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Nuclear Semiotics, Atomic Tourism, and International Law: Tourism to the Chernobyl Site

Cannon Lane†

> "[A] misfortune has befallen us - the accident at the Chernobyl nuclear power plant. It has painfully affected Soviet people and caused the anxiety of the international public. For the first time ever we encountered in reality such a sinister force as nuclear energy that has escaped control."
>
> - Mikhail S. Gorbachev[1]

I. Introduction

On July 16, 1945, Manhattan Project scientists gathered in a New Mexico desert to test the first atomic bomb.[2] At 5:29:45 A.M.,

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1 *Excerpts from Gorbachev's Speech on Chernobyl Accident*, N.Y. TIMES, May 15, 1986, https://www.nytimes.com/1986/05/15/world/excerpts-from-gorbachev-s-speech-on-chernobyl-accident.html [https://perma.cc/2QC2-2K9B].

2 *See Trinity Site – World's First Nuclear Explosion,* ENERGY.GOV, https://www.energy.gov/management/trinity-site-worlds-first-nuclear-explosion [https://perma.cc/EP85-57TL] (last visited Aug. 12, 2020).

scientists detonated the device.[3] The bomb, known as "Gadget," instantly vaporized the tower from which it was launched, "turning the surrounding asphalt and sand into green glass."[4] As he watched the explosion, lead Manhattan Project Scientist, J. Robert Oppenheimer, famously recited a line from Hindu scripture: "Now I am become Death, destroyer of worlds."[5]

Though the initial blast from Gadget resulted in no casualties, the radiation created by the bomb had a lasting and damaging effect on the surrounding communities.[6] Since the test, the communities located downwind from the detonation site (known as "Downwinders")[7] have been plagued by the then-unknown side effects of nuclear radiation.[8] Though Downwinders were not immediately exposed to the blast, these tests would have lasting health effects on civilians in the area.[9] After the detonation, radioactive fallout landed on vegetables and grasses in the area.[10] Downwinders ate the vegetables, and local livestock ate the grasses.[11] Downwinders then drank milk from these livestock, which contained high amounts of radionuclides.[12] Children especially were exposed to radiation through this chain of events.[13]

Though no studies on the after-effects of Gadget on the surrounding community were conducted at that time or in the years following the detonation, eating foods with high levels of radiation

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3 *Trinity Test – 1945*, ATOMIC HERITAGE FOUND. (June 18, 2014), https://www.atomicheritage.org/history/trinity-test-1945 [https://perma.cc/9JPV-Q5AV].

4 *Trinity Site – World's First Nuclear Explosion*, *supra* note 2.

5 Becky Little, *"Father of the Atomic Bomb" Was Blacklisted for Opposing H-Bomb*, HIST. (Aug. 31, 2018) (internal quotations omitted), https://www.history.com/news/father-of-the-atomic-bomb-was-blacklisted-for-opposing-h-bomb [https://perma.cc/K3QA-92BE].

6 *Trinity Test – 1945*, *supra* note 3.

7 *Id.*

8 *See id.*; *Tularosa Basin Downwinders*, ATOMIC HERITAGE FOUND. (July 31, 2018), https://www.atomicheritage.org/history/tularosa-basin-downwinders [https://perma.cc/H8PX-PSEJ].

9 *See Nevada Test Site Downwinders*, ATOMIC HERITAGE FOUND. (July 31, 2018), https://www.atomicheritage.org/history/nevada-test-site-downwinders [https://perma.cc/3AKT-4XCN].

10 *Id.*

11 *Id.*

12 *Id.*

13 *Id.*

has since been proven to cause stillbirths, cancers, and birth defects, and radioactive exposure can cause epigenetic changes, or gene mutations, in exposed persons.[14] These genetic changes have a lasting effect since they are passed down indefinitely and hereditarily to successive generations.[15] Downwinders continue to suffer from the effects of this first atomic detonation, long after the catastrophic damage imposed by the initial blast.[16]

Since this first explosion, scientists have learned much more about the effects of the radiation emitted by atomic bombs and by nuclear energy, changing our perspective of both time and energy.[17] Radioactivity exists on a timeline of millennia; its half-life is thought to be roughly 10,000 years.[18] This means that scientists now face the problem of protecting future generations from the effects of our nuclear waste and, consequently, effectively communicating these efforts to a society 10,000 years in the future.[19]

This issue, dubbed "nuclear semiotics,"[20] confronts the problem that language decays much more quickly than radioactivity.[21] In other words, while the radioactive materials we now create will survive to harm future generations tens of thousands of years in the future, our language will not survive that same length of time.[22] The nuclear waste will survive, but our ability to communicate will not.[23] The lifespan of a language is nothing compared with that of radioactivity.[24] To illustrate, *Beowulf*, written just 1,000 years ago,

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14 *Tularosa Basin Downwinders*, *supra* note 8.

15 *Id.*

16 *See id.*

17 *See* Scott Beauchamp, *How to Send a Message 1,000 Years to the Future,* ATLANTIC (Feb. 24, 2015),
https://www.theatlantic.com/technology/archive/2015/02/how-to-send-a-message-1000-years-to-the-future/385720/ [https://perma.cc/PW4F-FXPZ].

18 *See id.*

19 *See id.* ("How do we tell our distant descendants where nuclear waste is buried and that it's dangerous for humans to be around?").

20 "Nuclear semiotics" may be understood as "human communication along nuclear time." *Id.*

21 *See id.*

22 *See id*.

23 *See* Beauchamp, *supra* note 17.

24 *See id.*

is one of the first written works in the English language.[25] It begins, "*Hwaet wē Gār-Dena in geār-dagum þēod-cyninga þrym gefrūnon*, *hū ðā aeplingas ellen fremedon*."[26] In modern English, this passage reads: "So. The Spear-Danes in days gone by and the kings who ruled them had courage and greatness."[27] If this amount of change can occur in just 1,000 years, what change can we expect in 10,000 years? And how can we communicate the existence and the dangers of radioactive sites that will remain just as deadly long after our language has changed too much to provide any effective warning?

