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Earth's First Line of Defense: Establishing Celestial Body- Based Planetary Defense Systems

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I. INTRODUCTION

Planetary defense refers to detecting, preventing, mitigating, or eliminating potential impacts of near-earth objects (NEOs) on Earth.¹ Planetary defense has been widely recognized as a legitimate mission that benefits all humankind since about the 1980s when scientists concluded that NEOs can potentially cause large-scale catastrophic consequences to Earth.² The legal issues surrounding planetary defense have become some of the main points of concentration for space law practitioners and scholars. However, current discussions and scholarship in this field have been limited to analyzing Earth-based planetary defense activities and have yet to address legal and policy issues related to the establishment of off-Earth planetary defense systems.

Establishing planetary defense systems on celestial bodies, such as the moon or Mars, provides advantages not inherent in Earth-based systems. For example, considering that the vast majority of NEOs are near-Earth asteroids in the “asteroid belt” located between Mars and Jupiter,³ which is more than 110 million miles from Earth,⁴ building such systems on Mars can help more timely detect and more effectively defend against threatening NEOs. Intercepting or deflecting potentially harmful asteroids further from Earth can also relieve concerns of accidental or incidental damage to Earth and mitigate risks of generating space debris around Earth. In fact, while current discussions on planetary defense are primarily focused on Earth-based operations, some scholars have already proposed to establish celestial body-based planetary defense capacities.⁵

Establishing off-Earth planetary defense systems pose some practical problems. It is hard to differentiate between a system used solely for planetary defense purposes and one that can be used for non-peaceful purposes

1. See, e.g., *What Is Planetary Defense?*, DART, <https://dart.jhuapl.edu/Mission/Planetary-Defense.php> (last visited Nov. 15, 2023).

2. David Morrison, *The Cosmic Impact Hazard*, in *PLANETARY DEFENSE: GLOBAL COLLABORATION* 15, 17 (Nicola Schmidt ed., 2019).

3. William Crowe, *What Are NEOs and the Technical Means and Constraints of Solar System Mapping?*, in *PLANETARY DEFENSE: GLOBAL COLLABORATION*, *supra* note 2, at 33, 34.

4. Matt Williams, *How Far is the Asteroid Belt from Earth?*, *UNIVERSE TODAY* (Aug. 10, 2016), <https://www.universetoday.com/130136/far-asteroid-belt-earth/#:~:text=In%20short%2C%20it%20is%20approximately,the%20prospect%20of%20asteroid%20mining.>

5. Nikola Schmidt et al., *The Multipurpose Lunar Base as a First-Line Biosphere Defense and as a Gateway to the Universe*, in *PLANETARY DEFENSE: GLOBAL COLLABORATION*, *supra* note 2, at 419.

against the Earth. In fact, it is highly likely that all systems and techniques that can be used for planetary defense missions can also be used for military operations.

Then there are legal concerns. The lawfulness of establishing and using such systems on celestial bodies is highly ambiguous. Whereas the legal aspects of planetary defense have increasingly become one of the hottest topics for space law practitioners and scholars following the establishment of the Ad-hoc Working Group on Legal Issues in the UN Space Mission Planning Advisory Group in 2016, current discussions and scholarship in this field have been largely limited to analyzing planetary defense activities on Earth and have yet to address specific legal challenges surrounding establishing and using such celestial body-based planetary defense systems. Besides the lack of attention from the international space law community, the current international space law provisions concerning the non-militarization of celestial bodies are a product of significant compromise between the Soviet Union and the United States and were drafted before the importance of planetary defense was globally recognized. Thus, there are vital inherent ambiguities and challenges in their application to effectively regulate the establishment and use of such systems.

Current space technology is not adequate for building either such systems or military facilities on celestial bodies. But with the return of great power competition, leading States have been increasingly focusing on investing in space, and many States and private companies have made plans and even timelines for moon or Mars settlement.⁶ In light of this, it can be expected that building planetary defense systems or other pure military facilities on celestial bodies will become possible in the immediate future. Thus, it is critical to address legal ambiguities and study how to prevent States from using planetary defense as a pretext to militarize celestial bodies.

This article seeks to facilitate that discussion. It will describe infrastructure established on celestial bodies to operate planetary defense activities as “celestial body-based planetary defense systems” (CBPDS). The article will first introduce the history and techniques of planetary defense and explain

6. See, e.g., Peter W. Singer & Thomas Corbett, *China “Colonizes” Space with Its First Rice Harvest*, DEFENSE ONE (Mar. 21, 2023), <https://www.defenseone.com/ideas/2023/03/china-colonizes-space-its-first-rice-harvest/384285/>; *Moon to Mars Architecture*, NASA, <https://www.nasa.gov/moontomarsarchitecture/> (last visited Nov. 15, 2023); Mike Brown, *SpaceX: Here’s the Timeline for Getting to Mars and Starting a Colony*, INVERSE (July 3, 2019), <https://www.inverse.com/article/51291-spacex-here-s-the-timeline-for-getting-to-mars-and-starting-a-colony>.

the unique advantages of using CBPDS to conduct planetary defense activities in Part II. Then, Part III will focus on discussing the legal challenges regarding the establishment and use of CBPDS and will make a proposal to (partly) solve them.

II. PLANETARY DEFENSE: PAST, PRESENT, AND FUTURE

A. History of Planetary Defense

Planetary defense has a relatively short history. Scientists did not become aware of the possibility that Earth might be negatively impacted by NEOs until about a century ago.⁷ And it was not until the 1980s, when the link between NEOs and the Cretaceous-Paleogene mass extinction was discovered, that scientists and the public regarded NEOs as potential existential threats to humankind and realized the importance of planetary defense.⁸ Initially, not all scholars agreed on recognizing planetary defense as a legitimate endeavor.⁹ From a scientific perspective, some pointed out the relatively low frequency of celestial collisions and argued that it was an unnecessary and unwise use of limited resources to study and test planetary defense techniques.¹⁰ Besides, from a political perspective, some neorealists criticized planetary defense as a source of “hidden power politics.”¹¹ They expressed the concern that planetary defense would lead superpowers or leading nations to turn small or underdeveloped States into their followers and thus deepen geopolitical division and even revive the Cold War international order.¹² Notwithstanding these critiques, which are only supported by a minority of scholars, planetary defense has been globally recognized as a legitimate mission whose benefits to humankind outweigh its potential negative impacts, and international efforts to study and coordinate planetary defense activities emerged in the 1990s.

On the UN level, the two most important actors are the United Nations Office for Outer Space Affairs and the United Nations Committee on the

7. Morrison, *supra* note 2, at 15.

8. *Id.* at 17.

9. Nikola Schmidt, *Introduction: Planetary Defense as the Unique Historical Opportunity to Shape Our Shared Destiny*, in PLANETARY DEFENSE: GLOBAL COLLABORATION, *supra* note 2, at 1, 2–4.

10. *Id.*

11. *Id.* at 4.

12. *Id.* at 2.

Peaceful Uses of Outer Space.¹³ In 1995, the Office for Outer Space Affairs organized the United Nations International Conference on Near-Earth Objects. The conference highlighted the importance of planetary defense and proposed an increase in the capability to monitor outer space.¹⁴ Four years later, the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space formally recommended and called for international cooperation in planetary defense.¹⁵ Then, in 2001, the Committee on the Peaceful Uses of Outer Space established an Action Team on Near-Earth Objects to coordinate current planetary defense efforts and propose steps for future endeavors.¹⁶ Following its establishment, the Action Team made many contributions and became one of the most critical actors in international discussions on planetary defense.¹⁷ One of its most important contributions was a recommendation made in 2013 that led to the establishment of the International Asteroid Warning Network¹⁸ and the Space Mission Planning Advisory Group.¹⁹

The International Asteroid Warning Network's primary function is to coordinate international efforts to detect, track, and characterize potentially hazardous NEOs.²⁰ In contrast, the Space Mission Planning Advisory Group's primary duty is to prepare for an international response to threatening NEOs.²¹ In discussing and preparing plans to deal with potentially hazardous NEOs, the importance of the legal aspects of planetary defense was noticed and highlighted. Thus, during its sixth meeting in February 2016, the Space Mission Planning Advisory Group established an ad-hoc working

13. See generally Romma Kofler, Daniel Garcia Yarnoz & Martin Stasko, *Near-Earth Objects and the United Nations*, in PLANETARY DEFENSE: GLOBAL COLLABORATION, *supra* note 2, at 139.

14. See generally John L. Remo, *Near-Earth Objects: The United Nations Conference*, 822 ANNALS OF THE NEW YORK ACADEMY OF SCIENCES 1 (1997).

15. Rep. of the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space, resol. I(1)(c)(iii), at 7–8, U.N. Doc. A/CONF.184/6 (Oct. 18, 1999).

16. Comm. on the Peaceful Uses of Outer Space, Rep. on the Work of its Forty-Fourth Session, U.N. Doc. A/56/20 (2001).

17. Kofler et al., *supra* note 13, at 140–41.

18. Comm. on the Peaceful Uses of Outer Space, Rep. of the Scientific and Technical Subcomm. on Near-Earth Objects, 2011–2012, ¶¶ 8, 33, U.N. Doc. A/AC.105/C.1/L.329 (Dec. 21, 2012).

19. *Id.* ¶¶ 9, 44.

20. *Our Mission*, INTERNATIONAL ASTEROID WARNING NETWORK, <https://iawn.net/index.shtml> (last visited Nov. 15, 2023).

21. SPACE MISSION PLANNING ADVISORY GROUP, <https://www.cosmos.esa.int/web/mpag> (last visited Nov. 15, 2023).

group of legal issues to specifically study the lawfulness of different means and methods of planetary defense under current international space law.²² Since then, planetary defense has increasingly become one of the hottest topics in international space law scholarship and has received intense attention from space law practitioners and scholars.²³ In 2020, the ad-hoc working group published a report that summarized legal issues that were the focal point of discussion within the international space law community.²⁴

Current discussions on the legal aspects of planetary defense can be classified into seven categories: (1) whether States have a duty to undertake planetary defense activities;²⁵ (2) whether States have a duty to share information about potentially threatening NEOs;²⁶ (3) the limits and scope of States' right

22. Line Drube, *SMPAG Ad-hoc Working Group on Legal Issues*, European Space Agency, COSMOS (Oct. 14, 2016), https://www.cosmos.esa.int/documents/336356/1197204/Drube_Ad-hoc_WG_legal_issues_2016-10-14.pdf/9319db47-21f0-4b55-a17f-f62f31721f5b.

23. E.g., LEGAL ASPECTS OF PLANETARY DEFENCE (Irmgard Marboe ed., 2021); Andrea Harrington, *National and International Security in Space: International Law Implications of Space Force and Planetary Defense*, 48 GEORGIA JOURNAL OF INTERNATIONAL & COMPARATIVE LAW 767 (2020); David A. Koplow, *Exoatmospheric Plowshares: Using A Nuclear Explosive Device for Planetary Defense Against an Incoming Asteroid*, 23 UCLA JOURNAL OF INTERNATIONAL LAW & FOREIGN AFFAIRS 76 (2019); James A. Green, *Planetary Defense: Near-Earth Objects, Nuclear Weapons, and International Law*, 42 HASTINGS INTERNATIONAL & COMPARATIVE LAW REVIEW 1 (2019); Ram S. Jakhu & Joseph N. Pelton, *Cosmic Hazards and Planetary Defense*, in GLOBAL SPACE GOVERNANCE: AN INTERNATIONAL STUDY 417 (Ram S. Jakhu & Joseph N. Pelton eds., 2017). While relatively sparse, there were also some discussions on the legal aspects of planetary defense before the establishment of the ad-hoc working group. See, e.g., Fabio Tronchetti, *International Legal Consideration of Cosmic Hazards and Planetary Defense*, in HANDBOOK OF COSMIC HAZARDS AND PLANETARY DEFENSE 1027 (Joseph N. Pelton & Firooz Allahdadi eds., 2015); FRANS VON DER DUNK ET AL., LEGAL ASPECTS OF NEO THREAT RESPONSE AND RELATED INSTITUTIONAL ISSUES (Feb. 9, 2010), https://swfoud.org/media/40426/legal_aspects_neo_response_institutional_issues_final_report.pdf; Evan R. Seamone, *The Precautionary Principle as the Law of Planetary Defense: Achieving the Mandate to Defend the Earth Against Asteroid and Comet Impacts While There is Still Time*, 17 GEORGETOWN INTERNATIONAL ENVIRONMENTAL LAW REVIEW 1 (2004); John C. Kunich, *Planetary Defense: The Lawfulness of Global Survival*, 41 AIR FORCE LAW REVIEW 119 (1997).

24. LINE DRUBE ET AL., PLANETARY DEFENCE LEGAL OVERVIEW AND ASSESSMENT (Apr. 8, 2020), https://www.cosmos.esa.int/documents/336356/336472/SMPAG-RP-004_1_0_SMPAG_legal_report_2020-04-08.pdf.

