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A coordinated performance towards materially witnessing nuclear imperialism

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A coordinated performance towards materially witnessing nuclear imperialism

F I O N A A M U N D S E N

In the opening sequence shots of *Chernobyl: Chronicle of difficult weeks* (1986) the voice of Soviet filmmaker Vladimir Shevchenko intones:

Radiation is a fatal invisible foe. One that even penetrates steel plating. It has no odour, nor colour. But it has a voice. Here it is. We thought this film was defective. But we were mistaken. This is how radiation looks. (Shevchenko cited in Schuppli 2020: 62)

Shevchenko is referring to the white pockmarked splotches embedded in his film's emulsion, which was simultaneously documenting the immediate aftermath of Chernobyl's Nuclear Reactor Unit 4 explosion and meltdown. These splotches, known as fogging, were caused by high levels of ionizing radioactive energy absorbed by the film's silver halide crystals.¹ As ionizing radiation is invisible to human senses, photographic and celluloid film are ideal materials to visualize its presence, in nuclear powerplant meltdowns, weapon test sites and as a result of downwind radiation.

There is an inherent material connection between radiation and film emulsion: the former imprints itself on the other through a coordinated performance; silver halide crystals are activated and altered by radiation. This performative relationship forms the central concern of this article. I argue that this relationship offers methods for socio-ethical visualizing of not only ionizing radiation itself but also, by proxy, the associated discourses of nuclear imperialism. Through close readings of Polish artist Monika Niwelińska's photographic series *γ[gamma trace]* (2017), I explain that conceiving of radiation as a coordinated performative interaction, as captured in her images, may support justice for those impacted by, specifically, United States' nuclear weapons development and testing. Methodologically framed via artist and theorist Susan Schuppli's *Material Witness: Media, forensics, evidence*

(2020), I am interested in how this synchronizing of matter functions as its own form of evidential material witnessing, which both relies on and reveals the spatio-temporal presence of ionizing radiation. Of note is Schuppli's proposition that physical materials (environmental samples, architectural remnants or technological artefacts) have agency as witnesses, meaning they can reveal evidence concerning social and environmental histories.

Schuppli's theorizing of how materials record trace evidence 'of the violence that generated their contexts' is particularly pertinent to Niwelińska's *γ[gamma trace]* (2020: 3). These artworks have been created by directly exposing photographic emulsion coated aluminium and copper plates to the radioactive ground of the Trinity test site in Yootó Hahoodzo (New Mexico).² The resulting exposures consist of abstracted purplish-cyan-milky hues that, as the series title suggests, reveal trace radiation still present at the site. In the pursuit of nuclear justice, Niwelińska's images offer an important contribution, as they visualize the lasting presence of radiation, which impacts the health and lands of surrounding communities.³ Although Niwelińska's artworks focus on US nuclear contexts, by extension they also highlight broader issues of nation states developing and testing their weapons on unceded lands, oceans and communities. Since the first nuclear weapon was successfully detonated by the US in 1945, just over 2,000 tests have been conducted worldwide.⁴ These tests were either carried out in remote regions of the country's responsible, or on colonized lands and waters. For example, Britain tested (1952–63) weapons across three Australian sites – Montebello Islands, Emu Field and Maralinga – thereby displacing traditional First Nations (Aboriginal) custodians of the land.⁵ Maralinga has undergone extensive

¹ Fogging is a photographic technical term that refers to when an image is impacted by extraneous light, electromagnetic radiation, radioactivity or chemicals. A fogged negative contains traces of unintended exposure that are rendered as either dark patched or waves, and when processed as a print appear white.

² For the art work by Monika Niwelińska referred to in this article, see Niwelińska (2017a) and (2017b).

³ See historian Lesley M. M. Blume's 'Collateral damage: American civilian survivors of the 1945 Trinity test' (2023) for an account of how at the time of the Trinity test, half a million people were living in close proximity to the site. These communities were given no advance warning of the test and were therefore unaware of the enormity and dangers of what they had witnessed. People, flora and fauna who were downwind of Trinity's enormous mushroom cloud were covered with and ingested white ash that was mistaken for snow. Although in 1990 the US Congress passed the Radiation Exposure Compensation Act (RECA), providing compensation for those impacted by nuclear tests, 'civilian downwinders of the Trinity test were not included as eligible candidates – and remain ineligible to this day' (236).