To solve this problem, we may see communication revert to its earliest and most basic forms. Some in the nuclear semiotics field suggest using symbols, such as a skull and crossbones, engraved in stone to communicate the deadly nature of the site.[28] Others argue that the best way to protect future civilizations would be to leave the sites unmarked and hidden to prevent humans from intentionally seeking out these dangerous sites.[29]

The latter approach acknowledges the reality of a growing sector of the travel market in which people intentionally visit sites of destruction and past horrors, known as "dark tourism."[30] Atomic tourism, a subsection of dark tourism, encompasses tourists who travel across the world to visit nuclear sites, despite the dangers these sites pose due to lingering radiation.[31]

This paper will address the issue of how to protect persons from exposure to radioactive waste both at present and in the future as tourists increasingly travel to radioactive sites. In particular, this

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25 *See id.*; *Beowulf,* BRIT. LIBR, https://www.bl.uk/learning/timeline/item126510.html [https://perma.cc/5434-XHYB] (last visited Aug. 25, 2020).

26 *Beowulf (Old English Version)*, POETRY FOUND., https://www.poetryfoundation.org/poems/43521/beowulf-old-english-version [https://perma.cc/VC6G-G98L] (last visited Nov. 24, 2019).

27 SEAMUS HEANEY, BEOWULF: A NEW VERSE TRANSLATION 2-3 (Seamus Heaney trans., 2000).

28 *See* Beauchamp, *supra* note 17.

29 Robert Reid, *Is 'Dark Tourism' OK?*, NAT'L GEOGRAPHIC (Apr. 26, 2016), https://www.nationalgeographic.com/travel/features/is-dark-tourism-ok-chernobyl-pripyat-disaster-sites/ [https://perma.cc/F9LD-G66W].

30 Reid describes "dark tourism" as "visiting places associated with death and suffering[.]" *Id.* (internal quotations omitted).

31 *See*, *id.*

paper will address the recent efforts by the Ukrainian government to convert the Chernobyl nuclear site into a tourist attraction. Part II will explore the classification and regulation of radioactive materials. Next, Part III will examine international law as it applies to atomic tourism, while also providing recommendations for how international organizations can help combat the issues posed by nuclear semiotics. Finally, Part IV will conclude that, while the current nuclear waste regulations ensure the safe traveling of nuclear materials and the disposal of radioactive waste, they fail to account for the dangers that nuclear materials pose to those persons intentionally seeking out radioactive sites through atomic tourism.

II. Classification and Regulation of Radioactive Waste

Radioactive or nuclear waste is generated by "nuclear reactors, fuel processing plants, hospitals, and research facilities[,]" as well as by "decommissioning and dismantling nuclear reactors and other nuclear operations facilities."[32] In the United States, spent nuclear fuel, or fuel that is no longer able to produce electricity, is typically stored in "spent fuel pools" made of several feet of reinforced concrete lined with steel.[33] In these pools, spent nuclear waste is submerged in approximately forty feet of water, which serves as both a protective barrier against radioactivity and as a means of cooling the radioactive waste.[34] After three to ten years in the spent fuel pools, spent fuel is moved to "dry cask" storage, where it is kept in stainless steel canisters surrounded by concrete.[35]

The method of long-term storage for nuclear waste depends on the characteristics of the waste itself.[36] In the United States, for purposes of regulation, disposal, and safety, waste is divided into two broad classifications: high-level and low-level.[37] High-level waste is produced from the manufacture of electricity, while low-level waste originates from commercial use of radioactive

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32 U.S. NUCLEAR REG. COMM'N, BACKGROUNDER: RADIOACTIVE WASTE 1 (2019), https://www.nrc.gov/docs/ML0501/ML050110277.pdf [https://perma.cc/YX6R-7S9L] [hereinafter BACKGROUNDER: RADIOACTIVE WASTE].

33 *Id.* at 1-2.

34 *Id.* at 2.

35 *See id.*

36 *See id.* at 1-2.

37 *See* BACKGROUNDER: RADIOACTIVE WASTE, *supra* note 32, at 1.

materials.[38] High-level waste "produces fatal radiation doses during short periods of direct exposure."[39] High-level radioactive waste remains deadly for thousands of years, producing hazardous radiation with a half-life of 24,000 years.[40] Further, if isotopes from high-level waste leech into water sources, they can cause widespread exposure to radiation if they enter the food chain.[41] Although exposure through consumption is smaller and less deadly than any period of direct exposure to high-level waste, "a much larger population could be exposed."[42] Should nuclear waste continue to leech into water sources, the radiation could, over time, cause significant adverse health effects in exposed populations.[43]

High-level waste is primarily uranium fuel used in nuclear power facilities to produce electricity.[44] However, once the uranium is "spent" and no longer efficient in producing electricity, it becomes high-level waste.[45] Low-level waste, though less dangerous than high-level waste, also presents hazards to human health.[46] Defined as "radioactive wastes other than high-level[,]"[47] low-level waste encompasses matter exposed to radiation which could negatively affect human health.[48] Low-level waste is a broad category used to cover all materials which may have been exposed to radiation, including tools and work clothing from nuclear facilities.[49]

Internationally, foreign countries also adhere to this same classification system for nuclear waste with one notable exception.[50]

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38 *See id.*

39 *Id.*

40 *Id.* at 1-2.

41 *Id.*

42 *Id.* at 2.

43 *See* BACKGROUNDER: RADIOACTIVE WASTE, *supra* note 32, at 1-2.

44 *Id.* at 1-2.

45 *See id.* at 1, 4-5.

46 *See id.*

47 *Id.* at 4.

48 *See id.* at 4-5.

49 BACKGROUNDER: RADIOACTIVE WASTE, *supra* note 32, at 4; *What Is Nuclear Waste, and What Do we Do With it?*, WORLD NUCLEAR ASS'N, https://www.world-nuclear.org/nuclear-essentials/what-is-nuclear-waste-and-what-do-we-do-with-it.aspx [https://perma.cc/NK8M-6EAC] (last visited Aug. 15, 2020) [hereinafter WORLD NUCLEAR ASS'N].

50 *See* WORLD NUCLEAR ASS'N, *supra* note 49.