25. E.g., Cordula Steinkogler, *Rules of International Law Regarding an Obligation of States to Undertake Planetary Defense Activities*, in LEGAL ASPECTS OF PLANETARY DEFENCE, *supra* note 23, at 174.

26. E.g., Irmgard Marboe, *International Law Rules Related to the Sharing of Information About Potential NEO Threats*, in LEGAL ASPECTS OF PLANETARY DEFENCE, *supra* note 23, at 149.

to undertake planetary defense activities;²⁷ (4) the lawfulness of using nuclear weapons for planetary defense;²⁸ (5) State liability for causing incidental or accidental harm to another State when conducting planetary defense activities;²⁹ (6) international bodies and procedures concerning planetary defense;³⁰ and (7) the intersection between commercial space activities and planetary defense.³¹ While there have been diverse and abundant discussions about legal aspects of planetary defense, these discussions have been limited to analyzing planetary defense activities on Earth and have yet to address the complex and unique legal challenges concerning the establishment and use of CBPDS in planetary defense activities.

B. Planetary Defense Techniques

Since the lawfulness of a particular planetary defense activity can be influenced by the means and methods adopted,³² it is helpful to have a basic grasp of different planetary defense techniques that are currently under development. To begin with, planetary defense techniques can be classified into passive and active techniques. Passive planetary defense techniques do not require active intervention of a NEO's orbit and include detection systems, warning systems, evacuation systems, etc. Passive techniques can be critical for the success of planetary defense. For example, warning and evacuation

27. E.g., Setsuko Aoki, *The Use of Force and Planetary Defence*, in LEGAL ASPECTS OF PLANETARY DEFENCE, *supra* note 23, at 209, 217.

28. E.g., David A Koplou, *Legal Aspects of the Use of Nuclear Explosive Devices in Planetary Defence*, in LEGAL ASPECTS OF PLANETARY DEFENCE, *supra* note 23, at 226; Jack M. Beard, *Nuclear Non-Proliferation and Planetary Defence*, in LEGAL ASPECTS OF PLANETARY DEFENCE, *supra* note 23, at 246; Koplou, *Exoatmospheric Plowshares*, *supra* note 23; Green, *supra* note 23.

29. E.g., Alexander Soucek, *The Current International Space Law Regime on Liability and Its Application to Planetary Defence*, in LEGAL ASPECTS OF PLANETARY DEFENCE, *supra* note 23, at 286; Henry Hertzfeld, *Critical Issues and Future Perspectives on Liability in the Context of Planetary Defence*, in LEGAL ASPECTS OF PLANETARY DEFENCE, *supra* note 23, at 313.

30. E.g., Olavo de Oliveira Bittencourt Neto, *International Bodies and Procedures for Decision-Making Regarding Planetary Defence Actions*, in LEGAL ASPECTS OF PLANETARY DEFENCE, *supra* note 23, at 371.

31. E.g., Peter Stubbe, *The Involvement of Private Actors in Planetary Defence Missions*, in LEGAL ASPECTS OF PLANETARY DEFENCE, *supra* note 23, at 354.

32. E.g., Koplou, *Exoatmospheric Plowshares*, *supra* note 23, at 111–17 (arguing that it is generally illegal to use nuclear devices to conduct planetary defense activities, but using gravity tractors is generally legal).

systems can effectively deal with relatively small NEOs.³³ Besides, since there are more than fifteen thousand known NEOs,³⁴ and since many NEOs are constantly changing so that non-threatening ones can become threatening in the future,³⁵ an effective detection system is necessary for successful planetary defense. However, because passive techniques are unlikely to cause severe legal problems, they are not the focus of our discussion.

Instead, what is more relevant for our discussion is active planetary defense techniques, which are used to “deflect the asteroid . . . or break it up far enough from Earth that the debris are dispersed and miss the planet.”³⁶ There are many kinds of active planetary defense techniques and different ways to classify them. For the purpose of our discussion, an insightful classification is to classify them into (1) impulsive techniques and (2) slow push/pull techniques.³⁷

Impulsive techniques work by imposing a “strong but short-lived force” on a NEO to “cause a sudden change in its orbits, or possibly intentionally break it up, depending on its size.”³⁸ The two most important impulsive techniques are kinetic impactors and conventional explosives. Kinetic impactors work by sending one or more large, high-speed spacecraft into the path of an approaching near-earth object to deflect it away from the Earth’s orbital path.³⁹ While using a kinetic impactor to deflect a threatening NEO can lead to fragmentation risks, it is currently the most well-studied and promising planetary defense technique.⁴⁰ In the United States, the National Aeronautics and Space Administration (NASA) has devoted a lot of resources to studying kinetic impactor techniques. It cooperated with the Aerospace Corporation and developed a NEO deflection application to study

33. David Morrison, *Overview of Active Planetary Defense Methods*, in PLANETARY DEFENSE: GLOBAL COLLABORATION, *supra* note 2, at 113.

34. Crowe, *supra* note 3, at 34.

35. *Id.* at 33.

36. Morrison, *supra* note 33, at 113.

37. Alan Harris, *Planetary Defence Technologies*, in LEGAL ASPECTS OF PLANETARY DEFENSE, *supra* note 23, at 35. For the potential legal relevance of this classification, *see infra* notes 183–185 and accompanying text.

38. *Id.* at 36.

39. *See NASA Invites Media to Launch of Double Asteroid Redirection Test*, NASA (Oct. 4, 2021), <https://www.nasa.gov/news-release/nasa-invites-media-to-launch-of-double-asteroid-redirection-test/>.

40. Kohei Yamaguchi & Hiroshi Yamakawa, *Visualization of Kinetic-Impact Effectiveness for Asteroid Deflection Using Impact-Geometry Maps*, 55 JOURNAL OF SPACECRAFT & ROCKETS 1181 (2018).

hypothetical scenarios and analyze quantitatively the potential uses and restrictions of kinetic impactors.⁴¹ Recently, it has successfully used a kinetic impactor to alter the orbit of the Dimorphos asteroid, which represents the first time in human history that the motion of an asteroid was purposively and successfully changed.⁴² Besides kinetic impactors, it is also possible to use traditional explosive weapons, including nuclear devices, to conduct planetary defense operations.⁴³ While using conventional explosives has clear drawbacks and can cause a more severe risk of fragmentation, they can be the last resort when facing a sudden threat of a large NEO.⁴⁴

Unlike impulsive techniques, slow push/pull techniques work by imposing a “weak but long-lived force to cause a gradual acceleration or deceleration” of a NEO.⁴⁵ The two most-discussed slow push/pull techniques are gravity tractors and direct energy. Gravity tractor techniques work by sending spacecraft to fly alongside the asteroid for a long period of time (years to decades) and slowly pull it out of Earth’s path.⁴⁶ Direct energy techniques change a NEO’s trajectory by sending high-power lasers to melt and vaporize certain materials in the NEO.⁴⁷

41. See generally Nahum Melamed, *NASA NEO Deflection Application: Current Capacities and Limitations*, in PLANETARY DEFENSE: GLOBAL COLLABORATION, *supra* note 2, at 123.

42. Roxana Bardan, *NASA Confirms DART Mission Impact Changed Asteroid’s Motion in Space*, NASA (Oct. 11, 2022), <https://www.nasa.gov/press-release/nasa-confirms-dart-mission-impact-changed-asteroid-s-motion-in-space>.

43. Lawrence Livermore National Laboratory, *Planetary Defense: Nuclear Explosion Can Disrupt Hazardous Asteroid To Protect the Earth*, SCITECHDAILY (Oct. 27, 2021), <https://scitechdaily.com/planetary-defense-nuclear-explosion-can-disrupt-hazardous-asteroid-to-protect-the-earth/>.

44. *Id.*

45. Harris, *supra* note 37, at 36.

46. See *Asteroid Redirect Mission Planetary Defense Demonstration*, NASA (Mar. 25, 2015), <https://www.nasa.gov/image-article/asteroid-redirect-mission-planetary-defense-demonstration/>.

47. Philip Lubin & Gary B. Hughes, *Directed Energy for Planetary Defense*, in HANDBOOK OF COSMIC HAZARDS AND PLANETARY DEFENSE 941, 941 (Joseph N. Pelton & Firooz Allahdadi eds., 2015).

C. CBPDS and the Future of Planetary Defense

Planetary defense activities can be conducted through (1) an Earth-based system, (2) an orbital station, or (3) a CBPDS.⁴⁸ While most current discussions on planetary defense are limited to Earth-based operations, some scholars have noticed the possibility and advantages of establishing and using CBPDS to conduct planetary defense activities.⁴⁹ For example, some scholars recently proposed establishing a “multipurpose lunar base” that is capable of conducting planetary defense operations with laser techniques.⁵⁰ They noted that Earth-based planetary defense can have limitations; thus, it can be expected that nuclear devices must be used under certain circumstances if we only have Earth-based planetary defense systems.⁵¹ However, there are always inherent risks that using nuclear devices can lead to international political destabilization.⁵² Thus, they argued that establishing a moon-based planetary defense system equipped with lasers can promote international security.⁵³

Another advantage of CBPDS concerns effectiveness. To begin with, since Earth’s atmosphere can partially or fully obstruct many wavelengths and distort the images observed,⁵⁴ using CBPDS can more precisely and effectively detect and monitor potentially harmful NEOs by bypassing Earth’s atmosphere. Second, with the rapid development of low earth orbit satellites, Earth’s orbit will get increasingly crowded.⁵⁵ On the one hand, these satellites might negatively impact the operation of Earth-based planetary defense systems. On the other hand, using Earth-based planetary defense systems can also risk harming these satellites. Using CBPDS, in contrast, can substantially

48. Chris Flaherty, *Planetary Defence Concepts*, SPACE & DEFENSE (Aug. 23, 2021), [https://spaceanddefense.io/planetary-defence-concepts/#:~:text=There%20are%20three%2Dways%20to,\(3\)%20An%20Asteroid%2DBased](https://spaceanddefense.io/planetary-defence-concepts/#:~:text=There%20are%20three%2Dways%20to,(3)%20An%20Asteroid%2DBased).

49. *E.g.*, Schmidt et al., *supra* note 5.

50. *Id.*

51. *Id.* at 420–23; *see also* Thomas J. Ahrens & Alan W. Harris, *Deflection and Fragmentation of Near-Earth Asteroids*, 360 NATURE 429, 429–33 (1992).

52. Schmidt et al., *supra* note 5, at 420–23.

53. *Id.*

54. Peter Veres, *Vision of Perfect Observation Capacities*, in PLANETARY DEFENSE: GLOBAL COLLABORATION, *supra* note 2, at 95, 104.

55. *E.g.*, *Low-Earth Orbits Are Getting Crowded*, THE EUROPEAN SPACE AGENCY (Apr. 22, 2022), https://www.esa.int/ESA_Multimedia/Images/2022/04/Low-Earth_orbits_are_getting_crowded.

reduce the likelihood of accidental and incidental damage to Earth and mitigate the risks of generating space debris around Earth. Third, since most NEOs are asteroids in the asteroid belt, which is between Mars and Jupiter and more than 110 million miles away from Earth,⁵⁶ establishing CBPDS on Mars or other nearby celestial bodies can help more timely detect and more effectively defend against threatening NEOs.

Additionally, it is likely that a moon or even a Mars settlement will become a reality in the foreseeable future as many States have already begun working on outer space settlement. NASA's Artemis program⁵⁷ and the European Space Agency's Moon Village Project⁵⁸ are examples of highly promising plans currently underway. When the scale of outer space colonies reaches a certain degree, it can be expected that the mission of planetary defense will expand to not only protect Earth but also these colonies from threatening NEOs. At that time, building and using CBPDS might become a necessary and natural choice for successful planetary defense.

III. CBPDS UNDER CURRENT INTERNATIONAL SPACE LAW

The need for developing international space law first emerged in the 1950s after the Soviet Union launched Sputnik I in 1957, which triggered international concerns that outer space might be militarized and controlled by a few powerful States.⁵⁹ On December 13, 1958, the United Nations General Assembly voted to establish the United Nations Committee on the Peaceful Uses Of Outer Space,⁶⁰ which became the "principal multilateral body involved in the development of international space law."⁶¹ In 1962, the Committee created a legal subcommittee preparing for the establishment of an

56. Williams, *supra* note 4.

57. *Artemis*, NASA, <https://www.nasa.gov/specials/artemis/> (last visited Nov. 15, 2023).

58. Muaz Emre, *Moon Village, The First Self-Sufficient Lunar Masterplan by SOM and ESA*, PARAMETRIC ARCHITECTURE (June 25, 2022), <https://parametric-architecture.com/moon-village-by-som-and-esa/#:~:text=Moon%20Village%20is%20a%20collaborative,settleme nt%20on%20the%20lunar%20surface%E2%80%9D>.

59. See generally John Myers, *Extraterrestrial Property Rights: Utilizing the Resources of the Final Frontier*, 18 SAN DIEGO INTERNATIONAL LAW JOURNAL 77, 92–100 (2016).

