Research Note 1

Nuclear Weapons and Outer Space

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The summer of 2020 is the 75th anniversary of the first nuclear weapons test (16 July 1945) and the bombing of Hiroshima (6 August 1945) and Nagasaki (9 August 1945). Since then there have been thousands of additional tests and a proliferation of nuclear weapons. The history of nuclear weapons development and security issues in outer space are inextricably linked. There have also been efforts to limit the spread of nuclear weapons[1], ban explosions of nuclear weapons for test or other purposes[2], establish 'nuclear weapons free zones'[3], and even ban nuclear weapons altogether[4]. Outer space is one of these 'nuclear weapons free zones'[5], and with talk of resuming nuclear testing on Earth[6] and 'nuking' Mars in order to 'terraform' it[7], it is worth discussing this topic.

Nuclear Weapons in Space

There is, at first blush, a great deal of commonality between the development of nuclear weapons and the early years of human space activity. Both activities were contingent upon, and forced the pace of, the development of rocket technology. Both involved technology that was at the very edge of human understanding and there was, perhaps the first genuine collaborative partnership between the military and the science community. Perhaps crucially, both involved the spending of almost unimaginable amounts of money by both superpowers.

[1]Treaty on the Non-Proliferation of Nuclear Weapons (adopted 1 July 1968, entered into force 5 March 1970) 729 UNTS 161 (NPT)

[2]Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water (adopted 5 August 1963, entered into force 10 October 1963) 480 UNTS 43 (Test Ban Treaty/PTBT); Comprehensive Nuclear Test Ban Treaty (adopted 10 September 1996, Not in Force) (CTBT)

[3]Treaty for the Prohibition of Nuclear Weapons in Latin America and the Caribbean (adopted 15 February 1967, entered into force 22 April 1968) (Treaty of Tlatelolco); South Pacific Nuclear Free Zone Treaty (adopted 6 August 1985, entered into force 11 December 1986) 1445 UNTS 177 (Treaty of Rarotonga); Southeast Asian Nuclear-Weapon-Free Zone Treaty (adopted 15 December 1995, entered into force 28 March 1997) (Treaty of Bangkok); African Nuclear-Weapon-Free Zone Treaty (adopted 11 April 1996, entered into force 15 July 2009) (Treaty of Pelindaba); Treaty on a Nuclear-Weapon-Free Zone in Central Asia (adopted 8 September 2006, entered into force 21 March 2009) (Treaty of Semipalatinsk); The Antarctic Treaty (adopted 1 December 1959, entered into force 23 June 1961) 402 UNTS 71; Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies (adopted 27 January 1967, entered into force 10 October 1967) 610 UNTS 205 (Outer Space Treaty/OST); and Treaty on the Prohibition of the Emplacement of Nuclear Weapons and Other Weapons of Mass Destruction on the Sea-Bed and the Ocean Floor and in the Subsoil Thereof (adopted 11 February 1971, entered into force 18 May 1972) UKTS 13/1973 (Seabed Treaty)

[4]Treaty on the Prohibition of Nuclear Weapons (adopted 20 September 2017, Not in Force) (Nuclear Ban Treaty)

[5]Outer Space Treaty, Article IV

[6]Greg Webb, 'Trump Officials Consider Nuclear Testing' *Arms Control Today* June 2020 https://www.armscontrol.org/act/2020-06/news/trump-officials-consider-nuclear-testing

[7]Caroline Dilbert 'Elon Musk Needs 10,000+ Missiles to Nuke Mars. 'No Problem,' He Says' *Popular Mechanics* 19 May 2020 https://www.popularmechanics.com/science/a32588385/elon-musk-terraform-mars-nuclear-missiles/; Mike Wall 'Looks Like Elon Musk is Serious About Nuking Mars' *Space.com* 21 August 2019 https://www.space.com/elon-musk-serious-nuke-mars-terraforming.html#:~:text=Elon%20Musk%20seems%20serious%20about,colonists%20to%20live%20relatively%20comfortably.