⁴ For a specific breakdown of the different countries involved in nuclear

weapon development, see the web resource Atomic Archive's 'Nuclear Testing Chronology' for a breakdown of the number of devices tested by China, France, India, North Korea, Pakistan, Russia, the United Kingdom and the United States: 'at least eight nations have detonated 2,056 nuclear test explosions at dozens of test sites, including Lop Nor in China, the atolls of the Pacific, Nevada, Algeria where France conducted its first nuclear device, western Australia where the U.K. exploded nuclear weapons, the South Atlantic, Semipalatinsk in Kazakhstan, across Russia' (Atomic Archive n.d.).

⁵ In addition to testing in Australia, Britain also detonated nine hydrogen bombs (1957–8) at Kiribati, the British colony formally named Gilbert and Ellice Islands. These tests exposed lands, oceans, local communities and Aotearoa New Zealand and Fijian enlisted soldiers to high levels of ionizing radiation. See Fijian-Australian artist Torika Bolatagici's photographic series *Remembrance (Viti)* (2016), which documents the first official parade recognizing surviving Fijian veterans who witnessed these tests.

⁶ See Larissa Behrendt's (director) documentary *Maralinga Tjarutja* (2020), which tracks the impact of British testing on the Maralinga people, along with their fight for the clean-up, decontamination and return of custodial lands. In addition, see the earlier documentary *Australian Atomic Confessions* (2005), by directors Kathy Aigner and Gregory K. Young.

⁷ See 'Walking back delusional nuclear policies' (Karnad 2018) for a critique of India's nuclear policies, including the impact of weapons testing on local populations.

Indigenous-led efforts for state recognition and reparations, as well as clean-up of plutonium and uranium contaminated soil and debris.⁶ Comparably, France subjected the islands of French (occupied) Polynesia and colonized Algeria to just over 200 nuclear tests. Repeated testing (1966–96) at Moruroa and Fangataufa atolls – French (occupied) Polynesia – resulted in downwind radiation that affected Tahiti, creating intergenerationally high cancer rates that communities are continuing to fight for compensation for from the French government.

A similar pattern of disregard is evident in Soviet Union testing, which poisoned the now independent lands of Kazakhstan, Uzbekistan, Ukraine and Turkmenistan. Kazakhstan bore the brunt of this testing with 456 tests conducted at Semipalatinsk Test Site from 1949 to 1989. An estimated 1.5 million people and many kilometres of land were exposed to radioactive fallout as a result of these tests (Kassenova 2008). Equally, India detonated, as late as 1998, a series of nuclear weapons a short distance from Khetolai village in Jaisalmer. Presently villagers report high cases of radiation-associated cancers, as well as heart and skin disease among local human and animal populations; none of which are acknowledged or compensated at a governmental level.⁷ These events form a significant framing for Niwelińska's *γ[gamma trace]* with respect to what constitutes socio-ethical forms of visualizing this history. They demonstrate a repeated pattern of nation states testing their weapons on unceded lands, oceans and communities with radioactive particles invisibly impacting the DNA of local human, animal and plant life. Niwelińska's methods of working directly with this residue speak to this much larger context of weapons testing, and ideologies of power and control that motivated it.

The images that make up *γ[gamma trace]* function in stark contrast to the iconic photographic imagery of nuclear explosions rising to form their distinctive mushroom-shaped clouds, which has dominated public consciousness concerning nuclear weaponry. Accordingly, this article begins with an analysis – in 'Terror and Wonderment: Awestruck by mushroom cloud imagery' – of the inherent representational problems associated with

such imagery. Put simply, mushroom cloud imagery abstracts what it represents so that focus is directed towards the terror and, equally, awesomeness of an atomic bomb's aerial explosion, as opposed to any on-the-ground consequences. Referencing theorists Robert Hariman and John Louis Lucaites's (2012) argument that situates mushroom cloud imagery as containing a 'Cold War nuclear optic', I suggest that the photographs of *γ[gamma trace]* provide a counter iconography that highlights the actual and long-lasting effects of atomic weapons. Niwelińska's method involving the placement of radioactive soil directly on to photographic plates provides a causal and visual link to the presence of environmental radiation. Her method of utilizing the inherent material properties of photographic emulsion to register the presence of ionizing radiation is explored more fully in 'Ionizing radiation and silver halide crystals as artistic method'. This section argues that the methods of *γ[gamma trace]* are a device by which to move beyond the limits of human perceptibility and vision within nuclear imperial contexts.