60. Sergio Marchisio, *The Evolutionary Stages of the Legal Subcommittee of the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS)*, 31 JOURNAL OF SPACE LAW 219, 220 (2005).

61. Steven Freeland, *Overview of Current International Space Law in the Context of Planetary Defence*, in LEGAL ASPECTS OF PLANETARY DEFENCE, *supra* note 23, at 109, 112.

international treaty on outer space.⁶² After several intense international sessions and negotiations, the Outer Space Treaty (OST)⁶³ was signed by over fifty States, including the United States, USSR, and United Kingdom, on January 27, 1967.⁶⁴

The OST lays out the most fundamental principles of international space law and has been described as the “constitution” of outer space.⁶⁵ Following the establishment of the OST, many other space treaties have been established to cover more detailed areas of space activities.⁶⁶ Together, these treaties constitute the “major source” of international space law.⁶⁷ Article III of the OST requires States to carry out space activities “in accordance with international law, including the Charter of the United Nations.”⁶⁸ Thus, customary international law and treaties on other subject matter like the law of armed conflict, nuclear non-proliferation, and arms control, can also play an important role in the discussion of the lawfulness of activities in outer space.

Notwithstanding the rich and diverse sources of international space law, for the purpose of our discussion there exists only one most essential source—Article IV of the OST—which is the core provision in preventing arms races and promoting peaceful uses of outer space. Article IV comprises two paragraphs. The first paragraph lays out a specific prohibition of nuclear weapons and weapons of mass destruction: “States Parties to the Treaty undertake not to place in orbit around the Earth any objects carrying nuclear weapons or any other kinds of weapons of mass destruction, install such weapons on celestial bodies, or station such weapons in outer space in any other manner.”⁶⁹ In the planetary defense context, this prohibition has been

62. Marchisio, *supra* note 60, at 223.

63. Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, Jan. 27, 1967, 18 U.S.T. 2410, T.I.A.S. No. 6347, 610 U.N.T.S. 205 [hereinafter Outer Space Treaty].

64. Marchisio, *supra* note 60, at 225–27.

65. *E.g.*, Tanja Masson-Zwaan & Richard Crowther, *Legal and Regulatory Issues*, in *THE INTERNATIONAL HANDBOOK OF SPACE TECHNOLOGY* 657 (Malcolm Macdonald & Viorel Badescu eds., 2014).

66. Some of most important treaties include: Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space, Dec. 3, 1968, 19 U.S.T. 7570 (Rescue Agreement); Convention on International Liability for Damage Caused by Space Objects, Mar. 29, 1972, 24 U.S.T. 2389 (Liability Convention); Convention on Registration of Objects Launched into Outer Space, Jan. 14, 1975, 28 U.S.T. 695 (Registration Convention).

67. FRANCIS LYALL & PAUL B. LARSEN, *SPACE LAW: A TREATISE* 36–38 (2018).

68. Outer Space Treaty, *supra* note 63, art. III.

69. *Id.* art. IV.

the focal point of discussions about the lawfulness of using nuclear weapons to deflect threatening NEOs.⁷⁰ However, this paragraph is not particularly important for this article's discussion because the text makes it clear that it does not make any legal difference whether nuclear weapons or other weapons of mass destruction are installed and stationed in CBPDS or elsewhere in outer space.

Instead, the focal point of this article and the more important clause for our discussion is the second paragraph of Article IV, which provides that:

The moon and other celestial bodies shall be used by all States Parties to the Treaty exclusively for peaceful purposes. The establishment of military bases, installations and fortifications, the testing of any type of weapons and the conduct of military maneuvers on celestial bodies shall be forbidden. The use of military personnel for scientific research or for any other peaceful purposes shall not be prohibited. The use of any equipment or facility necessary for peaceful exploration of the moon and other celestial bodies shall also not be prohibited.⁷¹

Applying this clause to analyze the lawfulness of CBPDS, five issues arise:

- (1) What does the term “exclusively for peaceful purposes” mean? Does the establishment of CBPDS per se violate this clause?
- (2) Is a CBPDS a “military base, installation, or fortification”?
- (3) Will the test of any particular planetary defense technique through CBPDS be regarded as prohibited testing of weapons?
- (4) Does the use of CBPDS to conduct planetary defense operations constitute “conduct of military maneuvers”?
- (5) If the establishment or use of CBPDS violates any of these clauses, can it nevertheless be legal according to the last sentence of Article IV because it is “necessary for peaceful exploration of the moon and other celestial bodies”?

Sections A–E will separately consider these five issues. The analysis will follow customary treaty interpretation methods⁷² as reflected in Articles 31

70. *See supra* note 28 and accompanying text.

71. Outer Space Treaty, *supra* note 63, art. IV.

72. *See, e.g.*, Case Concerning the Arbitral Award of 31 July 1989 (Guinea-Bissau v. Sen.), Judgment, 1991 I.C.J. 53, 69–70 (Nov. 12) (holding Articles 31 and 32 of the Vienna Convention on the Law of Treaties are customary international law).

and 32 of the Vienna Convention on the Law of Treaties.⁷³ Article 31 requires first analyzing the “ordinary meaning” of the text, the context, subsequent agreement between State parties, subsequent practice in the application of the treaty, and other applicable international laws.⁷⁴ If relying on these sources does not lead to an unambiguous interpretation or causes manifestly absurd or unreasonable outcomes, Article 32 allows reference to “supplementary means of interpretation, including the preparatory work of the treaty and the circumstances of its conclusion.”⁷⁵ Our analysis will also discuss related scholarly articles and discussions. Additionally, since the above sources are not enough to solve all problems, other areas of law, especially the law of armed conflict, will also be examined to guide our analysis.

Besides substantive legal issues about CBPDS, Section F will consider oversight mechanisms under international space law. This is critical because, considering the likely dual-use nature of CBPDS, the mission of avoiding arms races and militarization of celestial bodies will be substantially jeopardized unless there exists an effective international oversight mechanism that can ensure that CBPDS is established and used solely for peaceful purposes.

A. Exclusively for Peaceful Purposes

As it is in many other international treaties that deal with *res communis*, the term “peaceful purpose” is included in the OST and shows up four times. On the one hand, the preamble of the OST recognizes “the common interest of all mankind in the progress of the exploration and use of outer space for peaceful purposes”⁷⁶ and party States’ desire to “contribute to broad international co-operation in . . . the legal aspects of the exploration and use of outer space for peaceful purposes.”⁷⁷ On the other hand, as addressed above, Article IV requires the moon and other celestial bodies to be used “exclusively for peaceful purposes.”⁷⁸ But it also explicitly allows the use of military personnel for “scientific research or for any other peaceful purposes.”⁷⁹

73. Vienna Convention on the Law of Treaties arts. 31–32, May 23, 1969, 1155 U.N.T.S. 331.

74. *Id.* art. 31.

75. *Id.* art. 32.

76. Outer Space Treaty, *supra* note 63, pmb. para. 2.

77. *Id.* pmb. para. 4.

78. *Id.* art. IV.

79. *Id.*

It should be emphasized that Articles I, II, and III of the OST, which lay out the most fundamental binding principles of international space law, do not mention “peaceful purposes” or even “peace.”⁸⁰ In fact, the *travaux préparatoires* of the OST indicate that it is a deliberate choice or compromise of party States to limit the expression of “peaceful purposes” to the non-binding preamble section⁸¹ and the second paragraph of Article IV, which deals solely with the moon and other celestial bodies. The *travaux* show that a proposal sponsored by Argentina and India to incorporate the peaceful purpose provision into Article I,⁸² as well as an Indian proposal to extend Article IV’s peaceful purpose provision to all of outer space,⁸³ were explicitly rejected by party States. Together with the fact that the term “peaceful purposes” is not defined in the OST, the language and the *travaux préparatoires* of the OST have left room for different interpretations of the coverage and scope of the four peaceful purposes provisions.

Scholars and space lawyers have already had some discussions on the application of the peaceful purpose clauses to planetary defense, primarily in the context of using weapons or dual-use instruments to deflect NEOs.⁸⁴ While there are still some disagreements, most have reached a consensus that using weapons as a means of planetary defense would violate the peaceful purposes clauses.⁸⁵

The discussion of establishing and using CBPDS for planetary defense, however, will raise more challenging legal issues that have yet to be addressed and thus require new analysis. The reasons are twofold. On the one hand, unlike Earth-based planetary defense operations, which are only covered by the two peaceful purposes provisions in the non-binding preamble, the establishment and use of CBPDS on celestial bodies will be directly regulated by the binding clause in Article IV. On the other hand, unlike other peaceful purposes provisions that use the term “for peaceful purposes,” Article IV

80. *Id.* arts. I–III.

81. Preambles are generally not binding under international treaty laws. See Laura Dalton, *Stanford v. Kentucky and Wilkins v. Missouri: A Violation of an Emerging Rule of Customary International Law*, 32 WILLIAM & MARY LAW REVIEW 161, 175 (1990) (“The preamble is not binding legally, however, except insofar as it may constitute a statement of customary international law”).

82. Comm. on the Peaceful Uses of Outer Space, Summary Record of the Legal Sub-Comm. Sixty-Fifth Meeting, U.N. Doc. A/AC.105/C.2/SR.65, at 11 (Oct. 24, 1966).

83. Comm. on the Peaceful Uses of Outer Space, Summary Record of the Legal Sub-Comm. Sixty-Sixth Meeting, U.N. Doc. A/AC.105/C.2/SR.66, at 6 (Oct. 21, 1966).

84. See, e.g., Koplow, *Exoatmospheric Plonshares*, *supra* note 23, at 115 n.98.

85. See, e.g., Kunich, *supra* note 23, at 139–40.

requires the use of celestial bodies to be “*exclusively* for peaceful purposes,”⁸⁶ a unique expression that only shows up once in the whole OST.

The term “peaceful purposes” has been subjected to two different interpretations. The United States and the majority of western States argue that it does not cover all military activities but only prohibits “aggressive” military operations.⁸⁷ Thus, non-aggressive or defensive military activities are not prohibited by the peaceful purposes provisions.⁸⁸ A minority of States, primarily those of the former Soviet Union and its allies, strongly advocate for the view that “peaceful” means “non-military” and thus all military use of outer space is prohibited.⁸⁹

Focusing on the text of the OST, supporters of the “non-military” approach can bring up Article I, which establishes the principle that outer space shall be used “in the interests of all countries.”⁹⁰ For example, Marko Markoff, arguably the most famous early supporter of the “non-military” reading, argued in 1976 that all military uses of outer space are prohibited because “no military activity, in present circumstances, could be carried out ‘in the interests of all countries’; even if ‘defensive’ and ‘beneficial’, it can be in the interests of a sole State, or a group of States, only.”⁹¹ This textual argument, however, has become less relevant in today’s world where planetary defense has been recognized as a valid mission that benefits all humankind. Thus, even if there was no military use of outer space in the 1970s that was in the interest of all countries, it is conceivable today that a planetary defense operation that employed military or quasi-military measures could be in congruence with Article I.

Besides the textual argument, another major argument made by States supporting the “non-military” interpretation is that the original intent of State parties in including the peaceful purposes clauses in the OST was to

86. Outer Space Treaty, *supra* note 63, art. IV (emphasis added).

87. Kunich, *supra* note 23, at 131.

88. Marko G. Markoff, *Disarmament and “Peaceful Purposes” Provisions in the 1967 Outer Space Treaty*, 4 JOURNAL OF SPACE LAW 3, 6 (1976).

89. Vladlen S. Vereshchetin, *Limiting and Banning Military Use of Outer Space: Issues of International Law*, in ESSAYS IN INTERNATIONAL LAW IN HONOUR OF JUDGE MANFRED LACHS 679–81 (Jerzy Makarczyk ed., 1984).

90. Outer Space Treaty, *supra* note 63, art. I.

91. Markoff, *supra* note 88, at 7; *see also* S. HOUSTON LAY & HOWARD J. TAUBENFELD, THE LAW RELATING TO ACTIVITIES OF MAN IN OUTER SPACE 97 n.3 (1970).

achieve the “total demilitarization of outer space.”⁹² Thus, they argued that the “non-aggressive” approach, which allows some military uses of outer space, is inconsistent with the (subjective) original meaning of the term “peaceful purposes.”⁹³ Admittedly, there were indeed some countries that proposed the total demilitarization of outer space during the negotiating process. For example, the Indian delegate stated that “[India] cannot contemplate any prospect other than that outer space should be a kind of warless world, where all military concepts of this earth should be totally inapplicable.”⁹⁴ Overall, however, this article does not find that the *travaux préparatoires* of the OST contains any evidence that the party States accepted this total demilitarization approach or intended “peaceful” to mean “non-military.”

