots into deep outer space are at a decreased risk of colliding with one another, that will likely change as more countries decide to do space exploration.¹⁵³ In the past, governments would cover collateral damage in the event of a disaster during a commercial rocket launch.¹⁵⁴ However, with the increase in commercial space travel, the government cannot shield the potential liability of all private space crafts.¹⁵⁵ This increase in space travel and space liability is evidence that Article VII should be supplemented with a comprehensive baseline insurance code.¹⁵⁶ As more private

alter or affect any rule of law applicable to any contract of insurance other than a contract of marine insurance as by this Act defined").

¹⁴⁹ See *generally id.* at 1 (discussing how marine insurance protects against complete loss by allowing for losses incident to marine travel).

¹⁵⁰ Jackie Wattles, *Why on Earth Would a Company Offer Insurance for Space Travel?*, CNN Bus. (Sep. 15, 2018), <https://money.cnn.com/2018/09/15/technology/business/space-insurance-industry/index.html>.

¹⁵¹ *Id.*

¹⁵² *Id.*

¹⁵³ *Id.*; see also Cohen, *supra* note 68.

¹⁵⁴ See, e.g., Wattles *supra*, note 150 (discussing how three decades ago the U.S. government decided to cover collateral damage in cases of disaster during a commercial rocket launch).

¹⁵⁵ See, e.g., *id.* (discussing how the cost of space flight insurance covered by the U.S. government does not take into consideration the cost of a rocket or its valuable contents).

¹⁵⁶ See Alexander P. Reinert, *Updating the Liability Regime in Outer Space: Why Spacefaring Companies Should Be Internationally Liable for Their Space Objects*, 62 WM. & MARY L. REV. 325, 334 (2020) (defining Art. VII of the Outer Space

companies from separate states send vessels into outer space, the likelihood of accidents increases.¹⁵⁷ Moreover, having a baseline insurance code for all countries will allow a comprehensive system if a collision were to happen.¹⁵⁸

C. Criticism of Insurance for Space Vessels

While some believe that providing more insurance for outer space vessels is necessary, others say it is not feasible.¹⁵⁹ As outer space commerce rises, so does the likelihood of accidents within outer space.¹⁶⁰ Some insurance agencies may see the risk of space collision as too high and thus too expensive to cover.¹⁶¹ Space collisions will also increase as more private entities around the globe send commercial space vessels.¹⁶² Even as of now, it is said that some insurance agencies that offer satellite coverage are pulling back or exiting the market due to the increased risk of satellite liability.¹⁶³ Although this is a well-founded concern on its face, as the market increases in outer space commerce, insurers will likely be more inclined to include outer space insurance for vessels.¹⁶⁴ Moreover, even though the costs for collisions are high, as the market increases for outer space insurance, insurance agencies will receive

Treaty as an international agreement whereby member states are held liable for objects launched from their territories, which cause damage to other member state's space objects in orbit).

¹⁵⁷ Noor Zainab Hussain & Carolyn Cohn, *Launching into Space? Not so Fast. Insurers Balk at New Coverage*, REUTERS (Sept. 1, 2021, 3:55 PM), <https://www.reuters.com/lifestyle/science/launching-into-space-not-so-fast-insurers-balk-new-coverage-2021-09-01/>.

¹⁵⁸ See Reinert, *supra* note 156, at 347 (stating that implementing an international liability regime would promote global cooperation).

¹⁵⁹ See Hussain & Cohn, *supra* note 157 (explaining that as the amount of debris rapidly increases, it will inevitably cause space to become so crowded that entire orbits will be uninsurable).

¹⁶⁰ *Id.* (reasoning that as more debris and satellites enter space, the higher the potential is for collisions).

¹⁶¹ See *generally id.* (discussing the reasoning for insurance companies to begin declining coverage for satellites, largely basing their decisions on cost and risk).

¹⁶² Hussain & Cohn, *supra* note 157 (referring to a quote from Charles Wetton, the underwriting manager for space policies at Global Aerospace.).