By the start of the 1960s, the two superpowers, armed with nuclear weapons and rockets to mount them, would look towards expanding the use of nuclear weapons into space. Following a ferocious period of weapons testing in the 1950s, including the testing of nuclear weapons in the upper atmosphere there was a brief voluntary (i.e. non-treaty) moratorium on testing.

By the 1960s, however, internal Soviet politics had caused Premier Khrushchev to recant and resume nuclear testing. This included testing the awesome Tsar Bomba, a 50-megaton hydrogen bomb (by some distance the most powerful weapon ever tested, and one of 45 nuclear tests conducted by the USSR in October 1961). The USA responded with Operation Dominic, a series of nuclear tests in the Pacific, including Project Fishbowl, a series of high-altitude explosions to test the effects of nuclear weapons in space. Starfish Prime is possibly the best known and most devastating of these tests. Launched on the 9 July 1962, on a Thor Missile, the weapon flew up to 1100km and then arced back down. When at an altitude of 400km, the 1.4 megaton bomb exploded.

The effects of Starfish Prime were significant. Most obvious was the creation of a huge, artificial aurora, visible from thousands of kilometres away. There was the creation of a brief but intensely powerful Electromagnetic Pulse (EMP) which was far more powerful than scientists had predicted. A radiation belt, which persisted at high altitude for many months caused significant damage to a number of satellites. The effects were not limited to space, however, with the EMP causing disruption to domestic telephone lines and electrical supplies in Hawaii (over 900 km from the blast). The effects of this orbital test led to the cancellation of Operation Urraca (a 1 Mt blast at high altitude) for fear of further damaging satellites.

Operation Fishbowl, and Starfish Prime in particular illustrated the extreme dangers of exploding nuclear weapons (even relatively low yield devices) at high altitudes for both the space and terrestrial environments. Added to that, the frenzied pace of testing by both superpowers, the increasingly extreme nature of those tests and the intense damage caused and the political uncertainty of the early 1960s arguably positioned this time as being the closest that humanity has been to the edge of destruction. By 1963, and following the Cuban missile crisis, renewed diplomatic efforts had seen states recognise the dangers posed by unfettered testing of nuclear weapons, including the risk of lasting environmental damage and the proliferation of these weapons. The Partial Test Ban Treaty represented a significant diplomatic breakthrough and was the start of a trend towards nuclear arms control that would continue throughout the 1960s.

Nuclear Weapons Free Zone

There are several treaties which prohibit nuclear weapons in certain areas. There broadly fall into two categories, the regional treaties such as the Treaty of Tlatelolco which covers Latin American and the Caribbean; the Treaty of Rarotonga – the South Pacific; Treaty of Bangkok – Southeast Asia; Treaty of Pelindaba – Africa; and the Treaty of Semipalatinsk. There are also three treaties covering areas of the 'global commons' – the Antarctic Treaty, the Outer Space Treaty and the Seabed Treaty.[8] All three have been acceded to by 4 of the P5 and NPT nuclear powers (US, Russia, UK, and China) and India. France and Pakistan are party to all but the Seabed Treaty.

[8]Becky Alexis-Martin, *Disarming Doomsday: The Human Impact of Nuclear Weapons* (Pluto Press 2019), 82-84, 94-97 (see also, footnote 2)

Outer Space is actually covered by two treaties. Article IV of the Outer Space Treaty stipulates that States cannot

> …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.

While this has generally been interpreted to allow the transit of nuclear weapons through space on ICBMs or similar delivery mechanisms as they are not stationed in outer space nor placed in orbit (this paper does not go into the legality of nuclear weapons as general matter) it fairly clearly establishes outer space as a 'nuclear weapons free zone.' However, it is potentially limited to 'weapons' and not necessarily as broad as 'nuclear explosive device,'[9] of course this is complicated by the general lack of a definition of 'weapon' in international law.[10] However, the Test Ban Treaty of 1963 bans nuclear weapons tests "**or any other nuclear explosion**…[11] "in the atmosphere; beyond its limits, **including outer space…**"[12] (our emphasis). Therefore, even if Article IV OST does not prohibit the placement or storing of non-weapon 'nuclear explosive devices' in outer space the Test Ban Treaty does render it rather pointless to do so given that you can't explode them.