While the United States treats all radioactive materials created as a byproduct of producing nuclear power as waste, other countries instead categorize some of these byproducts as recyclable materials.[51] These recyclable materials can be used to create more nuclear energy by extracting the plutonium and uranium and reusing the recycled materials in conventional reactors.[52] "France, Japan, Germany, Belgium and Russia have all used plutonium recycling to generate electricity, whilst also reducing the radiological footprint of [] waste" from their facilities.[53]

Due to the differences in each of these types of waste, different regulations govern their disposal.[54] All waste moves through a series of storage phases, with different methods and regulations governing short and long-term storage methods.[55] Short term storage methods, which can last for up to forty years,[56] use spent waste fuel pools followed by a period of storage in dry cask storage units.[57] "Deep geological disposal" is the current, most widely favored method of long-term high-level waste disposal.[58] In this method of storage, radioactive nuclear waste is encased in dry casks and buried far below the earth's surface.[59] Salt deposits are particularly appealing sites for this type of storage.[60] The salt acts as a barrier between the radioactive waste and other substances.[61] Additionally, the existence of the salt signals that the environment is dry and less likely to interact with groundwater which the radiation might leech into otherwise.[62] "Deep geological disposal is the preferred option for nuclear waste management in several

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51 *Id.*

52 *Id.*

53 *Id.*

54 *See id.*

55 *See* WORLD NUCLEAR ASS'N, *supra* note 49.

56 *See* U.S. NUCLEAR REG. COMM'N, *supra* note 31; BACKGROUNDER: RADIOACTIVE WASTE, *supra* note 32, at 1-2.

57 *See* BACKGROUNDER: RADIOACTIVE WASTE, *supra* note 32, at 1-2.

58 *Storage and Disposal of Radioactive Waste*, WORLD NUCLEAR ASS'N, https://www.world-nuclear.org/information-library/nuclear-fuel-cycle/nuclear-waste/storage-and-disposal-of-radioactive-waste.aspx [https://perma.cc/F9QX-SEH3] (last updated Mar. 2020).

59 *See id.*

60 *Id.*

61 *Id.*

62 *Id.*

countries, including Argentina, Australia, Belgium, Canada, Czech Republic, Finland, France, Japan, the Netherlands, Republic of Korea, Russia, Spain, Sweden, Switzerland," the United Kingdom, and the United States.[63]

III. International Law and Atomic Tourism

Travel to sites such as Auschwitz, the ruins of Pompei, and the catacombs of Rome and Paris, to name a few, highlight the allure of sites of death and devastation.[64] This type of macabre travel, dubbed "dark tourism,"[65] is neither novel nor infrequent.[66] Instead, it represents a significant and popular form of travel.[67]

Over years of studying dark tourism, sociologists have posited several theories about what draws humanity to these sites of mass death and devastation.[68] While a number of theories have been proposed, research largely converges into three main categories of motivations.[69] First, sociologists suggest that people travel to these sites as a means of contemplating life and death.[70] While dark tourism was originally viewed as a morbid fascination with death,[71] later studies have reframed this draw instead as an examination of mortality and an attempt to make sense of horrific and dehumanizing events.[72] Under this framework, people visit these sites in an attempt to understand how and why such devastation occurs.[73] Second, sociologists suggest that education and remembrance motivate people to visit these sites.[74] Sociologists

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63 *Id.*

64 *See*, *e.g.*, Beauchamp, *supra* note 17.

65 *See, e.g.*, Philip R. Stone, *Dark Tourism Consumption – A Call for Research*, 3 E-REV. OF TOURISM RSCH., 109, 112 (2005).

66 *See id.* at 112.

67 *See id.* at 111-12; Reid, *supra* note 29.

68 *See* Stone, *supra* note 65, at 111-15.

69 *See* Avital Biran & Kenneth F. Hyde, *New Perspectives on Dark Tourism*, 7 INT'L J. CULTURE, TOURISM & HOSPITALITY RSCH. 191, 191-98 (2013); Ria Dunkley, Sheena Westwood & Nigel Morgan, *A Shot in the Dark? Developing a New Conceptual Framework for Thanatourism,* 1 ASIAN J. TOURISM & HOSPITALITY RSCH. 54, 56-59 (2007).

70 Biran & Hyde, *supra* note 69, at 114-15.

71 *See id.* at 110.

72 *Id.* at 114-15.

73 *See id.*

74 See *id.* at 111-12.

argue that tourists visiting these sites develop a stronger national identity and connect with history.[75] In this sense, the reality of the physical site can spur an interest in past events as well as a feeling of attachment to the community in which the horror occurred.[76] Third, sociologists acknowledge that tourists visit sites of dark tourism simply for leisure reasons, including entertainment, escape, and relaxation.[77] While the motivations of tourists vary widely, they suggest the potential for the physical markers of often senseless and dehumanizing devastation to bring people together.[78]

A subsection of dark tourism, atomic tourism, or the travel to sites of destructive nuclear events, is undergirded by these same motivations.[79] Atomic tourism, however, is different from the wider

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75 *See id.*; Eldad Brin, *Politically-Oriented Tourism in Jerusalem*, 6 TOURIST STUD., 215, 232–38 (2006).

76 *See id.*

77 *See* Avital Biran & Yaniv Poria, *Re-Conceptualizing Dark Tourism*, *in* CONTEMPORARY TOURIST EXPERIENCE: CONCEPTS AND CONSEQUENCES, 59, 59-62 (Richard Sharpley & Philip Stone eds.,2012); Dunkley et al., *supra* note 69, at 6-9; Rami K. Isaac & Erdinç Çakmak, *Understanding Visitor's Motivation at Sites of Death and Disaster: The Case of Former Transit Camp Westerbork*, the Netherlands, 17 CURRENT ISSUES IN TOURISM, 164, 167-69 (2014); Caroline Winter, *Battlefield Visitor Motivations: Explorations in the Great War Town of Ieper, Belgium*, 13 INT'L J. TOURISM RSCH., 164, 164-66 (2011).

78 *See*, *e.g.*, Biran & Poria, *supra* note 77, at 59-62; Dunkley et al., *supra* note 69, at 3.