In fact, in justifying their original meaning argument, many “non-military” scholars, instead of focusing on the *travaux préparatoires* of the OST, relied heavily on U.S. official records. For example, Vladlen Vereshchetin, a Russian jurist who served as a judge of the International Court of Justice between 1995–2006, argued that the United States’s “non-aggressive” approach strayed from its “official stand” when negotiating and ratifying the OST.⁹⁵ He highlighted that a staff report prepared for the Senate Committee on Aeronautical and Space Sciences to use in considering the OST supported the non-military approach by stating that “[i]t is generally believed to be the interest of long-range peace plans and arms control to ensure that the Moon and other celestial bodies will be non-nuclear, *non-military zones*.”⁹⁶ Other scholars also noted that many earlier U.S. official statements in addressing military satellite projects used the term “peaceful” not as “non-aggressive” but as “non-military.”⁹⁷

Besides the inquiry of subjective or actual original intent, some scholars brought up the objective or constructive intent approach and argued that it is unreasonable for State parties to the OST to use the term “peaceful” to mean anything but “non-military.” For example, Bin Cheng, recognized by

92. Bin Cheng, *Military Use of Outer Space: Article IV of the 1967 Space Treaty Revisited*, in *THE UTILIZATION OF THE WORLD’S AIR SPACE AND FREE OUTER SPACE IN THE 21ST CENTURY* 305 (Chia-Jui Cheng & Doo Hwan Kim eds., 1997).

93. *Id.*

94. Comm. on the Peaceful Uses of Outer Space, Verbatim Record of the Third Meeting, U.N. Doc. A/AC.105/PV.3, at 63 (1962).

95. Vereshchetin, *supra* note 89, at 679–81.

96. *Id.* at 680 (emphasis added).

97. *E.g.*, STAFF OF S. COMM. ON AERONAUTICAL AND SPACE SCIENCES, 88TH CONG., DOCUMENTS ON INTERNATIONAL ASPECTS OF THE EXPLORATION AND USE OF OUTER SPACE, 1954–1962, at 52, 66 (1963), *cited in* Markoff, *supra* note 88, at 8.

some Chinese scholars as the “Father of International Air Law,”⁹⁸ highlighted the historical background under which the OST was drafted.⁹⁹ He noted that:

In order to drive home further the point that “peaceful” can only mean, in the context of outer space, “non-military” and not “non-aggressive,” one merely has to reflect whether President Eisenhower, especially as he was harking back to the Antarctic Treaty and the Atoms for Peace Plan, *could really and realistically have suggested* that States should establish a program under the United Nations for international cooperation in the non-aggressive uses of outer space, including military uses.¹⁰⁰

These arguments indicated the United States’ struggle in making its space policy. However, merely examining the U.S. domestic records cannot establish an original consensus among party States about the total demilitarization of outer space. Moreover, a more comprehensive reading of historical records indicates that the United States did not use the term “peaceful” as “non-military” when negotiating the OST.¹⁰¹ Instead, the official stand of the United States was quite consistent in advocating not to ban defensive uses of outer space under international law.¹⁰² For example, prior to the negotiation of the OST, the United States passed the National Aeronautic Space Act of 1958 and created NASA.¹⁰³ On the one hand, the Act illustrated the U.S. space policy to devote space activities to “peaceful purposes,”¹⁰⁴ but on the other hand, it also involved defensive military uses of outer space.¹⁰⁵ Two years later, President Eisenhower further made it clear that the U.S. policy

98. CHIA-JUI CHENG, *STUDIES IN INTERNATIONAL AIR LAW: SELECTED WORKS OF BIN CHENG* (2017).

99. Cheng, *Military Use of Outer Space*, *supra* note 92, at 305–18.

100. *Id.* at 318 (emphasis added).

101. Robert L. Bridge, *International Law and Military Activities in Outer Space*, 13 AKRON LAW REVIEW 649, 658 (1980).

102. *Id.*

103. National Aeronautic Space Act of 1958, Pub. L. No. 85-568 (1958).

104. *Id.* § 102(a).

105. *See, e.g., id.* § 204(a) (establishing a civilian-military liaison committee); *cf.* Exec. Order No. 11129, 3 C.F.R. 794 (1959–1963) (authorizing NASA to provide certain technical assistance to the Department of Defense for military space activities).

was to avoid only “warlike activities” in outer space.¹⁰⁶ During the negotiation process of the OST, Senator Albert Gore, representing the United States, made it clear that “[i]t is the view of the United States that outer space should be used only for peaceful—that is, *non-aggressive* and beneficial—purposes.”¹⁰⁷ Furthermore, he went on to indicate that the United States “is determined to pursue every *non-aggressive* step which it considers necessary to protect its national security and the security of its friends and allies.”¹⁰⁸ The total demilitarization approach was also explicitly rejected by him: “we cannot banish all military activities in space until we banish them on earth.”¹⁰⁹ Lastly, after the OST was signed, the Senate Committee on Foreign Relations also confirmed the “non-aggressive” approach when ratifying the OST.¹¹⁰

Not only did the United States intend “peaceful” to mean “non-aggressive”; most scholars have agreed that the “non-aggressive” interpretation is the better and more precise reading of the OST.¹¹¹ The “non-aggressive” interpretation is supported by three core arguments. First, from a textual perspective, if “peaceful” means “non-military,” the following provisions

106. Address by President Dwight Eisenhower Before the 15th General Assembly of the United Nations (Sept. 22, 1960), <https://www.presidency.ucsb.edu/documents/address-before-the-15th-general-assembly-the-united-nations-new-york-city>.

107. Comm. on the Peaceful Uses of Outer Space, Verbatim Record of the Twelve Hundred and Eighty-Ninth Meeting, U.N. Doc. A/C.1/PV.1289, at 13 (1962) (emphasis added).

108. *Id.* at 14 (emphasis added).

109. *Id.* at 15.

110. Markoff, *supra* note 88, at 7 (citing *Treaty on Outer Space: Hearing Before the S. Comm. on Foreign Relations*, 90th Cong. 59 (1967)).

111. See, e.g., Aoki, *supra* note 27, at 217–19; Lyall & Larsen, *supra* note 67, at 468–69; Kubo Mačák, *Silent War: Applicability of Jus in Bello to Military Space Operations*, 94 INTERNATIONAL LAW STUDIES 1, 15–19 (2018); Stephan Hobe, *The Meaning of “Peaceful Purposes” in Article IV of the Outer Space Treaty*, 40 ANNALS AIR & SPACE LAW 9 (2015); Kunich, *supra* note 23, at 131–38; Richard A. Morgan, *Military Use of Commercial Communications Satellites: A New Look at the Outer Space Treaty and “Peaceful Purposes,”* 60 JOURNAL OF AIR LAW & COMMERCE 296, 300 (1994); Pal Dunay, *Military Use of Outer Space: Implications for International Law*, in MILITARY TECHNOLOGY, ARMAMENTS DYNAMICS AND DISARMAMENT 471, 474 (Hans Günter Brauch ed., 1989); Michael G. Gallagher, *Legal Aspects of the Strategic Defense Initiative*, 111 MILITARY LAW REVIEW 41 (1986); CARL QUIMBY CHRISTOL, THE MODERN INTERNATIONAL LAW OF OUTER SPACE 29 (1982); Bridge, *supra* note 101, at 658; Stephen Gorove, *Arms Control Provisions in the Outer Space Treaty: A Scrutinizing Reappraisal*, 3 GEORGIA JOURNAL OF INTERNATIONAL & COMPARATIVE LAW 114, 119–20 (1973); Paul G. Dembling & Daniel M. Arons, *The Evolution of the Outer Space Treaty*, 33 JOURNAL OF AIR LAW & COMMERCE 419, 432–35 (1967).

that prohibit specific military uses of outer space would be “meaningless redundancy.”¹¹² Second, the non-military interpretation is in conflict with State practice because major space powers have consistently used outer space for military purposes.¹¹³ Third, the term “peaceful purposes” is also used in other international law treaties, and in those contexts, there are consensuses that it means “non-aggressive” instead of “non-military.” For example, Article II of the UN Charter requires States to “settle their international disputes by peaceful means in such a manner that international peace and security, and justice, are not endangered.”¹¹⁴ However, Article 51 makes it clear that using military force for self-defense does not violate the Charter.¹¹⁵ Thus, the term “peaceful” in the UN Charter means “non-aggressive” instead of “non-military.”¹¹⁶ Besides the UN Charter, the law of the sea is also a good example. While Article 88 of the 1982 United Nations Convention on the Law of the Sea requires the high seas to be “reserved for peaceful purposes,”¹¹⁷ the passage of military vessels is globally recognized as a lawful use of high seas.¹¹⁸

After concluding that the term “peaceful purposes” refers to “non-aggressive purposes,” we now turn to the second and more challenging issue: whether and how the term “exclusively” changes the scope of prohibitions of Article IV.

At first glance, a natural reading of the term “exclusively for peaceful purposes” indicates that it is prohibited to use celestial bodies in a way that can serve both peaceful and non-peaceful purposes. Thus, this clause, at a minimum, prohibits a State from using CBPDS and conducting planetary defense activities in a way that intentionally causes physical damage to another State’s territory, personnel, or property. What is less clear, however, is whether the establishment of CBPDS per se violates the dual-purpose prohibition. Installing infrastructure on celestial bodies that can possibly be used to launch rockets, missiles, and other objects possessing a military nature can certainly stimulate distrust between States and threaten the international peaceful order. However, since “peaceful” should be interpreted as “non-

112. Dunay, *supra* note 111, at 474.

113. Hobe, *supra* note 111, at 15–21.

114. U.N. Charter art. 2(3).

115. *Id.* art. 51.

116. Kunich, *supra* note 23, at 132; Dunay, *supra* note 111, at 474–75; CHRISTOL, *supra* note 111, at 29.

117. United Nations Convention on the Law of the Sea art. 88, Dec. 10, 1982, 1833 U.N.T.S. 397.

118. Mačák, *supra* note 111, at 15–19.

aggressive,” and since the establishment of CBPDS is not an inherently aggressive measure, as it does not inherently constitute “threat or use of force,”¹¹⁹ it seems more reasonable to argue that it is not per se prohibited by the OST.

To be sure, the term “purpose” here can theoretically restrict a State’s right to establish CBPDS—a sound argument can be made that it is illegal if a State establishes CBPDS, on the one hand, to conduct planetary defense operations, and, on the other hand, to prepare for future use of force or to threaten another State with aggressive measures. However, considering that it is not always easy to ascertain the true purpose of a State for building CBPDS, such a restriction might lack practical importance and be hard to enforce. Moreover, even if a State originally establishes CBPDS for peaceful purposes only, the possibility that it can change its mind and use CBPDS for aggressive purposes later can still risk escalating international tension and might lead to the militarization of celestial bodies.

Recognizing the problematic implications, some have argued that this natural reading of the term “exclusively for peaceful purposes” is incorrect.¹²⁰ They contend that the term “exclusively” changes the meaning of the term “peaceful” from “non-aggressive” to “non-military.”¹²¹ According to these scholars, the OST requires a partial de-militarization of outer space in general but a total demilitarization of the moon and other celestial bodies.¹²² Several arguments can be made in support of this reading. First, some scholars, while objecting to the reading that the OST requires total demilitarization of outer space, argue that the primary or only reason why this interpretation is incorrect is that States did not intend to prohibit “obvious and widely accepted” uses of outer space, such as military satellites.¹²³ Building upon this approach, one might argue that the moon and other celestial bodies should be totally demilitarized because they were not used for military purposes when the OST was drafted. Second, some scholars reasoned that the total demilitarization of celestial bodies is supported by a holistic reading of Article IV because otherwise the clause that explicitly authorizes the use

119. U.N. Charter art. 2(4).

120. *Commentary on 1967 Outer Space Treaty Article IV Para. 2*, 1 COLOGNE COMMENTARY ON SPACE LAW 70, 82–84 (Stephan Hobe et al. eds., 2009); see also Gallagher, *supra* note 111.

121. *Commentary on 1967 Outer Space Treaty Article IV Para. 2*, *supra* note 120, at 82–84; see also Gallagher, *supra* note 111.

122. *Commentary on 1967 Outer Space Treaty Article IV Para. 2*, *supra* note 120, at 82–84; see also Gallagher, *supra* note 111.

123. Morgan, *supra* note 111, at 300.

of military personnel for scientific research and other peaceful purposes would be redundant.¹²⁴ However, a counterargument can be easily made: if the peaceful purposes clause means total demilitarization of celestial bodies, the specific prohibitions of building military bases, installations and fortifications, testing weapons, and conducting military maneuvers are redundant.

In any case, while this reading might have its merits, it is not supported by the plain meaning of the text. The dictionary meaning of the term “exclusively” is simply “in an exclusive manner; in a way limited to a single person, group, category, method, etc.”¹²⁵ If one accepts the majority reading that “peaceful purposes” mean “non-aggressive purposes,” the “exclusively for peaceful purposes” clause can only have one textual meaning—the use of celestial bodies shall be “limited to non-aggressive purposes.” Moreover, subsequent State practice also rejects the total demilitarization reading. For example, Article II of the Convention for the Establishment of a European Space Agency, a treaty drafted and signed only eight years after the OST entered into force, incorporated the OST Article IV’s “exclusively peaceful purposes” expression;¹²⁶ notwithstanding this clause, however, the ESA has been involved in research and operations in the (defensive) military space sphere.¹²⁷

To sum up, the general principle that the moon and other celestial bodies should be used exclusively for peaceful purposes does not per se prohibit establishing or using CBPDS for planetary defense purposes. While it is prohibited to have both an aggressive purpose and a peaceful or non-aggressive purpose when building or using CBPDS, it is not clear how such a prohibition can be enforced. Additionally, even if it is enforceable, this clause does not help in reducing the concern of escalation and over-militarization of outer space. Therefore, in discussing the legitimacy of CBPDS, this article concludes that it is more critical to look at the specific prohibitions contained in Article IV of the OST.