Nuclear Powered Terraforming?

As mentioned, Elon Musk (and others) have posited using nuclear weapons (or nuclear explosive devices) in order to terraform Mars. I will not go into whether this makes any scientific or technical sense I'm just going to focus on international law. I'm also not going to examine the ability of a private citizen or corporation to obtain a nuclear weapon.

Article IV OST may not be as much help to us here as we would like. As mentioned, it would seem, that the article is limited to nuclear *weapons* which used in this proposed manner they would not be. However, the Outer Space Treaty contains another provision which may be relevant here, Article IX. Article IX calls for states to avoid the harmful contamination of celestial bodies such as Mars. Now while 'harmful contamination' hasn't been precisely defined and is generally regarded as relating to 'biological contamination' in the sense of the COSPAR Planetary Protection Policy, radiation and nuclear fallout are certainly *harmful* and *contaminating*, which is why the nuclear Test Ban Treaty was passed in the first place.[13]

And it's the Test Ban Treaty which is the biggest help to preventing nuclear weapons from being set off on Mars. The prohibition on nuclear explosions is all encompassing and includes Mars (as per the Outer Space Treaty, outer space includes 'the celestial bodies' which includes, among other objects, Mars.)

Does this apply to Elon Musk? Yes, although not directly. The obligation not to allow or enable a nuclear explosion in outer space rests upon the United States government (or any other government party to the relevant treaties, but Mr Musk is a US citizen with a US based company so I will use the US as an example), the same is true of the 'harmful contamination'

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[9]Kai-Uwe Schrogl and Julia Neumann 'Article IV' *in* Hobe, S., Schmidt-Tedd, B., and Schrogl, K., (eds), *Cologne Commentary on Space Law*, vol 1 (1st edn, Carl Heymanns Verlag 2009)
[10]Stuart Casey-Maslen and Tobias Vestner *A Guide to International Disarmament Law* (Routledge 2019), 26
[11]PTBT, Article 1.1
[12]PTBT, Article 1.1(a)
[13]See generally, Robert A. Divine, *Blowing on the Wind: The Nuclear Test Ban Debate 1954-1960* (OUP 1978)

provision in Article IX of the OST. However, the United States has an obligation under international law (Article VI OST) to 'authorise and continually supervise' the activities of their nationals in outer space, this, of course includes Elon Musk and SpaceX (who do have an obligation under US law to get a licence for space activities.)[14] The United States cannot authorise a citizen or corporation to bring about a nuclear explosion in outer space. 'Harmful contamination' is less clear cut, so I would focus on the Test Ban Treaty but I would also argue that setting off a nuclear device also constitutes harmful contamination and would therefore also be something the United States could or should authorise. Using nuclear devices to 'terraform' Mars is therefore a violation of international law.

Keep Space Nuclear (Weapon) Free

Nuclear weapons are abhorrent. A sizeable proportion of UN members have made their opposition to nuclear weapons clear.[15] And the 5 Permanent Members of the UN Security Council, the 'founding members' of the 'nuclear club' have all undertaken binding international obligation to abolish nuclear weapons.[16] Nuclear weapons must not spread into outer space. International law makes this clear. Further, the space community should take better care of how these weapons are discussed. It is irresponsible, morally reprehensible to discuss a weapon of mass destruction, a weapon that has caused considerable death and destruction and continues to threaten Armageddon in the flippant manner which Elon Musk does, particularly at a time of increasing nuclear tension. We should work towards a future without nuclear weapons. It is possible, and given that the supposed point of settling Mars is to enable humanity to escape the existential threats we face, it seems logical to work towards removing one of those human made threats.

[14]US Code Title 51, Chapter 509, Section 50904– whether or not this element of US law would cover 'terraforming Mars' is a reasonable question but beyond the scope of this paper; a launch licence would be needed at some point in the endeavour and the US Congress has expanded the scope of the law to cover new activities in the past (see space resources et al) so it is reasonable to assume they will continue to do so.

[15]*Legality of the Threat or Use of Nuclear Weapons*, Advisory Opinion, I.C.J. Reports 1996, p. 226, para 62-62 and 73

[16]NPT, Art 6