¹⁶³ *Id.*

¹⁶⁴ Rachael Zisk, *As Satellites Launch More Frequently, can Space Insurers Keep up?*, FAST COMPANY (Nov. 7 2022), <https://www.fastcompany.com/90805667/as-satellites-launch-more-frequently-can-space-insurers-keep-up>.

multiple premiums from companies that would cover the cost of a damaged vessel.¹⁶⁵ Finally, space coverage thus far has been seen as a lucrative niche for insurers.¹⁶⁶ Insurers have, up to date, taken \$475 million in gross premiums to cover satellites, rockets, and uncrewed space flights in 2020 and only paid \$425 million in losses.¹⁶⁷ This data shows that premiums can cover accidents enough where insurers are not deterred from covering space vessels.¹⁶⁸

Like limited liability, insurance policies for outer space vessels can be easily implemented into the current space law system. If China implements a law where private companies can receive insurance for their outer space vessels, they will likely feel more protected and supported in their commercial space endeavors. This, in turn, would help China's goal to implement more space exploration because companies would not be discouraged by the possibility of accidents with other space vessels or with other objects outside of space. Thus, China and other countries would benefit from insurance options to private companies involved in commercial space exploration.

VI. MARITIME EMPLOYERS' LIABILITY

Limited Liability and vessel insurance would substantially change the protection of private companies as they invest in new space technologies; however, employees also need to be considered when adding supplements to the Outer Space Treaty. Unlike in the past, more objects are being sent into outer space.¹⁶⁹ As outer space commerce begins to expand, more humans will venture out of Earth's orbit.¹⁷⁰ While considering China, most may believe that employers' insurance would not apply since asteroid mining robots

¹⁶⁵ Jason Rainbow, *Connecting the Dots | Space Insurers Toast to Another Profitable Year*, SPACE NEWS (Jan. 20, 2023), <https://spacenews.com/connecting-the-dots-space-insurers-toast-another-profitable-year/>.

¹⁶⁶ Hussain & Cohn, *supra* note 157.

¹⁶⁷ *Id.*

¹⁶⁸ *See, e.g., id.* (explaining that "[s]pace premiums are 10-20 times aviation premiums").

¹⁶⁹ *See* Reinert, *supra* note 156, at 326 (describing the rapidization of space exploration and crowding).

¹⁷⁰ *See generally* *Space: Investing in the Final Frontier*, MORGAN STANLEY (July 24, 2020), <https://www.morganstanley.com/ideas/investing-in-space> (discussing how private space firms have been developing more space technologies with the hopes of having "manned landings on the moon").

do not have anyone aboard the vessel while in Outer Space;¹⁷¹ however, there may still be an issue in cases where ships with individuals onboard may need to retrieve or repair the robot.¹⁷² Additionally, as other countries gain new technology, they could make mining robots that require regular maintenance in outer space that can only be conducted by an outer space vessel operated by individuals.¹⁷³ In cases where individuals are needed to work in outer space on vessels, there becomes an increased issue of individuals being injured in their work.¹⁷⁴ Further, when individuals are injured while on an outer space vessel, companies can be held liable for personal injuries during an individual's work.¹⁷⁵ From increased workers' liability in outer space, Article VII of the Outer Space Treaty should adopt Maritime Employers liability concepts.¹⁷⁶

A. *Maritime Employers Liability*

Like maritime employees, outer space employees can be prone to many exposures that may cause injuries or illnesses.¹⁷⁷ Under Maritime Employers Liability ("MEL"), companies can provide

¹⁷¹ See R. P. Mueller & P. J. van Susante, *A Review of Extra-Terrestrial Mining Robot Concepts*, NASA, <https://ntrs.nasa.gov/api/citations/20120008777/downloads/20120008777.pdf> (last visited Jan. 30, 2023) (explaining that asteroid mining robots in space are remotely controlled by humans).

¹⁷² See, e.g., *NASA Astronauts Fix Robotic Arm on Space Station in Time to Grab Next Cargo Ship*, MINT (Oct. 21, 2017, 2:21 PM) [hereinafter *NASA Robotic Arm*], <https://www.livemint.com/Science/8czC5jhZrkI5EiWWE0xpeJ/Nasa-astronauts-fix-robotic-arm-on-space-station-in-time-to.html> (explaining how NASA's Joe Acaba and Randy Bresnki put the finishing touches on repairs done to the Canadarm 2 during a six-hour, spacewalk).