124. *Commentary on 1967 Outer Space Treaty Article IV Para. 2*, *supra* note 120, at 82.

125. See, e.g., *Exclusively*, MERRIAM-WEBSTER DICTIONARY, <https://www.merriam-webster.com/dictionary/exclusively> (last visited Nov. 15, 2023).

126. Convention for the Establishment of a European Space Agency art. II, *opened for signature* May 30, 1975, 1297 U.N.T.S. 161 (entered into force Oct. 30, 1980).

127. *Commentary on 1967 Outer Space Treaty Article IV Para. 2*, *supra* note 120, at 83.

B. *Military Bases, Installations, and Fortifications*

The first relevant specific prohibition is building “military bases, installations and fortifications,” which is critical in determining whether the establishment of CBPDS is per se illegal.¹²⁸ The origin of this prohibition is a U.S. proposal in a 1966 meeting of the Committee on the Peaceful Uses of Outer Space:

The moon and other celestial bodies shall be used exclusively for peaceful purposes. The establishment of military bases and fortifications, the testing of any type of weapons, and the conduct of military maneuvers shall be forbidden. The present Treaty does not prohibit the use of any types of personnel or equipment for scientific research or any other peaceful purpose.¹²⁹

Note that this proposed article did not prohibit “military installations” but only “military bases and fortifications.”¹³⁰ The language of this proposal mirrored Article I, section 2 of the Antarctic Treaty: “The present Treaty shall not prevent the use of military personnel or equipment for scientific research or for any other peaceful purpose.”¹³¹

The Soviet Union objected to this proposal, however. The Soviets made their own proposal, which contained two objections. First, they disagreed that military equipment can be used for scientific research or other peaceful purposes as proposed by the United States; instead, they argued that military equipment, like military bases and fortifications, should be per se banned because otherwise “a loophole would be created.”¹³² This view was supported by Bulgaria, which argued the Soviet proposal “would afford a firm guarantee of the use of [celestial] bodies for peaceful purposes.”¹³³ Second,

128. Outer Space Treaty, *supra* note 63, art. IV.

129. Comm. on the Peaceful Uses of Outer Space, Rep. of the Legal Subcomm. on its Fifth Session, U.N. Doc. A/AC.105/35, annex III, at 4 (Sept. 16, 1966) (United States revision of its Working Paper No. 6).

130. *Id.*

131. Antarctic Treaty art. 1(2), Dec. 1, 1959, 12 U.S.T. 794, T.I.A.S. No. 4780, 402 U.N.T.S. 71.

132. Comm. on the Peaceful Uses of Outer Space, U.N. Doc. A/AC.105/C.2/SR.65, *supra* note 82, at 11 (“if the use of military equipment in outer space was allowed, the essence of the treaty would be distorted and a loophole would be created for evading one of its most fundamental provisions”).

133. Comm. on the Peaceful Uses of Outer Space, Fifth Session Summary Record of the Seventy-First Meeting of the Legal Subcomm., U.N. Doc. A/AC.105/C.2/SR.71, at 23

the Soviet proposal did not prohibit military fortifications but only military bases and military “installations.”¹³⁴

During the initial negotiation, the Soviet delegate made it clear that while it agreed to add the U.S. proposed term “fortifications,” it would refuse to delete the term “installations.”¹³⁵ The Czech delegate also supported adding the expression “military installations” because the term is “more general.”¹³⁶ After the initial negotiation, the Soviets submitted an amended proposal, which stated that:

The establishment of military bases, installations and fortifications, the testing of any type of weapons and the conduct of military maneuvers on celestial bodies shall be forbidden. The use of military personnel for scientific research or for any other peaceful purposes shall not be prohibited.¹³⁷

The United States objected to both Soviet amendments. With respect to military equipment, it noted that much equipment used for peaceful explorations of outer space “had, in many cases, been developed through military research.”¹³⁸ It further argued that military equipment is an “indispensable” and “essential” part of future space programs.¹³⁹ The British delegate added that “[t]he fact that a piece of equipment owed its origin to military development should not preclude its use for peaceful purposes foreseen by the

(Oct. 21, 1966) (“The inclusion of a provision prohibiting the use of military equipment on celestial bodies would afford a firm guarantee of the use of those bodies for peaceful purposes only, and might be the means of averting future disaster”).

134. Comm. on the Peaceful Uses of Outer Space, U.N. Doc. A/AC.105/C.2/SR.65, *supra* note 82, at 10.

135. *Id.*

136. Comm. on the Peaceful Uses of Outer Space, U.N. Doc. A/AC.105/C.2/SR.66, *supra* note 83, at 3.

137. Comm. on the Peaceful Uses of Outer Space, Rep. of the Legal Subcomm. on its Fifth Session, U.N. Doc. A/AC.105/35, annex III, at 7 (Sept. 16, 1966) (amendment proposed by the USSR).

138. Comm. on the Peaceful Uses of Outer Space, Fifth Session Summary Record of the Seventieth Meeting, U.N. Doc. A/AC.105/C.2/SR.70, at 6 (Oct. 21, 1966).

139. Comm. on the Peaceful Uses of Outer Space, U.N. Doc. A/AC.105/C.2/SR.65, *supra* note 82, at 9 (“As in the exploration of the Antarctic, man could not have penetrated outer space and survived in that hostile environment unless he had been able to draw up the benefits of all research, civilian or military, involving both personnel and equipment. For any country engaging in space activity, military personnel, facilities and equipment played an indispensable role and would continue to be an essential part of future space programs.”).

Treaty and apparent to all as peaceful purposes.”¹⁴⁰ In terms of military installations, the United States highlighted the importance of being “very precise” and argued that the term “installations” is “far too vague.”¹⁴¹

Finally, a compromise was reached. On the one hand, the OST adopted the Soviet proposal and explicitly prohibited military “bases, *installations* and fortifications.”¹⁴² On the other hand, the OST rejected the Soviet’s argument that military equipment should be per se banned. But neither did it adopt the original U.S. proposal under which military equipment is treated like military personnel. Instead, it added a new and ambiguous clause stating that the use of “*any equipment or facility necessary for peaceful exploration* of the moon and other celestial bodies shall also not be prohibited.”¹⁴³ The *travaux préparatoires* do not explain the reasons for these compromises, which further complicates the inquiry into the meaning of these clauses. We will focus on the first clause in this section and will pick up the “equipment or facility” clause in section 5.

Since the OST adopts the Soviet proposal and adds the expression “installations,” without contradicting evidence we will assume that the contracting parties also accepted the underlying rationale that it is better to have a broader and possibly overinclusive ban than to have a more precise but possibly underinclusive one. Thus, in conducting the textual analysis, the term “military bases, installations and fortifications” should be interpreted broadly.

According to the *Department of Defense Dictionary of Military and Associated Terms*, “base” can refer to a “locality from which operations are projected or supported,” an “area or locality containing installations which provide logistic or other support,” or “[h]ome airfield or home carrier.”¹⁴⁴ “Installation” refers to a “grouping of facilities, located in the same vicinity, which support particular functions.”¹⁴⁵ The term “fortification” is not defined, but “field fortifications” are defined as “emplacement or shelter of a temporary

140. Comm. on the Peaceful Uses of Outer Space, U.N. Doc. A/AC.105/C.2/SR.71, *supra* note 133, at 5.

141. Comm. on the Peaceful Uses of Outer Space, U.N. Doc. A/AC.105/C.2/SR.70, *supra* note 138, at 6.

142. Outer Space Treaty, *supra* note 63, art. IV.

143. *Id.* (emphasis added).

144. *Base*, Joint Chiefs of Staff, Joint Publication 1-02, Department of Defense Dictionary of Military and Associated Terms 60 (June 9, 2004) [hereinafter Joint Publication 1-02].

145. *Installation*, *id.* at 259.

nature.”¹⁴⁶ These definitions in the *DOD Dictionary* are similar to and in congruence with civilian dictionaries in general.¹⁴⁷ Based on the dictionary meaning, it seems that CBPDS can be a “base” because it can project and support planetary defense operations. More unequivocally, CBPDS can constitute an “installation” because it supports the planetary defense function. Taking into account the presumption of broad interpretation, there should be no serious doubt that CBPDS is covered by the term “bases, installations and fortifications.”

Therefore, the key issue becomes whether CBPDS is a *military* or a *non-military* base, installation, or fortification. The term “military” is not defined in the *DOD Dictionary*. Civilian dictionaries generally define “military” as “of or relating to armed forces, soldiers, arms, or war.”¹⁴⁸ But this definition does not solve the problem. Strict adherence to this definition will render nearly all space installations military installations because most of them will likely contain some technologies or equipment that are derived from, controlled by, or otherwise “relating to” armed forces. Thus, it is vital to consider the threshold question—how close must the relationship between an installation and the armed forces be to render the installation a military installation under the OST?

Unfortunately, based on the author’s research, neither the language of the OST, its *travaux préparatoires*, subsequent scholarship, nor State statements deal with this threshold issue. The similar clause in the Antarctic Treaty also received little attention from scholars and practitioners; thus, while Article IV of the OST borrowed much of the Antarctic Treaty’s language, referring to the Antarctic Treaty is not helpful. Perhaps the most or even the only source that relates to this discussion is the law of armed conflict, which establishes standards for different military and civilian objects.

146. *Fortification*, *id.* at 195.

147. *E.g.*, *Base*, MERRIAM-WEBSTER DICTIONARY, <https://www.merriam-webster.com/dictionary/base> (last visited Nov. 15, 2023); *Installation*, MERRIAM-WEBSTER DICTIONARY, <https://www.merriam-webster.com/dictionary/installation> (last visited Nov. 15, 2023); *Fortification*, MERRIAM-WEBSTER DICTIONARY, <https://www.merriam-webster.com/dictionary/fortification> (last visited Nov. 15, 2023).

148. *E.g.*, *Military*, MERRIAM-WEBSTER DICTIONARY, <https://www.merriam-webster.com/dictionary/military> (last visited Nov. 15, 2023).

Under the law of armed conflict, civilian objects are defined as “all objects which are not military objectives.”¹⁴⁹ And the definition of military objectives comprises two elements: (1) such objects must “by their *nature, location, purpose or use* make an effective contribution to military action” and (2) their “total or partial destruction, capture or neutralization, in the circumstances ruling at the time, offers a definite military advantage.”¹⁵⁰ Since the second prong is specifically applicable during armed conflicts, it is not very relevant to our discussion, and thus we will only focus on the first prong. In case of doubt about whether an object is military or civilian, the law of armed conflict requires a presumption of treating it as a civilian one.¹⁵¹ But since the purpose of the law of armed conflict is to prevent unnecessary civilian casualties while the purpose of the OST is to prevent arms races, the over-militarization of outer space, and to ensure equal and free access thereof, we will reject this presumption of civilian status in the analysis.

The law of armed conflict’s first criterion in differentiating military and civilian objects concerns the “nature” of an object. According to the Commentary of the International Committee of the Red Cross,¹⁵² this category covers all objects “directly used by the armed forces” like weapons, transportation, fortifications, and “buildings occupied by armed forces.”¹⁵³ The DOD *Law of War Manual* adopts this definition and explains that military objects in this category can “by their nature, make an effective contribution to military action.”¹⁵⁴ The problem with applying this criterion in our context is that the law of armed conflict does not provide any guidance to deal with instruments that are dual-use in nature.¹⁵⁵ On the one hand, CBPDS can

149. Protocol Additional to the Geneva Conventions of 12 August 1949, and Relating to the Protection of Victims of International Armed Conflicts art. 52(1), June 8, 1977, 1125 U.N.T.S. 3 [hereinafter Additional Protocol I].

150. *Id.* art. 52(2).

151. *Id.* art. 52(3).

152. For the relevance and importance of International Committee of the Red Cross Commentaries in interpreting the law of armed conflict, see, e.g., Sean D. Murphy, *Joint Series: The Role of the ICRC Commentaries in Understanding International Humanitarian Law*, HUMANITARIAN LAW & POLICY (July 6, 2016), <https://blogs.icrc.org/law-and-policy/2016/07/07/joint-series-the-role-of-the-icrc-commentaries-in-understanding-international-humanitarian-law/>.

153. COMMENTARY ON THE ADDITIONAL PROTOCOLS OF 8 JUNE 1977 TO THE GENEVA CONVENTIONS OF 12 AUGUST 1949, ¶ 2020 (Yves Sandoz, Christophe Swinarski & Bruno Zimmermann eds., 1987).