79 *See generally* JOHN LENNON & MALCOLM FOLEY, DARK TOURISM (2000) (seeking to explain the phenomenon of dark tourism through various illustrations such as concentration camps in Poland and Germany and sites within the United States such as Pearl Harbor); Paul Williams, *Witnessing Genocide: Vigilance and Remembrance at Tuol Sleng and Choeung Ek*, 18 HOLOCAUST & GENOCIDE STUD., 234 (2004) (analyzing the two principal memorials to the victims of the Cambodian genocide and their "effectiveness as vehicles for commemoration"); Senija Causevic & Paul Lynch, *Tourism Development and Contested Communities*, ESPACESTEMPS.NET (Oct. 21, 2008), https://www.espacestemps.net/en/articles/tourism-development-and-contested-communities-en/?output=pdf [https://perma.cc/5RT6-ZA7A] (addressing dark tourism "in the context of post-conflict, focusing on its relevance to social reconciliation and urban regeneration" in Belfast, Northern Ireland's emerging tourism economy);

Philip Stone, *A Dark Tourism Spectrum: Towards a Typology of Death and Macabre Related Tourist Sites, Attractions and Exhibitions*, 54 TOURISM: INTERDISC. INT'L J. 145 (2006); THE DARKER SIDE OF TRAVEL: THE THEORY AND PRACTICE OF DARK TOURISM (Richard Sharpley & Philip R. Stone eds., 2009) (providing a series of chapters, written by individual contributors, lending to the book's overall exploration of dark tourism in modern, wider disciplinary contexts); Philip Stone & Richard Sharpley, *Consuming Dark Tourism: A Thanatological Perspective*, 35 ANNALS OF TOURISM RSCH. 574 (2008) (addressing the "demand" for dark tourism and experiences therein).

category of dark tourism in one significant way.[80] While travelers drawn to sites such as Auschwitz or the catacombs of Paris face no increased risk of death by being at these sites of historic atrocities, the same cannot always be said for those who visit atomic sites.[81] In atomic tourism, the sites of destruction are still laced with radiation, making travel more than a visceral confrontation with death.[82] While nuclear semiotics focuses on how to adequately warn future populations to protect them against the hazards of radiation from nuclear waste and residue from nuclear weapons,[83] studies of atomic tourism show that labeling a site as a nuclear hazard can have the opposite effect.[84]

Twice a year, the U.S. government opens the site of the first atomic bomb test, known as the Trinity Site, to visitors at no cost and with no reservations required.[85] While pregnant women and children are permitted to visit the site, the U.S. Army, who run the tours, warns that "the choice is yours."[86] In 2016, almost two million people visited the Peace Memorial commemorating the atomic bombing in Hiroshima, Japan.[87] Tourism to these sites shows not only a historical interest in the events which occurred there, but also a growing fascination with, and desire to be close to, physical sites of nuclear destruction and radioactivity.[88] At the Chernobyl site, these different strains of analysis combine to show the disjuncture between ideologically driven international regulation of radioactive waste and products, and understandings of

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80 Jenna Berger, *Nuclear Tourism and the Manhattan Project*, 7 COLUM. J. AM. STUD. 196, 198-99 (2006).

81 *See id.*

82 *See id.*

83 *See*, *e.g.*, Beauchamp, *supra* note 17.

84 *See*, *e.g.*, Berger, *supra* note 80, at 4-11.

85 *See Trinity Site Open House*, U.S. ARMY, https://www.wsmr.army.mil/Trinity/Pages/Home.aspx [https://perma.cc/R9CJ-4RZK] (last updated Aug. 18, 2020).

86 Jeni Hackett, *These Atomic Tourists Have Visited 160 Forgotten Nuclear Sites Across the U.S.*, ATLAS OBSCURA (Oct. 6, 2015) (internal quotations omitted), https://www.atlasobscura.com/articles/these-atomic-tourists-have-visited-160-forgotten-nuclear-sites-across-the-us [https://perma.cc/E54M-RDXG].

87 Ari Beser, *Hiroshima Tourism is More Popular than Ever,* NAT'L GEOGRAPHIC (Aug. 4, 2017), https://www.nationalgeographic.com/travel/destinations/asia/japan/hiroshima/ [https://perma.cc/E54M-RDXG].

88 *See id.*

human behavior.

A. Atomic Tourism and the Opening of Chernobyl as a Tourist Attraction

In April of 1986, the Chernobyl nuclear power plant exploded, resulting in the largest known uncontrolled release of radioactivity into the environment from any civilian operation.[89] For ten days following the explosion, large quantities of radioactive materials were released into the air.[90] Though the initial blast killed thirty people, the resulting radiation would have a much larger and long-lasting effect on the area.[91] While studies on the resulting health effects from the radiation are ongoing, reports reveal the devastating and long-lasting health effects of the radiation on the surrounding Chernobyl population.[92] Recent studies show that seventy percent of the fallout from the disaster landed in areas of Belarus, Russia, and Ukraine, contaminating over 200,000 square kilometers.[93] This contaminated territory included one-fifth of all agricultural land in Belarus.[94] A 2018 report by the United Nations ("UN") Scientific Committee on the Effects of Atomic Radiation found that the high levels of radioactive iodine released in the early days following the accident have been responsible for nearly 20,000 documented cases of thyroid cancer among persons who were under the age of eighteen at the time of the accident.[95] Estimates vary on how many total people will eventually die from cancer related to the Chernobyl

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89 *See Chernobyl Accident and its Consequences*, NUCLEAR ENERGY INST. (May 2019), https://www.nei.org/resources/fact-sheets/chernobyl-accident-and-its-consequences [https://perma.cc/Z8R5-UYH9] [hereinafter *NEI Fact Sheet: Chernobyl*].

90 *Id.*

91 *See id.*

92 *Chernobyl Accident 1986*, WORLD NUCLEAR ASS'N, https://www.world-nuclear.org/information-library/safety-and-security/safety-of-plants/chernobyl-accident.aspx [https://perma.cc/JX5J-UCCQ] (last updated Apr. 2020).

93 INT'L ATOMIC ENERGY AGENCY, CHERNOBYL'S LEGACY: HEALTH, ENVIRONMENTAL, AND SOCIOLOGICAL IMPACTS AND RECOMMENDATIONS TO THE GOVERNMENTS OF BELARUS, THE RUSSIAN FEDERATION AND UKRAINE 22 (2006), https://www.iaea.org/sites/default/files/chernobyl.pdf [https://perma.cc/QY8U-SQSF] [hereinafter CHERNOBYL'S LEGACY].