¹⁷³ *Id.* (explaining how "[t]here have been 10 spacewalks ... to repair and maintain the ISS, with nine outings by NASA and one by Russian Cosmonauts").

¹⁷⁴ See, e.g., Jonathan Hogeback, *7 Accidents and Disasters in Spaceflight History*, BRITANNICA, <https://www.britannica.com/list/7-accidents-and-disasters-in-spaceflight-history> (last visited Jan. 26, 2023) (discussing how Luca Parmito took on water as he was working outside the ISS and that, during his spacewalk, his helmet began to fill with liquid, making it impossible for him to hear or speak with other astronauts.).

¹⁷⁵ See *What is Maritime Employer's Liability Coverage?*, MERRIMAC MARINE INS., LLC [hereinafter MERRIMAC MARINE], <https://www.merrimacins.com/what-is-maritime-employers-liability-coverage/> (last visited Jan. 26, 2023).

¹⁷⁶ *Maritime Employers Liability Insurance*, ACCESSIBLE MARINE INS. [hereinafter MEL], <http://ami-ins.com/maritime-employers-liability/> (last visited Jan. 26, 2023) (discussing what maritime employees may sue their employers for, and what insurance typically covers for work-related injuries).

¹⁷⁷ See MERRIMAC MARINE, *supra* note 175.

solutions to employees after they have been injured or become ill at sea.¹⁷⁸ MEL covers two classes of employees: those on a vessel that is not yours and those who are on your vessel.¹⁷⁹ This allows both companies' clients to be protected and for the company itself to be protected.¹⁸⁰ Additionally, this coverage can protect companies in cases where tort-based claims are under admiralty law.¹⁸¹ In cases where companies do not provide MEL coverage for their employees, there becomes an increased risk of high legal fees and damages that will need to be paid.¹⁸² By having MEL coverage, companies protect themselves and individuals from unpredictable injuries and illnesses.¹⁸³

While applying MEL coverage to the Outer Space Treaty, it would help protect companies and future employees from unexpected legal and damage fees.¹⁸⁴ It would also safeguard prospective employees as well.¹⁸⁵ Covering outer space employees with liability insurance could also lead to an increased willingness of companies to invest in space exploration.¹⁸⁶ This is because employers will not be afraid of costs associated with injured employees while on an outer space vessel.¹⁸⁷ Moreover, outer space employment liability could help increase the willingness of prospective employees to go into outer space on privately owned vessels.¹⁸⁸ Employees will feel that the coverage protects them financially when

¹⁷⁸ *Id.*

¹⁷⁹ *Id.*

¹⁸⁰ *Id.*

¹⁸¹ *Id.*

¹⁸² See MEL, *supra* note 176 (discussing the damages MEL covers and that crew members are not restricted to statutory compensation, allowing them to sue for injuries during the course of their employment).

¹⁸³ MERRIMAC MARINE, *supra* note 175.

¹⁸⁴ See MEL, *supra* note 176.

¹⁸⁵ See *generally id.* (discussing how workers can be subject to litigation and may present unanticipated exposures).

¹⁸⁶ See, e.g., Van C. Ernest, *Third Party Liability of the Private Space Industry: To Pay What No One has Paid Before*, 41 CASE W. RESV. L. REV. 503, 506 (1991).

¹⁸⁷ *Id.* at 516 (discussing Congress's creation of the Commercial Space Launch Act, which limits the amount of insurance required, thus keeping the insurance companies from overextending themselves and preventing launch operators from paying the premiums for future launches in the event of a catastrophic accident).

¹⁸⁸ Ernest, *supra* note 181.

they are injured or become hurt while on an outer space mission.¹⁸⁹ Thus, outer space employment liability should be implemented in Article VII of the Outer Space Treaty to further space exploration and protect private companies and space employees.¹⁹⁰

B. *Maritime Labor Convention*

Another international method that China and other countries should look to when creating employment for private outer space companies is the Maritime Labor Convention ("MLC").¹⁹¹ The MLC was adopted by the International Labor Organizations ("ILO") International Labor Conference in 2006.¹⁹² Within the MLC, there is a set of international standards based on previous ILO maritime labor instruments.¹⁹³ The MLC specifically discusses "seafarers rights to decent conditions of work and creates conditions of fair competition for shipowners."¹⁹⁴ This convention is relevant because it is the most up-to-date model for conditions that could negatively affect seafarers.¹⁹⁵ By using the MLC as an example for outer space employment coverage, private companies will have a more recent and comprehensive code to follow in order to protect themselves and their employees.¹⁹⁶

C. *History Of Space Employment Insurance and Critics*

Looking at employers' insurance is essential not only because of current events but because of past ones as well. Governments have not provided their own insurance coverage for astronauts in

¹⁸⁹ See *id.* at 506 (explaining how the federal government implementing some type of third party liability would increase the market for international space launch).