154. OFFICE OF THE GENERAL COUNSEL, U.S. DEPARTMENT OF DEFENSE, LAW OF WAR MANUAL § 5.6.6.1 (updated ed. July 2023) [hereinafter LAW OF WAR MANUAL].

155. *Id.* § 5.6.1.2.

likely provide some contributions to military operations by its nature because most, if not all, kinds of active planetary defense technologies can be used for aggressive purposes. On the other hand, unlike pure military instruments, CBPDS is neither designed for pure military use nor necessary to be “directly used by armed forces” and can be instead controlled by civilian agencies.

The dual-use problem has been recognized as one of the most challenging problems of the law of armed conflict, and scholars have proposed different solutions to it.¹⁵⁶ Overall, as Michael Schmitt pointed out, the decisive factor is likely the possessor of an instrument.¹⁵⁷ Thus, as he explained, while military satellites are military objectives by nature even if they are serving civilian purposes, civilian-controlled satellites are military objectives only if used for military purposes.¹⁵⁸ Some might challenge this test from a policy perspective by arguing that it is impractical and detrimental to the liberal order because an authoritarian State can either disguise a military company/agency as a civilian one or bypass the test through a high level of civil-military integration. But it is beyond this article’s scope to deal with such a challenging law of armed conflict issue; instead, it is enough to note that there is no sound reason to argue that CBPDS is unambiguously a military object by nature when it is regulated and operated by a civilian agency.

The second criterion is location. Examples in this category include bridges¹⁵⁹ and locations that provide a vantage point.¹⁶⁰ This test is primarily applicable in an armed conflict context, but one can argue that it nevertheless provides some guidance to our discussion. For example, one argument can be made that the closer the distance between the CBPDS and Earth, the greater that risk that it can be used to attack another State’s territory. One can also argue that for a CBPDS equipped only with laser planetary defense technologies, it will not be a military installation if it is located in an area that always faces away from Earth, like on the far side of the moon. However, these kinds of conclusions are suspicious. The prohibition of military installations on celestial bodies was not simply to protect the security of States’ territories, personnel, or assets on Earth; it is also intended to guarantee free

156. E.g., David A. Koplow, *Reverse Distinction: A U.S. Violation of the Law of Armed Conflict in Space*, 13 HARVARD NATIONAL SECURITY JOURNAL 25 (2022) (discussing the dual-use dilemma in applying the reverse distinction principle to space).

157. Michael N. Schmitt, *International Law and Military Operations in Space*, 10 MAX PLANCK YEARBOOK OF UNITED NATIONS LAW 89, 116 (2006).

158. *Id.*

159. COMMENTARY ON THE ADDITIONAL PROTOCOLS OF 8 JUNE 1977, *supra* note 153, ¶ 2021.

160. LAW OF WAR MANUAL, *supra* note 154, § 5.6.1.1.

access to outer space.¹⁶¹ Thus, even if the location of a CBPDS makes it unable to constitute a direct threat to Earth-based facilities, it can still be used to attack other States' spacecraft and other civilian personnel and properties in outer space and chill their free exploration of outer space. Thus, this article does not view location as an important factor in ascertaining the nature of an outer space installation.

The third and fourth criteria are “purpose” and “use.” Both are concerned with the function of an installation. If an installation is currently being used by armed forces, it will be regarded as a military objective “by use.”¹⁶² If an installation is intended to be used by armed forces in the future, it will count as a military objective “by purpose.”¹⁶³ The “use” test is straightforward and can be easily applied here, but the conclusion is not meaty and is likely underinclusive—if a State is actually using its CBPDS to conduct military operations, it will certainly violate the OST. The “purpose” test, in contrast, can be more comprehensive in its coverage but likely overinclusive. As the DOD *Law of War Manual* indicates, as long as there is a “possibility” that an otherwise civilian object can be used for military purposes and make an effective military contribution, it can be a military objective.¹⁶⁴ Moreover, effective contribution includes direct as well as indirect contributions to not only “war-fighting” but also “war-supporting” and “war-sustaining” functions.¹⁶⁵ If this test is adopted, it seems that many purely commercial and civilian installations on celestial bodies will be banned, which will unreasonably thwart the important purpose of the OST to encourage the free exploration of outer space.¹⁶⁶

Overall, the analysis in this section indicates that while CBPDS is clearly an “installation,” the lack of definition and related *travaux préparatoires* renders Article IV of the OST too ambiguous to decide if CBPDS are prohibited “military installations.” Whereas the law of armed conflict provides some

161. *E.g.*, Comm. on the Peaceful Uses of Outer Space, U.N. Doc. A/C.1/PV.1289, *supra* note 107, at 17.

162. COMMENTARY ON THE ADDITIONAL PROTOCOLS OF 8 JUNE 1977, *supra* note 153, ¶ 2022; LAW OF WAR MANUAL, *supra* note 154, § 5.6.6.1.

163. COMMENTARY ON THE ADDITIONAL PROTOCOLS OF 8 JUNE 1977, *supra* note 153, ¶ 2022; LAW OF WAR MANUAL, *supra* note 154, § 5.6.6.1.

164. LAW OF WAR MANUAL, *supra* note 154, § 5.6.6.1.

165. *Id.* § 5.6.6.2.

166. *E.g.*, Outer Space Treaty, *supra* note 63, pmb. para. 2 (“Recognizing the common interest of all mankind in the progress of the exploration and use of outer space for peaceful purposes”).

tests in differentiating military and civilian objects, those tests cannot be easily applied to supplement the OST's language. This is not surprising because the law of armed conflict's tests are concerned with the immunity of an object from an enemy's attack, while the OST's provision concerns the responsibility of a State to refrain from certain activities that might lead to arms races and over-militarization of outer space. The difference in underlying purposes renders the application of the law of armed conflict to Article IV of the OST to be either overinclusive or underinclusive. And the only meaningful conclusion might be that a State cannot run its CBPDS with armed forces and military personnel and cannot use it for military purposes. Therefore, as long as a State uses a civilian agency to regulate and operate its CBPDS and does not use its CBPDS to conduct military operations, there is no strong and unambiguous evidence that it is restricted by current international law to establish CBPDS on the moon and other celestial bodies.

C. *Testing of Weapons*

The second relevant specific prohibition is “the testing of any type of weapons and the conduct of military maneuvers.”¹⁶⁷ Assuming that it is not per se prohibited to establish CBPDS on celestial bodies, this prohibition will be important in ascertaining the limits on its use. We consider the weapon testing prohibition in this section and will pick up the military maneuver clause in the following section.

To start off, the *DOD Dictionary* does not define the term “weapon.” But civil dictionaries generally define the term based on its utility. For example, the *Cambridge Dictionary* defines weapon as “any object *used* in fighting or war, such as a gun, bomb, knife, etc.”¹⁶⁸ And the *Merriam-Webster Dictionary* defines weapon as “something (such as a club, knife, or gun) *used* to injure, defeat, or destroy” or “a means of contending against another.”¹⁶⁹ Based on this textual meaning, some scholars and practitioners argued that whether an instrument constitutes a weapon under the OST depends on its intended and actual use.¹⁷⁰ Specifically, they argued that an instrument can be a weapon only if it is designed to be used or is actually used against “a living being or

167. *Id.* art. IV.

168. *Weapon*, CAMBRIDGE DICTIONARY, <https://dictionary.cambridge.org/us/dictionary/english/weapon> (last visited Nov. 15, 2023).

169. *Weapon*, MERRIAM-WEBSTER DICTIONARY, <https://www.merriam-webster.com/dictionary/weapon> (last visited Nov. 15, 2023).

170. *E.g.*, Kunich, *supra* note 23, at 139–40.

an instrumentality.”¹⁷¹ Since instruments designed for planetary defense purposes are supposed to be used against “totally natural, inanimate object[s] independent of human control,” they are not weapons unless they are utilized in a manner that serves the same purpose as traditional weapons.¹⁷²

The biggest advantage of this “intended and actual use” reading is that it provides legal clarity that the use of CBPDS to test planetary defense techniques is not *per se* restricted by the “testing of weapons” clause. However, this approach cannot help relieve concerns that the owner of a CBPDS will use it for non-peaceful purposes. The *travaux préparatoires* of the OST indicate that an important function of the prohibition of testing weapons on celestial bodies is to ensure free access to outer space,¹⁷³ but if a State is allowed to build a CBPDS equipped with traditional weapons, especially nuclear weapons, other States’ right to free access will be put at risk.

Due to such practical concerns, this intended and actual use approach has been recently criticized and rejected by the Space Mission Planning Advisory Group in its 2020 *Legal Report*, which noted that the “nature” of an instrument is as important as its intended and actual use in ascertaining whether it is a weapon.¹⁷⁴ However, the Advisory Group report does not provide any guidance on how to apply this nature-based test. In fact, the application of this test can be challenging because, as highlighted by the Advisory Group, it is highly unlikely that we can develop any technologies or instruments that can solely be used to conduct planetary defense operations but cannot be used for any non-peaceful ways.¹⁷⁵

David Koplow has argued that at the least nuclear devices should be regarded as weapons by nature.¹⁷⁶ He made four points. First, since it is difficult to ascertain a State’s intended use of nuclear instruments stationed in outer space, the nature-based approach is necessary to prevent arms races in outer space.¹⁷⁷ Second, in terms of State practice, no States have “placed a

171. *Id.* at 140.

172. *Id.* at 140 n.91; *see also* Harrington, *supra* note 23, at 771 (“With regard to the Outer Space Treaty, I would argue this sort of a nuclear explosive device [used for planetary defense] is not in fact a nuclear weapon. Whether or not you have to put it in Earth’s orbit first to get it to the asteroid is irrelevant if it’s being used against a natural threat, while it is surely a device, it’s not a weapon in that context.”).

173. Comm. on the Peaceful Uses of Outer Space, U.N. Doc. A/C.1/PV.1289, *supra* note 107, at 17.

174. DRUBE ET AL., *supra* note 24, at 28–30.

175. *Id.*

176. Koplow, *Exoatmospheric Plowshares*, *supra* note 23, at 114–17.

177. *Id.*

nuclear explosive device into space and claimed justification based upon its purpose, size, or function.”¹⁷⁸ Third, all nuclear devices are currently maintained in “weapon stockpile[s]” and are “designed, developed, and tested as weapons.”¹⁷⁹ Fourth, no currently existing nuclear devices were designed for peaceful purposes.¹⁸⁰

However, Koplow also did not provide a more general test for us to ascertain, *ex ante*, what instrument is inherently a weapon. Additionally, he recognized that some instruments cannot be analyzed under the nature-based test but should be analyzed according to their “immediate application.”¹⁸¹ He brought up the gravity tractor as an example and argued that it is not a weapon by nature and can constitute a weapon only if it is used in aggressive ways.¹⁸² But what differentiates nuclear devices and gravity tractors? Koplow did not explain this in his article. Since it is conceivable that the malicious use of gravity tractors to cause asteroids to crash into another State’s territory can possibly cause comparable or even more severe damage than nuclear bombs, the difference in “nature” is not apparent and cannot be explained merely by noting the devastating consequences that nuclear devices can cause.

Admittedly, based on Koplow’s analysis, a distinction can be made between nuclear devices and gravity tractors based on his last three rationales on why nuclear devices are weapons by nature. It is at least conceivable that a State will use civilian agencies to develop and manage gravity tractor techniques and actively advocate for their lawfulness under international space law. However, this article argues that these potential differences do not capture the key distinction between nuclear weapons and gravity tractors. In fact, Koplow’s nature-based test is very similar to the intended use approach—the only difference might be that instead of focusing on the intended use of an instrument when it is *deployed*, Koplow’s test requires us to look into the intended use of an instrument when it is originally *invented*. While this approach has some potential to contribute to the peaceful uses of outer space, it is not that helpful in ascertaining what kinds of new and emerging planetary defense techniques should be allowed to be tested through CBPDS. It is plausible that a new technique that is invented and

178. *Id.*

179. *Id.*

180. *Id.*

181. *Id.* at 117.

182. *Id.*

managed by a civilian agency or even a commercial space company for planetary defense purposes only is nevertheless too weapon-like to be unregulated. On the other hand, from a policy perspective, it might not be a good idea to focus too heavily on factors like where these instruments are stored because it is not that challenging for an authoritarian State to bypass these restrictions through a higher level of military-civilian integration.