The final section – 'Material witnessing of the Trinity test site: Cause and effect' – argues the need for forms of politicized witnessing that move beyond iconic mushroom cloud imagery with its recognizable, obviously nuclear, visibility. Instead, my focus is on how quantifiable evidence of the nuclear is physically embedded, via a coordinated performance between emulsion and radiation, in the image. Niwelińska's *γ[gamma trace]* resists the kind of spectacular military produced mushroom cloud imagery that abstracts the devastating power of nuclear weapons into a type of aesthetic wonder to be both marvelled at and feared. Just like Shevchenko, *γ[gamma trace]* seems to also be saying: 'this is how radiation looks', albeit not in the same spectacular form of a melting nuclear reactor. Rather, *γ[gamma trace]* speaks to the insidious long-lasting material nature of ionizing radiation. In addition to stating 'this is how radiation looks', these images also raise questions concerning how to address nuclear remnants, both materially and conceptually, with respect to communities whose lands, oceans and bodies still literally hold trace residues of this

history. Accordingly, I surmise that Niwelińska's artworks, although also visually abstracted, work to enable forms of socio-ethical witnessing that evidence the ongoing legacies of nuclear imperialism concerning the development and testing of atomic bombs.

TERROR AND WONDERMENT:
AWESTRUCK BY MUSHROOM CLOUD
IMAGERY

Ever since its conception, the development of nuclear weaponry within an American context has utilized photographic documentation to both deliver scientific data and to shape public opinion. Although the Manhattan Project and the Trinity test (1945) were initially a top-secret military affair, photography played a vital role in quite literally showing what an atomic bomb detonation looked like. High-speed cameras were specifically developed for the Trinity test in order to capture the rapidly changing matter inherent to nuclear explosions. The resulting photographs – taken milliseconds apart – show a massive fire ball that morphs into a mushroom cloud, seconds post-detonation. The scientists of the Manhattan Project would have no doubt hypothesized what the first detonation of a nuclear weapon might look like, however it was not until it was witnessed first-hand and then subsequently in photographs that the true scale of destruction of this newly formed weapon was understood. The National Park Service describe the Trinity detonation as follows:

At 5:30 a.m. on July 16, the nuclear device, known as 'Gadget,' was successfully detonated. To most observers – watching through dark glasses – the brilliance of the light from the explosion overshadowed the shock wave and sound that arrived some seconds later. A multi-coloured cloud surged 38,000 feet into the air within seven minutes. Where the tower had been was a crater one-half mile across and eight feet deep. Sand in the crater was fused by the intense heat into a glass-like solid, the colour of green jade. This material was given the name trinitite. The explosion point was named Trinity Site. (National Park Service 2023)

What had been witnessed was undoubtedly awe inspiring, to the point where the Manhattan project director Robert Oppenheimer famously likened his creation to that as producing

'the radiance of a thousand suns' (cited in DeLoughrey 2011: 245). This often-quoted phrase simultaneously refers to the intensity of the bomb's blast flash, and also its aerial scale, both of which are represented via mushroom cloud images. Despite what these images depict for those possessing the knowledge of how to read them, its focus on the aerial blast and resulting fire ball served to mask the actuality of an atomic bomb's enormous on-the-ground destructive power. 'Visual representation became crucial to identifying and understanding the new weapon, and to managing public opinion regarding its use' (Hariman and Lucaites 2012: 136). The image of the atom-bomb-generated mushroom cloud that started with the Trinity explosion established what would become the dominant iconographic representation of the nuclear era (O'Brian 2015: 80).