94 Alan Taylor, *Still Cleaning Up: 30 Years After the Chernobyl Disaster*, ATLANTIC (Apr. 4, 2016), https://www.theatlantic.com/photo/2016/04/still-cleaning-up-30-years-after-the-chernobyl-disaster/476748/ [https://perma.cc/KV62-LM74].

95 *NEI Fact Sheet: Chernobyl*, *supra* note 89.

disaster.[96] While the Chernobyl Forum estimates that 4,000 to 9,000 people will die, the Union of Concerned Scientists estimates 23,000, and Greenpeace estimates a whopping 93,000 deaths.[97]

Following the accident, the Ukrainian government resettled nearly 335,000 people from areas contaminated by the radiation released in the blast.[98] After conducting soil and water tests on the area surrounding the site of the accident, scientists drew an "exclusion zone"[99] of 4,000 square kilometers.[100] Every community within a thirty-kilometer radius of the reactor was evacuated.[101] Scientists now estimate that the site will not be habitable for the next 20,000 years.[102] Containment efforts and cleanup of the site are ongoing and expected to last until at least 2065.[103]

Despite the ongoing radiation, in 2011, Ukraine began allowing large numbers of tourists into the Chernobyl exclusion zone.[104] While prior to 2011 few were allowed into the exclusionary zone, tour guides have been conducting unauthorized tours in this area for years.[105] When deciding whether to open Chernobyl to the public, Ukrainian President Volodymyr Zelensky cited rampant corruption and unauthorized tours in the area as justifications for reopening the

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96 *See*, *e.g.*, *id.*; CHERNOBYL'S LEGACY, *supra* note 93, at 7-8; *Tularosa Basin Downwinders*, *supra* note 8; *Nevada Test Site Downwinders*, *supra* note 9.

97 *See* CHERNOBYL'S LEGACY, *supra* note 93, at 7-8; Jason Daley, *You Can Now Visit Chernobyl's Control Room, if You're Quick About it,* SMITHSONIAN MAG. (Oct. 11, 2019), https://www.smithsonianmag.com/smart-news/chernobyls-control-room-now-open-tourists-180973311/ [https://perma.cc/4HFT-CK7E].

98 NEI FACT SHEET: CHERNOBYL, *supra* note 89.

99 Victoria Gill, *Chernobyl: The End of a Three-Decade Experiment*, BBC NEWS (Feb. 14, 2019), https://www.bbc.com/news/science-environment-47227767 [https://perma.cc/F2SF-NAKW].

100 *Id.*

101 *See id.*; Taylor, *supra* note 94.

102 Erin Blakemore, *The Chernobyl Disaster: What Happened, and the Long-Term Impacts*, NAT'L GEOGRAPHIC (May 17, 2019), https://www.nationalgeographic.com/culture/topics/reference/chernobyl-disaster/ [https://perma.cc/GX77-8A6B].

103 *Id.*

104 Olivia Alabaster, *Dark Tourism: What Is Drawing Thousands to Chernobyl and Cambodia's Killing Fields?*, INDEPENDENT (July 3, 2019), https://www.independent.co.uk/news/long_reads/chernobyl-hbo-show-dark-tourism-auschwitz-killing-fields-cambodia-a8969611.html [https://perma.cc/D3D4-TN6P].

105 *Id.*

zone.[106] Since 2011, when the tours were officially sanctioned, the number of tourists who visit the site has increased each year.[107] In 2013, 8,000 tourists entered the exclusion zone.[108] In 2018, 65,000 tourists made the trip.[109] The number of visitors is expected to reach 100,000 in 2019.[110]

In July of 2019, President Zelensky announced official plans to convert the site of the 1986 Chernobyl nuclear reactor explosion into a government-sponsored tourist attraction.[111] The president made this announcement during the inauguration ceremony of a metal dome built to encase the immediate site of the exploded nuclear reactor.[112] Built to cover the decaying sarcophagus originally encasing the radioactive fourth reactor, this new dome spans an area 500 feet wide by 800 feet long.[113] Over $1.5 billion USD were raised to fund the project, yet the dome is only designed to last 100 years.[114]

This dome, however, offers little protection against the long-term dangers of radioactive waste. Since the creation of the first atomic bomb, the international community has struggled to impose regulations to protect humanity from the deadly effects of atomic weapons.[115] These efforts range from nuclear nonproliferation agreements and international treaties meant to prevent the actual use of atomic weapons, to international agreements imposing regulations on nuclear power facilities and the disposal of their

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106 Lianne Kolirin & Jack Guy, *Chernobyl to Become Official Tourist Attraction, Ukraine Says*, CNN TRAVEL, https://www.cnn.com/travel/article/chernobyl-tourist-attraction-intl-scli/index.html [https://perma.cc/289L-UQEE] (last updated July 11, 2019).

107 Alabaster, *supra* note 104.

108 *Id.*

109 *Id.*

110 *Id.*

111 *See Chernobyl Nuclear Site to Become 'Official Tourist Attraction'*, BBC NEWS (July 10, 2019), https://www.bbc.com/news/world-europe-48943814 [https://perma.cc/6VWF-F562].

112 *Id.*

113 Ivan Nechepurenko & Henry Fountain, *Giant Arch, a Feat of Engineering, Now Covers Chernobyl Site in Ukraine*, N.Y. TIMES (Nov. 29, 2016), https://www.nytimes.com/2016/11/29/world/europe/chernobyl-disaster-cover.html [https://perma.cc/BRK7-C2WX].