¹⁹⁰ See *generally id.* at 518-19 (providing an overview of the general principles laid out in Article VII of the Outer Space Treaty and how liability was purposefully left broad for additional development).

¹⁹¹ See *ILO MLC Frequently Asked Questions*, INT'L CHAMBER SHIPPING, <https://www.ics-shipping.org/shipping-fact/ilo-mlc-frequently-asked-questions/> (last visited Feb. 6, 2023) (explaining what the Maritime Labor Convention is and how it was adopted by the International Labor Conference).

¹⁹² *Id.*

¹⁹³ *Id.*

¹⁹⁴ *Id.*

¹⁹⁵ *Id.*

¹⁹⁶ See *id.* (illustrating how the MLC is one comprehensive convention combining four maritime labor instruments).

the past. One notable example was the National Aeronautics and Space Administration (NASA) not carrying specific astronauts' coverage.¹⁹⁷ Instead, astronauts were eligible for standard insurance offered to military and federal personnel.¹⁹⁸ When looking at private companies, this is an issue because they will not provide them alternative insurance offered through the government.¹⁹⁹ Moreover, the example of NASA not carrying coverage for astronauts shows how far behind even the government is in providing security for individuals going into outer space.²⁰⁰ This exemplifies why Article VII of the Outer Space Treaty needs to be supplemented with an employee insurance code.

Although there is general support around outer space employment insurance, there still may be skepticism behind the idea.²⁰¹ This is mainly due to how much astronauts are paid for going out on adventures.²⁰² Since being an astronaut is a high-risk job, employers may want to give them more incentives.²⁰³ Furthermore, it could be argued that a specific code outlining insurance will not be needed, since employers will likely give astronauts insurance regardless as a way to retain quality employees.²⁰⁴ While employers

¹⁹⁷ See *NASA had no Special Insurance for Astronauts*, L.A. TIMES, (Feb. 10, 2003, 12:00 AM), <https://www.latimes.com/archives/la-xpm-2003-feb-10-na-insure10-story.html> (stating that astronauts were not afforded special life insurance through NASA but other military personnel or federal employees were eligible for standard life insurance).

¹⁹⁸ *Id.*

¹⁹⁹ See *id.* (stating there is a limit on life insurance benefits that NASA, as a private company, will provide astronauts and they are not provided insurance through the government).

²⁰⁰ See generally *id.* (noting that NASA did not carry life insurance coverage specifically for astronauts aboard the space shuttle Columbia).

²⁰¹ See Miriam Kramer, *Spaceflight is a Pre-existing Condition*, MASHABLE, <https://mashable.com/feature/nasa-astronaut-healthcare-congress> (last visited Feb. 11, 2023) (highlighting that NASA and outside organizations has advocated for comprehensive health insurance for astronauts).

²⁰² See, e.g., Dana Severson, *What are the Yearly Wages of a NASA Astronaut?*, CHRON, <https://work.chron.com/yearly-wages-nasa-astronaut-14918.html> (June 29, 2018) (discussing how civilian astronauts have a starting annual salary of \$66,000 and seasoned astronauts can make up to \$144,566).

²⁰³ See generally *The Truth About Safety Incentives*, EHS TODAY (Oct. 15, 2007), <https://www.ehstoday.com/safety/article/21912352/the-truth-about-safety-incentives> (presenting the philosophy that in order for workers to prioritize safety, they need to have an incentive to do so).