Instead, this article argues that perhaps the soundest way to apply the nature-based test is to classify only those “impulsive” planetary defense techniques as weapons per se. In contrast, those “slow push/pull” planetary defense techniques will be treated as weapons only if they are intended or actually used for aggressive purposes. To start off, a relevant difference between these two kinds of techniques is that all current military techniques like missile techniques are similar to “impulsive techniques” in that they are designed to use a short-lived force to cause a sudden physical impact on the target. While slow push/pull techniques might also have military implications in the future,¹⁸³ no comparable techniques or weapons are used by any State’s armed forces at this time. Additionally, the more decisive difference between impulsive and slow push/pull techniques is that only the former can be used to conduct an effective *surprise attack*. As security and military scholars have long recognized, surprise attacks can pose a more substantial and existential threat to the target State’s national security and sovereignty than other kinds of aggressive behaviors.¹⁸⁴ Thus, testing impulsive planetary defense techniques through CBPDS will be regarded as a more threatening move and more like a measure to militarize outer space. In contrast, testing slow push/pull techniques can raise fewer concerns because a skeptical State will be able to monitor the process, ascertain the purpose of the operation, and take defensive measures if the planetary defense operation is likely to cause deliberate, accidental, or incidental harm to its security. Put another way, referring back to the first rationale proposed by Koplow, a State will have more time and opportunities to correctly identify whether another State, in any particular testing of its planetary defense techniques, intends

183. Carl Sagan & Steven J. Ostro, *Long-Range Consequences of Interplanetary Collisions*, 10 ISSUES IN SCIENCE & TECHNOLOGY 67 (1994). *But see* Russell L. Schweickart, *The Real Deflection Dilemma*, AEROSPACE RESEARCH CENTRAL (2004), <https://doi.org/10.2514/6.2004-1467>.

184. *See, e.g.*, Yang Liu, *A Meta-Critique of Frontier Scholarships on the Laws of Peacetime Espionage: Towards A Systemic Framework for Lex Specialis*, 14 CASE WESTERN RESERVE JOURNAL OF LAW, TECHNOLOGY & THE INTERNET 38, 74 (2023) (citing Raphael Bitton, *The Legitimacy of Spying Among Nations*, 29 AMERICAN UNIVERSITY INTERNATIONAL LAW REVIEW 1009, 1022–26 (2014)).

something malicious or aggressive. As a result, whereas this proposed approach cannot totally eliminate concerns about arms races, this article is optimistic that it can substantially reduce the risk to an acceptable level.

This proposed approach has its drawbacks. For example, some scientists have noted different planetary defense techniques have different application scenarios. The selection of techniques thus cannot be arbitrary but must be based on objective factors including the “size and density of the object, its orbit, and the time available before the predicted impact.”¹⁸⁵ Thus, it is not impossible that we will encounter a NEO that must be deflected with impulsive planetary defense techniques. Some might also highlight that the only planetary defense technique that has been tested at this time is the kinetic impactor. So, they might question the reasonableness of prohibiting this relatively mature technique. However, it must be emphasized that the classification of impulsive planetary defense techniques as weapons here only concerns their lawfulness when tested via CBPDS. It will still be legal to test kinetic impactors if they are launched from Earth. From a policy perspective, testing a kinetic impactor via CBPDS is unlikely to serve a substantial interest that cannot be served if it is launched from Earth. In contrast, there are sound reasons to test many kinds of slow push/pull planetary defense techniques through CBPDS. For example, since lasers can be blocked by opaque mediums like asteroids and satellites and might also be impacted by Earth’s atmosphere, using CBPDS to test direct energy planetary defense techniques might achieve better results.

Overall, this article concludes that this nature-based test best balances the need to establish planetary defense capacities in outer space and concern about arms races, over-militarization of outer space, and jeopardizing States’ free access to outer space.

D. Military Maneuvers

We now consider whether the prohibition of “conduct of military maneuvers” puts any restrictions on the use of CBPDS.¹⁸⁶ The term “maneuver” has four meanings in the *DOD Dictionary*:

- (1) A movement to place ships, aircraft, or land forces in a position of advantage over the enemy.
- (2) A tactical exercise carried out at sea, in the air, on the ground, or on a map in imitation of war.
- (3) The operation of a

185. Harris, *supra* note 37, at 35.

186. Outer Space Treaty, *supra* note 63, art. IV.

ship, aircraft, or vehicle, to cause it to perform desired movements. (4) Employment of forces in the battlespace through movement in combination with fires to achieve a position of advantage in respect to the enemy in order to accomplish the mission.¹⁸⁷

These definitions are comparable with and can be summarized by the two definitions in the *Merriam-Webster Dictionary*: “(a) a military or naval movement; (b) an armed forces training exercise.”¹⁸⁸ Other civilian dictionaries also define “maneuver” in a similar manner.¹⁸⁹

Compared to other clauses discussed above, the application of the military maneuver clause is relatively easy and straightforward. Since, as concluded in Section III(B), it is likely that a State is prohibited from running its CBPDS with armed forces and military personnel, the military maneuver clause generally does not further restrict a State’s use of CBPDS because neither military movement nor training can occur when there are only civilians operating CBPDS. The only function this clause can play in our discussion is perhaps to reinforce the conclusion that CBPDS cannot be controlled by armed forces. Otherwise, it might be difficult or even impractical to differentiate a test of planetary defense techniques for peaceful purposes and an “armed forces training exercise.”¹⁹⁰

E. Necessary for Peaceful Exploration

The last sentence of Article IV of the OST provides that “[t]he use of any equipment or facility necessary for peaceful exploration of the moon and other celestial bodies shall . . . not be prohibited.”¹⁹¹ In analyzing the relevance of this provision to the lawfulness of CBPDS, we have to consider two issues: (1) what is the relationship between this clause and preceding provisions that prohibit “military bases, installations and fortifications” and “testing of weapons”? Specifically, does this clause carve out an exception to these preceding provisions or are they totally independent? (2) If this clause carves out an exception, can establishing and using CBPDS be regarded as

187. Joint Publication 1-02, *supra* note 144, at 316.

188. *Maneuver*, MERRIAM-WEBSTER DICTIONARY, <https://www.merriam-webster.com/dictionary/maneuver> (last visited Nov. 15, 2023).

189. *E.g.*, *Maneuver*, CAMBRIDGE DICTIONARY, <https://dictionary.cambridge.org/us/dictionary/english/maneuver?q=Maneuver> (last visited Nov. 15, 2023) (“a planned and controlled movement of military forces”).

190. Outer Space Treaty, *supra* note 63, art. IV.

191. *Id.*

“necessary for peaceful exploration” and thus fall into this exception? If we answer both questions affirmatively, it seems that it will be legal for a State to establish CBPDS on celestial bodies even if it constitutes a military installation. And even if a particular planetary defense technique constitutes a weapon, a State is still allowed to test it via CBPDS.

According to the *DOD Dictionary*, “equipment” has a broad definition and comprises “all *nonexpendable* items needed to outfit or equip an individual or organization.”¹⁹² “Facility” means a “real property entity consisting of one or more of the following: a building, a structure, a utility system, pavement, and underlying land.”¹⁹³ The definitions of these two terms in civilian dictionaries are also very broad in scope. For example, the *Merriam-Webster Dictionary* indicates that “equipment” includes “the set of articles or physical resources serving to equip a person or thing” like “the implements used in an operation or activity” and “all the fixed assets other than land and buildings of a business enterprise.”¹⁹⁴ “Facility” comprises “something that makes an action, operation, or course of conduct easier” as well as “something . . . that is built, installed, or established to serve a particular purpose.”¹⁹⁵

A textual analysis thus indicates that “military bases, installations and fortifications” can qualify as both “equipment” and “facilities.” In contrast, however, “weapons” are clearly not “facilities,” and it is ambiguous whether they constitute “equipment.” An important difference between the *DOD Dictionary* and most civilian dictionaries is that only the former requires “equipment” to be “nonexpendable.” If the civilian dictionary’s definition is adopted, it seems that weapons can constitute equipment under a pure textualist approach, and we thus need to proceed to analyze whether it is necessary for peaceful exploration to test some kinds of weapons like impulsive planetary defense techniques through CBPDS. But if the DOD’s definition is adopted, most weapons as well as impulsive planetary defense techniques will not be covered.

Ascertaining the textual meaning, however, does not conclude our discussion. The relationship between the “necessary for peaceful exploration” clause and the preceding prohibitive clauses must also be analyzed in light of the *travaux préparatoires* of the OST. As noted above in Section III(B), the

192. Joint Publication 1-02, *supra* note 144, at 184 (emphasis added).

193. *Id.* at 193.

194. *Equipment*, MERRIAM-WEBSTER DICTIONARY, <https://www.merriam-webster.com/dictionary/equipment> (last visited Nov. 16, 2023).

195. *Facility*, MERRIAM-WEBSTER DICTIONARY, <https://www.merriam-webster.com/dictionary/facility> (last visited Nov. 16, 2023).

originally proposed language was “[t]he present Treaty does not prohibit the use of any types of personnel or equipment for scientific research or any other peaceful purpose.”¹⁹⁶ Because of the disagreements of the Soviets and the concern that this might cause a loophole leading to arms races in outer space, the final version of the OST strikes out the term “equipment” and reads “[t]he use of military personnel for scientific research or for any other peaceful purposes shall not be prohibited.”¹⁹⁷ At the same time, however, the final OST adds a new clause that was not in the originally proposed version and provides that “[t]he use of any equipment or facility necessary for peaceful exploration of the moon and other celestial bodies shall also not be prohibited.”¹⁹⁸

Compared to the original language, the compromised language added the term “facility,” which indicates that the scope and meaning of “any equipment or facility” were not intended to be narrowly construed. Besides, since the term “any” is preserved, military equipment and facility should also be covered by the provision. Some have argued that the term “any equipment or facility” shall not be interpreted as covering “military bases, installations and fortifications” and “weapons” because if this was what the drafters wanted, they could have “repeated” these terms instead of using a new term “equipment or facility.”¹⁹⁹ However, the problem with this argument is that the textual definition of “equipment and facility” is broader than that of “bases, installations and fortifications” and “weapons.” Thus, it is possible that the drafters did not repeat the words not because they wanted to exclude either “military bases, installations and fortifications” or “weapons,” but simply because they wanted the provision to have broader coverage. Since the *travaux préparatoires* do not explain the rationale for selecting the term “equipment and facility” and the original intent cannot be unambiguously inferred, this article argues that the textual meaning should prevail. Therefore, the “necessary for peaceful exploration” provision should not be interpreted as independent of preceding prohibitions; instead, the better interpretation is that it carves out an exemption to them.

196. Comm. on the Peaceful Uses of Outer Space, U.N. Doc. A/AC.105/35, *supra* note 129, at 4.

197. Outer Space Treaty, *supra* note 63, art. IV.

198. *Id.*

199. Ryan Esparza, *Event Horizon: Examining Military and Weaponization Issues in Space by Utilizing the Outer Space Treaty and the Law of Armed Conflict*, 83 JOURNAL OF AIR LAW & COMMERCE 333, 347–48 (2018).

This exemption, however, must be narrowly interpreted. The most significant difference between the originally proposed language and the final version of the OST is that while the former allows the use of any equipment for “scientific research or *any* other peaceful purpose,”²⁰⁰ the latter only recognizes “peaceful exploration of the moon and other celestial bodies” as a legitimate purpose.²⁰¹ Moreover, the final provision also requires the use of equipment and facility to be “necessary” for such a purpose to be covered.²⁰²

Does the peaceful exploration of celestial bodies necessarily require the establishment of CBPDS? At least for the near future, the answer seems to be clearly negative. Because the mission of planetary defense at this time is merely to defend Earth against NEOs, the relationship between planetary defense (and the establishment of CBPDS) and peaceful exploration of outer space is very weak. While it is possible that some “common infrastructure for NEO scientific and planetary defense missions” will be established in the future,²⁰³ such dual-use CBPDS will also not be covered by the exemption provision because the *travaux préparatoires* imply that the contracting States did not intend “peaceful exploration” to cover “scientific research,” otherwise there would be no need to divide the originally proposed clause into two subclauses.

Admittedly, in the long run, after a high degree of colonization of the moon, Mars, or other celestial bodies is achieved, the mission of planetary defense can be extended to protect not only Earth but also those extraterrestrial colonies from the harmful impacts of threatening asteroids or meteors. At that time, the establishment of CBPDS might become “necessary for peaceful exploration” of these celestial bodies and thus fall into the exemption clause. Then, we might have to dig deeper into analyzing the meaning of the term “necessary.” But for now, this article is satisfied to conclude that the “necessary for peaceful exploration” clause will not legalize an otherwise-prohibited use of CBPDS.

200. Comm. on the Peaceful Uses of Outer Space, U.N. Doc. A/AC.105/35, *supra* note 129, at 4.

201. Outer Space Treaty, *supra* note 63, art. IV.

202. *Id.*

203. Robert Adams & Rodney Wilks, *Common Infrastructure for Neo Scientific and Planetary Defense Missions*, NTRS-NASA TECHNICAL REPORTS SERVER (Jan. 1, 2009), <https://ntrs.nasa.gov/citations/20090026019>.