114 *Id.*

115 *See Nuclear Weapons*, U.N. OFF. FOR DISARMAMENT AFFS., https://www.un.org/disarmament/wmd/nuclear/ [https://perma.cc/P5QJ-5JZA] (last visited Aug. 25, 2020).

waste.[116] With atomic tourism, international law faces a different hurdle. While most international agreements seek to keep civilians as distant as possible from nuclear weapons and radiation, atomic tourism presents the problem of civilians actually seeking out radioactive sites.[117]

In 1981, the U.S. Department of Energy convened a group of engineers, anthropologists, nuclear physicists, and behavioral scientists, known as the Human Interference Task Force, to discuss the long-term disposal of radioactive waste and human safety.[118] This conference, which created the field of nuclear semiotics, led to many papers and extensive research on the topic of marking radioactive disposal sites for civilizations 10,000 years in the future.[119] In pondering the safe disposal of nuclear waste, this group largely failed to foresee that people would intentionally seek out marked radioactive sites.[120] Therefore, the rise of atomic tourism demands a reconsideration of the fundamental principles of nuclear semiotics by questioning whether marking sites as radioactive instead draws people to those sites.

With a new awareness of the appeal of atomic and radioactive sites to the public, governments now struggle not with how to mark atomic sites as dangerous to keep the public away, but instead how to keep the public from intentionally visiting these sites.[121] Many sites of atomic tourism have been able to avoid the dangers of radioactivity by separating tourist sites from the physical sites of

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116 *See id.*

117 *See* Alabaster, *supra* note 104.

118 *See* DETLOF VON WINTERFELDT, PREVENTING HUMAN INTRUSION INTO A HIGH-LEVEL NUCLEAR WASTE REPOSITORY: A LITERATURE REVIEW WITH IMPLICATIONS FOR STANDARD SETTING 3-4 (1994), https://www.nrc.gov/

docs/ML0400/ML040080812.pdf [https://perma.cc/A72Q-W7LA].

119 *See generally* OFF. OF NUCLEAR WASTE ISOLATION., REDUCING THE LIKELIHOOD OF FUTURE HUMAN ACTIVITIES THAT COULD AFFECT GEOLOGIC HIGH-LEVEL WASTE REPOSITORIES (1984), https://www.osti.gov/servlets/purl/6799619 [https://perma.cc/3KSW-9ATM].

120 *See generally id.* (making no mention of any potential tourism regarding these disastrous sites); VON WINTERFELDT, *supra* note 118 (making no predictions of dark, or atomic, tourism); KATHLEEN M. TRAUTH, STEPHEN C. HORA & ROBERT V. GUZOWSKI, EXPERT JUDGMENT ON MARKERS TO DETER INADVERTENT HUMAN INTRUSION INTO THE WASTE ISOLATION PILOT PLANT (1993), https://prod-ng.sandia.gov/techlib-noauth/access-control.cgi/1992/921382.pdf [https://perma.cc/CL2V-4KA7] (focusing on inadvertent human entry to nuclear sites, not purposeful tourism).

121 *See* Alabaster, *supra* note 104.

nuclear events.[122] While both Hiroshima and Nagasaki have museums dedicated to the events of World War II and the atomic weapons dropped by the United States on the two cities, neither of these sites are located at the epicenter of the bombing.[123] Similarly, while France built a museum dedicated to Marie Curie and her work, the museum itself is located far from the lab in which Curie performed her ground-breaking research on radioactivity.[124]

With the Chernobyl exclusion zone now open for tours, international law governing radiation must suit a new purpose. Instead of functioning to keep radiation contained, it must now regulate the people who actively seek it out.

B. Nuclear Watchdogs and Tourism to Radioactive Sites

Following the Chernobyl disaster, many in the field of international law considered the ramifications of the event from a legal perspective.[125] Though many considered the effects of pollution and cleanup from future nuclear accidents and the necessity for stronger international regulations for non-military nuclear facilities, no one contemplated that the sites of such disasters would later draw crowds of tourists despite the lingering radiation and consequent health hazards.[126] The phenomenon of atomic tourism demands a reconsideration of international law governing nuclear waste and radioactive sites to better encompass this new interaction between civilians and radioactivity.

To combat the issue of tourism to radioactive sites, some states have implemented their own methods, mimicking those used for

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122 *See* Erin Blakemore, *Museums Still Can't Agree on How to Talk About the 1945 Atomic Bombing of Japan*, HIST., https://www.history.com/news/atomic-bomb-hiroshima-nagasaki-museum-controversy-los-alamos [https://perma.cc/H86X-ZTP8] (last updated Aug. 31, 2018).

123 *See id.*

124 *See Museé Curie*, PARIS CONVENTION & VISITORS BUREAU, https://en.parisinfo.com/paris-museum-monument/71278/Musee-Curie-Institut-du-radium [https://perma.cc/PB4C-BMNW] (last visited Aug. 25, 2020).

125 *See generally* Victoria Riess Hartke, *The International Fallout from Chernobyl*, 5 PENN. ST. INT'L L. REV. 319 (1987) (discussing the fallout from the Chernobyl meltdown and the reparations owed to surrounding countries through tort law); Linda A. Malone, *The Chernobyl Accident: A Case Study in International Law Regulating State Responsibility for Transboundary Nuclear Pollution*, 12 COLUM. J. ENVTL. L. 203 (1987) (discussing international resolutions regarding the nuclear fallout from Chernobyl).

126 *See*, *e.g.*, Hartke, *supra* note 125; Malone, *supra* note 125.

disposal of nuclear waste.[127] In France, the government implemented measures to protect the lab of scientist Marie Curie from tourists.[128] Often called "Chernobyl on the Seine,"[129] the lab contains radiation levels that the French government warns will pose a health threat for millennia.[130] Despite its dangerously high levels of radiation, the lab is located in a residential area on the banks of the Seine.[131] To protect the people and area surrounding the lab from radiation, the French government has adopted a series of methods designed to keep the public away from the site.[132] Today, the lab is surrounded by concrete walls topped with barbed wire and is monitored around the clock by surveillance cameras and radioactivity detectors.[133]

This approach partly mirrors recommended disposal methods for high and low-level nuclear waste.[134] Recommended disposal methods for low-level waste suggest storing the waste in a safe environment for sufficient time for the radioactivity to dissipate.[135] By using a cement perimeter, the French government adopted an intermediary step between the recommended procedures for high and low-level radioactive waste.[136]

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127 *See* Tara Patel, *France is Still Cleaning Up Marie Curie's Nuclear Waste*, BLOOMBERG (Aug. 28, 2019), https://www.bloomberg.com/news/articles/2019-08-28/france-is-still-cleaning-up-marie-curie-s-nuclear-waste [https://perma.cc/8EHS-J7CR].