²⁰⁴ See *Pro and Cons: Offering Employment Benefits*, FINDLAW (Jan. 17, 2018), <https://www.findlaw.com/smallbusiness/employment-law-and-human->

will probably want to insure their employees as an incentive to stay in their high-risk positions, employers may not know what exactly should be covered. Injuries incurred in space are not the same as injuries incurred in a typical office space.²⁰⁵ Like the high seas, individuals are confined to small spaces for long periods.²⁰⁶ Astronauts are also subject to irregularities caused by the unique environment, affecting individuals differently while in space.²⁰⁷ An example of this is space adaptation syndrome, which is like seasickness, where someone's surroundings and visuals become impaired due to the constant sensation of being in motion.²⁰⁸ Thus, from space injuries being different from common workplace injuries, there should be a specific code for space employment insurance. Furthermore, this code should be based on maritime employment practices because of the similarities between maritime injuries and space injuries.

A code like maritime practices outlining outer space employment insurance should be used to supplement Article VII of the Outer Space Treaty. Due to the similarities in injuries of maritime employees and astronauts, maritime insurance policies would be a vital source in creating space employment insurance. Furthermore,

resources/pro-and-cons-offering-employee-benefits.html (arguing that comprehensive, health benefit packages help attract and retain quality workers).

²⁰⁵ See, e.g., Richard A. Sheuring et. al., *Musculoskeletal Injuries and Minor Trauma in Space: Incidence and Injury Mechanisms in U.S. Astronauts*, 80 AVIATION, SPACE, ENV'T MED. 117, 117 (Feb. 2009), <https://pubmed.ncbi.nlm.nih.gov/19198198/> (discussing how astronauts have sustained trauma and musculoskeletal injuries in space).

²⁰⁶ See e.g., Mark Matousek, *Cruise-ship Workers Describe the Tiny Cabins They Live in, Where Up to 4 Roommates can Share a Tight Space*, BUS. INSIDER (Dec. 27, 2019, 11:20 AM), <https://www.businessinsider.com/cruise-ship-workers-reveal-tiny-crew-cabins-they-live-in-2019-4> (explaining the likely similarities between living conditions in space travel and confined living quarters on the high seas); see *Social Isolation in Context*, NASA, <https://www.nasa.gov/hrp/social-isolation/in-context> (Mar. 24, 2020) (describing the six-bedroom sized area crew shares for six months on the International Space Station).

²⁰⁷ See Chelsea Gohd, *Getting Sick in Space: How Would NASA Handle an Astronaut Disease Outbreak?*, SPACE, <https://www.space.com/getting-sick-in-space-coronavirus-astronaut-health.html> (Mar. 23, 2020) (explaining how the unique stresses of space flight weaken astronauts' immune systems).

²⁰⁸ See P.A. Souvestre et al., *Reducing Incapacitating Symptoms During Space Flight: Is Postural Deficiency Syndrome an Applicable Model?*, NAT'L LIBR. MED (Aug. 2008), <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2577399/> (describing how astronauts often suffer from a sensation of being upside down in the first few days of orbital flight).

Outer Space employment insurance would allow more qualified employees to sign up for private companies' outer space commerce opportunities. These eligible employees would feel more protected and have better incentives to explore outer space commerce. Thus, Article VII of the Outer Space Treaty should supplement employment insurance based on maritime employment insurance concepts.

VII. LIMITED LIABILITY, VESSEL INSURANCE, AND EMPLOYMENT INSURANCE:
THE PERFECT TRIFECTA

Alone, maritime limited liability, vessel insurance, or employment insurance would be insufficient to create a comprehensive system for private space commerce. All three would need to be incorporated to supplement Article VII of the Outer Space Treaty. There is no mention of private companies within the Outer Space Treaty in its current form because it was written to avoid nuclear warfare and not towards future space commerce.²⁰⁹ Maritime limited liability, vessel insurance, or employment insurance are necessary because they protect different areas of private outer space liability. First, limited liability protects investors from accidents that are likely to occur during business.²¹⁰ Second, vessel and cargo insurance would cover the ship and any commodities on board in case of casualties or damage.²¹¹ Third, employment insurance would protect employees from injuries and accidents that happen during their course of business.²¹² Together, all three would create a veil needed to advance private companies' participation in space commerce and technology. Thus, the need for all three types of liability ideas is vital to ensure the future of private companies and to understand how they can be protected when investing in outer space technology.