F. International Oversight

Because of the risk that CBPDS can be used for non-peaceful purposes, it is important to have an effective international oversight mechanism. Whereas Article XII of the OST specifically addresses international inspection and oversight of States' activities on the moon and other celestial bodies,²⁰⁴ its requirement is not strict enough and creates many loopholes.²⁰⁵

Article XII of the OST provides that:

All stations, installations, equipment and space vehicles on the moon and other celestial bodies shall be open to representatives of other State Parties to the Treaty on the basis of reciprocity. Such representatives shall give reasonable advance notice of a projected visit, in order that appropriate consultations may be held and that maximum precautions may be taken to assure safety and to avoid interference with normal operations in the facility to be visited.²⁰⁶

There is no doubt that this provision was designed to supplement Article IV of the OST to prevent arms races in outer space and the militarization of celestial bodies.²⁰⁷ And just like Article IV, this provision received extensive debates during the negotiation process.²⁰⁸ Whereas countries, including the United States, preferred a comprehensive, unqualified, and unlimited right to inspect another State's installations on celestial bodies,²⁰⁹ countries, including the Soviet Union, rejected this broad inspection right and insisted to impose certain conditions on it to prevent harmful interference with normal operations.²¹⁰ Finally, contracting States were able to agree on a final version

204. Outer Space Treaty, *supra* note 63, art. XII.

205. *See, e.g.*, NICOLAS MATEESCO MATTE, SPACE ACTIVITIES AND EMERGING INTERNATIONAL LAW 321 (1984) (noting that “the requirement of compulsory advance notice and the principle of reciprocity dilute considerably the potency of the clause”).

206. Outer Space Treaty, *supra* note 63, art. XII.

207. MATTE, *supra* note 205, at 321.

208. *See generally* Dembling & Arons, *supra* note 111, at 447–51.

209. *See id.* at 448. The original provision proposed by the United States as Article 6 did not contain any restrictive provisions: “All areas of celestial bodies, including all stations, installations, equipment, and space vehicles on celestial bodies, shall be open at all times to representatives of other States conducting activities on celestial bodies.” *See* Comm. on the Peaceful Uses of Outer Space, Letter Dated 16 June 1966 from the Permanent Representative of the United States of America Addressed to the Chairman of the Committee on the Peaceful Uses of Outer Space, U.N. Doc. A/AC.105/32, at 5 (June 17, 1966).

210. Dembling & Arons, *supra* note 111, at 448.

of the inspection provision, but this compromised clause is likely to lead to both treaty interpretation disagreements and practical workability concerns.

To begin with, Article XII subjects the right to inspection “on the basis of reciprocity.”²¹¹ But it left the critical term “reciprocity” undefined. The *travaux préparatoires* indicate that the requirement of reciprocity was first introduced by the Soviets.²¹² After it was introduced, many delegates interpreted this requirement as conferring a right to reject another State’s inspection request as long as it had no intention to inspect other States’ installations on celestial bodies.²¹³ This interpretation will clearly further limit the value of Article XII in preventing the militarization of celestial bodies. Thus, when agreeing to add the principle of reciprocity to Article XII, the U.S. delegate made it clear that it did not intend this principle to give a State the right to reject inspection.²¹⁴ Instead, it stated that the principle of reciprocity simply means that a State cannot avail itself of this provision and require an inspection of another State’s installations if it has first denied an inspection request on it.²¹⁵ The U.S.’s interpretation has been endorsed by most space law scholars thus far.²¹⁶ However, a caveat is that the *travaux préparatoires* do not indicate that the Soviet Union or other contracting States explicitly accepted the U.S.’s interpretation. Thus, there remains the risk that a State will revive the narrow interpretation and claim a right to refuse inspection of its installations.

211. Outer Space Treaty, *supra* note 63, art. XII.

212. See Dembling & Arons, *supra* note 111, at 449. Some have argued that the reciprocity provision can encourage openness and reduce duplicate efforts. See Timothy M. Bass, *Persistent Optimism: The Inherency of Security Within International Space Law*, 31 FLORIDA JOURNAL OF INTERNATIONAL LAW 257, 266 (2019) (“The reciprocity-based approach encourages openness as well as efficiency. For instance, states may choose to focus on a variety of studies to gather more breadth of science if they know they can utilize each other’s facilities. While this certainly builds transparency and cooperation, it also encourages more efficient exploration with opportunities to decrease duplication of efforts.”). But the *travaux préparatoires* indicate that this was not the original purpose why the reciprocity provision was introduced. Instead, the sole purpose was to prevent harmful interference with normal space operations. See Dembling & Arons, *supra* note 111, at 448–49.

213. Dembling & Arons, *supra* note 111, at 449 (citing the statements of Australian, Mexican, and UK delegates).

214. Comm. on the Peaceful Uses of Outer Space, U.N. Doc. A/AC.105/C.2/SR.70, *supra* note 138, at 6–7.

215. *Id.*

216. E.g., Christopher M. Petras, “Space Force Alpha” Military Use of the International Space Station and the Concept of “Peaceful Purposes”, 53 AIR FORCE LAW REVIEW 135, 162 (2002); Bin Cheng, *The 1967 Outer Space Treaty*, 95 JOURNAL DU DROIT INTERNATIONAL 532 (1968).

Besides, another critical issue is whether a State has a duty to provide transportation and expenses to States that visit and inspect its installations in good faith. The text of Article XII does not contain any such requirements.²¹⁷ But if the visited State has no obligation to support a good faith inspection request, Article XII will possibly degrade into a tool of great power competition because few States have both technical and financial capacities to inspect another State's installations in outer space.²¹⁸ Some have argued that Article XII should be read as establishing a "latent duty on the developed nations" to provide assistance to countries lacking the capacity to carry out Article XII inspections.²¹⁹ But such an approach did not receive wide support from space lawyers and scholars, and it is unlikely that powerful States will accept this interpretation.

A comparison of Article XII with other international oversight mechanisms raises questions about its workability. While the language of OST was heavily influenced by the Antarctica Treaty, the Antarctica Treaty has a more robust international oversight mechanism. According to Article VII of the Antarctic Treaty, each contracting State has the right to designate observers to inspect another State's bases in the Antarctic.²²⁰ The visiting State does not have to give advance notice or meet any reciprocity requirements.²²¹ Instead, the designated observers have "complete freedom of access at any time to any or all areas of Antarctica" in carrying out their inspections.²²² And the visited State must cooperate by opening all their stations, installations, and equipment "at all times" to all observers.²²³ Moreover, the Antarctic Treaty imposed an affirmative duty on each State to inform all other contracting States whenever it intends to introduce any military personnel or equipment to Antarctica.²²⁴

Admittedly, the oversight mechanism under the Antarctica Treaty still shares many similarities with that under the OST. For example, it does not

217. Leslie I. Tennen, *Enterprise Rights and the Legal Regime for Exploitation of Outer Space Resources*, 47 UNIVERSITY OF THE PACIFIC LAW REVIEW 281, 295 (2016).

218. Matthew Schaefer, *The Contours of Permissionless Innovation in the Outer Space Domain*, 39 UNIVERSITY OF PENNSYLVANIA JOURNAL OF INTERNATIONAL LAW 103, 147 (2017).

219. Harminderpal Singh Rana, *The "Common Heritage of Mankind" & the Final Frontier: A Reevaluation of Values Constituting the International Legal Regime for Outer Space Activities*, 26 RUTGERS LAW JOURNAL 225, 245 (1994).

220. Antarctic Treaty, *supra* note 131, art. VII.

221. *Id.*

222. *Id.*

223. *Id.*

224. *Id.*

mention technological and financial assistance and thus might deprive many States' right to access and inspection.²²⁵ But we should emphasize that while the Antarctic area has important strategic value, it is not comparable with the potential strategic importance of outer space, including the moon, Mars, and other celestial bodies.²²⁶ Thus, it can be expected that the chance that a State will undertake the risk to violate international space laws and build military bases on celestial bodies is substantially greater than that of militarizing the Antarctic. If we focus on international oversight mechanisms that are established to deal with comparable risks, we find that they are much stronger than those in the Antarctic Treaty.

For example, a helpful reference is the international oversight system of nuclear materials and technologies. Unlike the State-centered inspection mechanism in the Antarctic Treaty and the OST, a specific international body, the International Atomic Energy Agency (IAEA), was established to promote peaceful uses and prevent military uses of nuclear technologies.²²⁷ Article XII of the IAEA founding treaty authorized broad powers to it to (1) examine a State's nuclear equipment and facilities, (2) prescribe safeguards and require a violating State to observe them, (3) require a State to maintain and provide operating records to assist the IAEA's investigation, (4) review a violating State's remedy measure and progress, (5) approve the measure used to process irradiated materials, (6) send representatives to a State to investigate potential violations, who "shall have access at all times to all places and data and to any person" reasonably related to the investigation, and (7) suspend or terminate a State's right to receive any nuclear materials and equipment from the IAEA and member States.²²⁸ The oversight function of the IAEA was later further enhanced by Article III of the Nuclear

225. *See id.*

226. Armel Kerrest, *Outer Space as International Space: Lessons from Antarctica*, in *SCIENCE DIPLOMACY: ANTARCTICA, SCIENCE, AND THE GOVERNANCE OF INTERNATIONAL SPACES* 133 (Paul Berkman et al. eds., 2011) ("we must keep in mind that outer space is much more sensitive for strategy and defence than Antarctica; the vision of a dominance of the Earth through space dominance is commonplace in geostrategic theories").

227. Statute of the International Atomic Energy Agency art. I, Oct. 26, 1956, 8 U.S.T. 1093, 276 U.N.T.S. 3.

228. *Id.* art. XII.

Non-Proliferation Treaty, which made it a requirement for all non-nuclear weapon States²²⁹ to accept the IAEA safeguard system.²³⁰

Equipped with these powers, the IAEA has been generally successful in ensuring and promoting nuclear safety.²³¹ However, we must also highlight that while the IAEA has performed an excellent job in overseeing the non-proliferation of nuclear weapons and peaceful uses of nuclear materials and technologies, the oversight mechanism is still not enough to completely prevent the proliferation of nuclear weapons. For example, there is evidence that Iran, Libya, and Syria, all signatories to the NPT, have actively pursued the development of their military nuclear capacities.²³²

Therefore, considering the comparable or even stronger strategic importance of outer space and the substantially weaker oversight mechanism, it is not surprising that some space lawyers have predicted that there are only “vague hopes” that the current international space law can effectively prevent the military use of celestial bodies and an arms race in outer space.²³³

IV. CONCLUSION AND WAYS FORWARD

This article discussed legal issues concerning the establishment and use of CBPDS, or celestial body-based planetary defense systems. The importance of this topic is primarily twofold. On the one hand, there exists the risk that a State will use planetary defense as a pretext to militarize celestial bodies. On the other hand, using CBPDS to conduct planetary defense activities has many unique advantages and might be an indispensable part of future planetary defense.

Under the current international space law, the lawfulness of the establishment and use of CBPDS depends primarily on Article IV of the OST, which is the core provision in preventing arms races and promoting peaceful

229. Non-nuclear weapon States are States that had not “manufactured and exploded a nuclear weapon or other nuclear explosive device prior to 1 January 1967.” See Treaty on the Non-Proliferation of Nuclear Weapons art. IX, July 1, 1968, 21 U.S.T. 483, T.I.A.S. 6839, 729 U.N.T.S. 161.

230. *Id.* art. III.

231. See generally ELISABETH ROEHLICH, INSPECTORS FOR PEACE: A HISTORY OF THE INTERNATIONAL ATOMIC ENERGY AGENCY (2022).

232. *Nuclear Weapons: Who Has What at a Glance*, ARMS CONTROL ASSOCIATION (last reviewed June 2023), <https://www.armscontrol.org/factsheets/Nuclearweaponswhohaswhat>.

233. Todd Barnet, *United States National Space Policy, 2006 & 2010*, 23 FLORIDA JOURNAL OF INTERNATIONAL LAW 277, 289 (2011).

uses of outer space. However, since Article IV is a product of significant compromise between the United States and Soviet Union, and because it was drafted before planetary defense became globally recognized as a legitimate mission, the application of Article IV to analyze the lawfulness of CBPDS can lead to many ambiguities and disagreements that have yet to be addressed, which creates loopholes in the current international space laws that might be maliciously utilized by States to jeopardize the missions to prevent arms races in outer space and to protect all States' free access to outer space.

This article has proposed a reading of Article IV to balance the need to develop celestial body-based planetary defense capacities and the risk of militarization of celestial bodies and arms races in outer space. According to this article's approach, neither the "exclusively for peaceful purposes" clause nor the clause prohibiting "military bases, installations and fortifications" on the moon and other celestial bodies prohibit the establishment of CBPDS *per se*, provided that a State does not employ its armed forces to manage and operate its CBPDS and does not use them or intend to use them for any aggressive purposes. However, a State can only use its CBPDS to test slow push/pull planetary defense techniques and shall not test impulsive techniques through CBPDS. Moreover, a State cannot rely on the peaceful exploration exemption in the last sentence of Article IV of the OST to bypass any of these restrictions.

Besides the need to address these substantive legal issues, this article highlighted that the current international space law fails to provide an effective oversight mechanism to ensure the peaceful use of CBPDS. Unlike substantive legal issues that can be addressed through treaty construction, the development of an effective oversight mechanism requires States' endeavor and cooperation, which shall be a high priority in the agenda of the international space community and States aiming to preserve a non-militarized outer space.