128 *Id.*

129 *Id.*

130 *See id.*

131 *See id.*

132 *See id.*

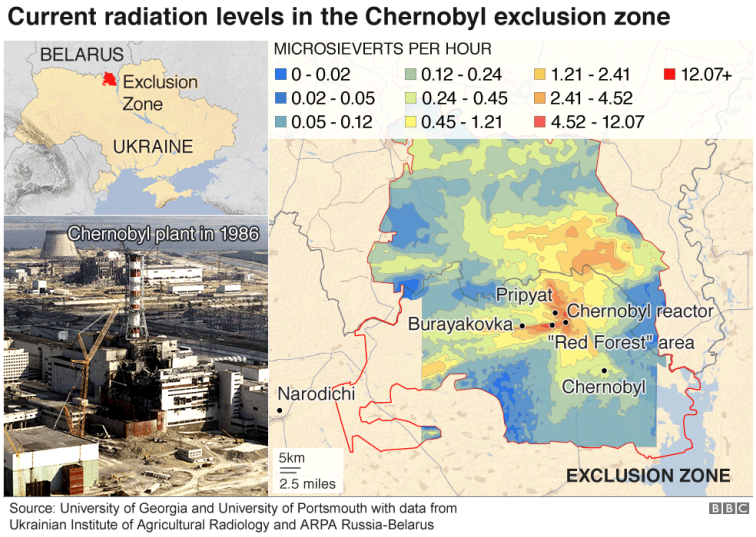
133 Patel, *supra* note 127.

134 *See* BACKGROUNDER: RADIOACTIVE WASTE, *supra* note 32.

135 *Storage and Disposal of Radioactive Waste*, *supra* note 58.

136 *Id.*

Ukrainian officials adopted a similar approach for one aspect of the Chernobyl site: the reactor which exploded and caused the disaster at Chernobyl.[137] Radiation levels throughout the site vary widely based on a range of environmental factors.[138] The highest levels of radiation, however, are concentrated around the immediate site of the explosion of the nuclear reactor.[139]



Similar to the French method for containing the radiation from Marie Curie's lab, in 2016, the Ukrainian government erected a concrete dome surrounding the site of the reactor.[140] Unlike the Curie lab, however, the high levels of radiation at the Chernobyl site are not limited to the area encased by the concrete dome.[141] Instead, they span for miles in different areas of the exclusion zone.[142]

In October 2019, the Ukrainian government announced that tourists would now be able to enter the control room of the Chernobyl nuclear reactor where radiation currently exists at levels 40,000 times higher than normal.[143] To enter the control room,

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137 *See* Blakemore, *supra* note 102.

138 *See* Gill, *supra* note 99.

139 *Id.*

140 *Id.*

141 *Id.*; Patel, *supra* note 127.

142 Gill, *supra* note 99.

143 Jack Guy, *Chernobyl Control Room Now Open to Visitors -- but Only Wearing a*

tourists must don a full body white hazmat suit complete with helmet and mask to protect themselves from the radiation.[144] After leaving the control room, visitors then go through two radioactivity scans to measure the degree of their exposure to radioactivity.[145] President Zelensky described the rationale for granting this broad access to Chernobyl as giving "this territory of Ukraine a new life,"[146] continuing to say, "[u]ntil now, Chernobyl was a negative part of Ukraine's brand. It's time to change it."[147]

C. Organizations Governing the Disposal and Safety of Radioactive Waste and Radioactive Sites

Various non-binding agreements between international organizations govern radioactive waste.[148] These organizations include the Nuclear Energy Agency ("NEA"), the International Nuclear Regulators Association ("INRA"), and the International Atomic Energy Agency ("IAEA").[149] Of these organizations, the NEA and the INRA focus more on research and intelligence than regulation enforcement.[150] The NEA primarily provides a forum for nuclear power and technology experts from countries with the highest nuclear capabilities to discuss means of advancing nuclear energy technologies.[151] The INRA also provides a primarily informational academic function by allowing for an exchange of regulatory policy perspectives among different countries to increase the safety and security of nuclear weapons among members.[152] While organizations like the INRA and NEA provide an important function in developing safer practices for the development and maintenance of nuclear facilities, their legal effect is limited to their

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Hazmat Suit, CNN TRAVEL, https://www.cnn.com/travel/article/chernobyl-control-room-tours-scli-intl/index.html [https://perma.cc/K4GK-SJBV] (last updated Oct. 3, 2019).

144 *Id*.

145 *Id.*

146 *Id.*

147 *Id.*

148 *See International Organizations*, U.S. NUCLEAR REG. COMM'N, https://www.nrc.gov/about-nrc/ip/intl-organizations.html [https://perma.cc/Y9S6-V7KL] (last updated Aug. 12, 2020).

149 *Id.*

150 *See id.*

151 *Id.*

152 *Id.*

ability to influence others to create or implement laws.[153] By themselves, they lack the capacity to enforce their findings and instead rely on other organizations to do so.[154] The IAEA is one such organization.[155]

Created in 1957 as the "Atoms for Peace" organization, the IAEA operates as a suborganization of the UN.[156] As of October 2020, 172 nations were IAEA members.[157] As a UN suborganization, the IAEA produces regulations for nuclear facilities and waste which carry the weight of UN treaties.[158] Three main legal instruments have been promulgated under the IAEA include the Convention on the Physical Protection of Nuclear Material ("CPPNM"), the 2005 Amendment to the CPPNM, and the Code of Conduct for the Safety and Security of Radioactive Sources.[159]

"[E]ntered into force on February 8, 1987 . . . [the CPPNM] establishes physical protection measures" for nuclear waste and criminal offenses related to nuclear material.[160] The CPPNM, however, applies only to nuclear material being transported internationally.[161] As such, it cannot govern radioactive sites within countries, such as the Chernobyl site.[162] Nonetheless, these regulations, provide an example of the infrastructure through which further regulation of future radioactive waste might be created, managed, and enforced.[163] Using this same framework, regulations contemplating the problem of nuclear semiotics could be passed and

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153 *Id.*

154 *International Organizations*, *supra* note 148.