In addition, this trifecta of liability should be modeled explicitly off maritime law. As discussed, outer space law is partially built off

²⁰⁹ See Rogers, *supra* note 9, at 746 (explaining how the treaty prohibits man made nuclear activity in outer space).

²¹⁰ *Id.* at 749.

²¹¹ *The Marine Insurance Act 1906*, UK P&I NEWS (Oct. 13, 2010) [hereinafter *Marine Insurance Act*], <https://www.ukpandi.com/news-and-resources/briefings/2010/the-marine-insurance-act-1906/>.

²¹² See MERRIMAC MARINE, *supra* note 175 (explaining the protections provided by maritime employer's liability insurance).

maritime concepts.²¹³ Moreover, traveling by space and by sea are similar in nature²¹⁴—for example, both travel in small quarters in unowned territories for an extended time in dangerous conditions.²¹⁵ Furthermore, maritime limited liability, vessel insurance, and employment insurance can easily be implemented into Article VII due to the underlying maritime concepts built into the Outer Space Treaty.²¹⁶ Thus, creating the baseline regulations of maritime limited liability, vessel insurance, and employment insurance would prevent further gaps within the Outer Space Treaty.²¹⁷ It would also allow for the protection of companies and employees who want to venture into space.

VIII. CONCLUSION

Maritime law concepts should supplement Article VII of the Outer Space Treaty. Specifically, creating space regulations based on maritime limited liability, vessel insurance, and employment insurance should be established. When looking at the underlying concepts of the Outer Space Treaty, we can see that they are directly related to maritime law.²¹⁸ Moreover, supplementing Article VII of the Outer Space Treaty with maritime law would better prepare countries for negligence actions in the case of negligence deriving

²¹³ Matthew Schaefer, *Analogues Between Space Law and Law of the Sea/International Maritime Law: Can Space Law Usefully Borrow or Adapt Rules From These Other Areas of Public International Law?*, 3 INT'L INST. SPACE L. 1, 1 (2012).

²¹⁴ See Paul D. Spudis, *Analogy for Space: Aviation or Seafaring?*, SMITHSONIAN MAG. (Apr. 13, 2012), <https://www.smithsonianmag.com/air-space-magazine/analogy-for-space-aviation-or-seafaring-66261521/> (noting the commonalities in operational styles between spaceflight and sea voyages).

²¹⁵ *Id.*

²¹⁶ See Rogers, *supra* note 9, at 741-42 (discussing the similarities of liability practices in maritime law and space law).

²¹⁷ See Spudis, *supra* note 214 (discussing the analogous operational styles of navies and outer space exploration including longer presence and larger crews); see also *Marine Insurance Act*, *supra* note 205 (describing the Marine Insurance Act of 1906, which includes total and partial loss, missing ships, ship abandonment, and more); see also MERRIMAC MARINE, *supra* note 151 (explaining maritime employer's insurance, who it covers, what it covers, and its applicability to admiralty law).

²¹⁸ See generally *The Outer Space Treaty Turns 50*, *supra* note 21 (drawing a connection between the Outer Space Treaty and Maritime law which attempts to guarantee all nations safe travel through waters).

from a private Chinese company.²¹⁹ Applying maritime liability and insurance options to private companies would also allow further innovation and protection.²²⁰ Furthermore, maritime law would allow Chinese companies and companies that are bound to follow in China's footsteps to understand better their options in the case of an accident derived from their technologies in outer space.²²¹ Thus, China and other countries would benefit from supplementing the Outer Space Treaty with the maritime law concepts of limited liability, vessel insurance, and employment insurance.

²¹⁹ See Limitation of Liability, *supra* note 84 (discussing theories of liability negligence on ships and in collisions between vessels); see also *The Outer Space Treaty Turns 50*, *supra* note 21 (mentioning concerns over maintaining peace in outer space in light of a Chinese hack into U.S. weather satellite networks several years ago).

²²⁰ See Rogers, *supra* note 9, at 757-59 (noting the benefits of the technology involved in space exploration, while also highlighting the concerns that costs of accidents will result in the hindrance of these advancements without the implementation of insurance policies).

²²¹ See generally *Marine Insurance Act*, *supra* note 205 (discussing how marine insurance protects against complete loss by allowing for losses incident to marine travel and adventures).