155 *Id.*

156 *History*, INT'L ATOMIC ENERGY AGENCY, https://www.iaea.org/about/overview/history [https://perma.cc/FW6D-334T] (last visited Aug. 25, 2020).

157 *List of Member* States, INT'L ATOMIC ENERGY AGENCY, https://www.iaea.org/about/governance/list-of-member-states [https://perma.cc/9843-Z4VV] (last updated Sept. 17, 2020).

158 *Id.*

159 *Nuclear Security Conventions*, INT'L ATOMIC ENERGY AGENCY, https://www.iaea.org/topics/nuclear-security-conventions [https://perma.cc/9D4V-SN6J] (last visited Aug. 25, 2020).

160 *Id.*

161 *Id.*

162 *Id.*

163 *Id.*

utilized to ensure the safe storage of nuclear waste in the future. This possibility underscores the important and unique ability of international law to contemplate problems that face all of humanity. While the individual storage sites for nuclear waste lay within sovereign nations, each with their own regulations and standards, these borders pale when placed on a timeline of 10,000 years.[164]

While the current nuclear waste regulations ensure the safe traveling of nuclear materials and the disposal of radioactive waste and byproducts, they do not account for radioactive sites transforming into tourist attractions or contemplate a timeline of storage on scale consistent with that of a radioactive half-life. Radioactive waste presents dangers for civilizations tens of thousands of years in the future, but the governance of physical radioactive sites remains in the control of individual nations and outside of the scope of nuclear laws developed before the rise of atomic tourism.[165]

D. Recommendations for Possible International Solutions to the Problem of Nuclear Semiotics

At present, there exists no uniform standard for the storage of nuclear waste.[166] Consequently, international law has yet to address solutions to the problem posed by nuclear semiotics.[167] Broader solutions are needed than our current efforts to contain and maintain nuclear waste to continue being effective more than 10,000 years from now. International law is best poised to make these regulations and standards and to advocate for the interests of future generations, even when at odds with those of the present generation. While the laws of different nations operate to protect those within their borders, individual countries alone do not possess the organizational ability that an international organization can bring to bear to provide a cohesive and uniform approach to the problem of nuclear semiotics.[168] Simply put, the nature of the problem requires an

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164 *See*, *e.g.*, Beauchamp, *supra* note 17.

165 *Id.*

166 *Storage and Disposal of Radioactive Waste, supra* note 58.

167 *See generally* OFF. SCI. & TECH. INFO., *supra* note 119 (providing an overview of potential issues arising with international law and regulation(s) of nuclear waste).

168 *See Security*, INT'L ATOMIC ENERGY AGENCY, https://www.iaea.org/topics/security [https://perma.cc/6ZRK-ACVH] (last visited Aug. 25, 2020).

international solution. Further, it is unprecedented for a civilization to survive for 10,000 years.[169] Throughout history, civilizations have survived for an average of just 336 years, with the longest-lasting civilizations surviving from between 1,000 and 2,000 years.[170] Even if currently existing nations last two or three times the length of the history's longest-lasting civilizations, it would still not be long enough to continue to oversee the safe storage of currently-existing nuclear waste.[171] The lifespan of nations and civilizations is too short to adequately protect and provide for the safe maintenance and marking of nuclear waste storage sites.[172]

There are several ways in which international law might prove a positive force in the future of radioactive waste. First, international institutions could make a greater effort to provide consequences for a nation's failure to abide by IAEA regulations. Second, the IAEA could propose, within its regulations for nuclear waste, a requirement that nations report each of their sites of nuclear waste storage to an international database. This database would contain information about the locations of these storage sites and be designed to continue in perpetuity. Under the guidance of the UN and the IAEA, this new organization would collect and store information with the goal of accessibility, creating a single map of all radioactive sites globally.

In the field of nuclear semiotics, one of the largest debates is whether marking a site of nuclear waste in a way that effectively communicates its lethality would decrease or increase the danger of future exposure.[173] Some argue that marking a site as deadly only draws more people to it,[174] a theory supported by the growing popularity of dark tourism.[175] Others argue that only by marking a

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169 Luke Kemp, *Are We on the Road to Civilisation Collapse?*, BBC FUTURE (Feb. 18, 2019), https://www.bbc.com/future/article/20190218-are-we-on-the-road-to-civilisation-collapse [https://perma.cc/VCU7-32DM].

170 *Id.*

171 *Id.*

172 *Id.*

173 Daniel Oberhaus, *Radioactive Cats and Nuclear Priests: How to Warn the Future About Toxic Waste*, VICE (May 4, 2017), https://www.vice.com/en_us/article/9aey95/radioactive-cats-and-nuclear-priests-how-to-warn-the-future-about-toxic-waste [https://perma.cc/3CN7-S62X].

174 *Id.*

175 Francesca Street, *Chernobyl and the Dangerous Ground of 'Dark Tourism'*, CNN TRAVEL, https://www.cnn.com/travel/article/dark-tourism-chernobyl/index.html

site will we be able to effectively protect others from the radiation of nuclear waste.[176] Creating an international database of sites could resolve these issues by facilitating a single ledger accessible to future civilizations, instead of forcing them to rely on the patchwork of documents held by different nation states.

IV. Conclusion

To provide comprehensive regulations governing the safety of radioactive waste and nuclear facilities, international nuclear associations ought to adopt policies that govern radioactive sites within nation-states. While this change would certainly require the implementation of new and more expansive treaties governing radioactive materials, it would also require an ideological shift in how radioactive materials are perceived and thus managed. Much like the debate in the field of nuclear semiotics, current action regarding the regulation of nuclear sites depends on a social, as well as a scientific, understanding of radioactive sites.[177] Dark tourism is on the rise, as is atomic tourism.[178] International law, policy, and treaties can no longer operate under the assumption that civilians will avoid radioactivity and its incumbent hazards.

[https://perma.cc/9PYY-8P9E] (last updated June 25, 2019).

176 Oberhaus, *supra* note 173.

177 Beauchamp, *supra* note 17.

178 *See* Beser, *supra* note 87; Alabaster, *supra* note 104.