Much scholarship has been devoted to the socio-ethical and political contextualizing of the mushroom cloud image.⁸ A consistent theme occurring across this scholarship is how the mushroom cloud image creates a division between visibility and invisibility with respect to the destructive capacity of nuclear weapons, and moral judgements to use them. I align with theorists Robert Hariman's and John Louis Lucaites' (2012: 141) argument, in the context of images of the Hiroshima and Nagasaki bombings, that the aerial perspective of the mushroom cloud

creates a profound disconnect between the spectator and whatever had happened before the blast, and whatever has happened beneath it. All sense of cause, proportion, or complicity is obliterated by the incredible power unleashed from a single bomb, and hundreds of thousands could be dying below but the spectator only sees smoke and sky. Most important, the image is wholly disembodied. There are neither people nor a familiar *mise en scène* of embodied social interaction to ground one's encounter with the image.

It is this division between what can and cannot be seen that functions to nullify the image's inherent political dimension with respect to what it represents – meaning weapons capable of vaporizing and irradiating entire communities, lands and waters within seconds. The images of γ [gamma trace] offer a contrasting representation in the sense that the radioactive soil that caused

⁸ The mushroom cloud image as an icon of nuclear weaponry has been widely theorized. For key additional resources, aside from what is directly referenced in this article, see, but not limited to, Rosenthal (1991), Taylor (2003), Feighery (2011), Hamilton and O'Gorman (2018) and Jacobson (2021). In addition, for analysis of the media circulation of the mushroom cloud image of the Nagasaki 'Fat Man' bombing, along with subsequent US conducted testing, namely Operation Crossroads (1946), see Hales (1991) and O'Brian (2015).

⁹ In making this claim, I acknowledge the many dissenting voices of the allied nuclear states of America, France and the United Kingdom that protested against nuclear weapons development, testing and proliferation. Equally Indigenous-led anti-nuclear protest movements developed in colonized countries with a close geographic proximity to nuclear weapons testing. These groups functioned in opposition to nuclear colonial and imperial agendas. For example, the Nuclear Free and Independent Pacific (NFIP) group grew out of the first regional Nuclear Free Pacific Conference in Fiji in 1975, which had been organized by the Against French Testing in Moruroa (ATOM) group, founded in Fiji in 1970. Further conferences were held at Ponape in the Caroline Islands in 1978, in Hawaii in 1980 and in Vanuatu in 1983. The NFIP movement brought together Indigenous peoples from Hawaii, the Great Turtle Island (North America), Aotearoa, East Timor, West Papua, the Philippines, Polynesia, Melanesia, South Korea, and Japan' (Disarmament & Security Centre, Aotearoa New Zealand 2018). For further context see, among other related sources, *Pacific Women Speak Out for Independence and Denuclearisation* (Zohl dé 1998). Also see theorist Marco de Jong's recent essay "Our Pacific through native eyes": Māori activism in the Nuclear Free and Independent Pacific Movement' (2023), which provides a thorough review of Pacific-centred Indigenous anti-nuclear activism.

¹⁰ Theorist Elizabeth DeLoughrey (2011: 236) echoes these sentiments when she suggests that in 'American Cold War propaganda these weapons of mass destruction were naturalized by likening them to harnessing the

their photographic exposures quite literally bonds these images to the ground. As such, the viewing experience becomes inextricably linked to the realities of how the communities, lands and oceans that are directly below an atomic bomb's detonation are irreversibly affected.

Following the use of atomic weapons on Japan, and subsequent Cold War era nuclear testing, images of mushroom clouds circulated, predominantly in Western media outlets. This imagery symbolized utter destructive ability and equally national security, which established a sense of nation state safety within a general American public imagination during the Cold War era.⁹ Hariman and Lucaites (2012: 141) argue that within the context of American nuclear weapons development and testing, the mushroom cloud image embodies a

'Cold War nuclear optic' which incorporated three recognisable visual features: (1) the structured absence of death and destruction, (2) the formal perfection of the explosion, and (3) the containment of the bomb within a closed circuit of military control. (Hariman and Lucaites 2012: 141, emphasis in original)

These features functioned to control public opinion and morality regarding the billions of dollars dedicated to developing ever-larger destructive weapons, as well as their testing on unceded Indigenous lands and waters. They also conveyed a sense of scientific and military advancement albeit to an everyday non-expert public. In part the task of the mushroom cloud image is to simultaneously inform while also creating a sense of sublime non-comprehension – a separating of cause from effect.

Theorist Peter Hales (1991: 9) argues that the mushroom cloud image functions as a form of 'atomic sublime' via its ability to evoke sensations of awe and wonder that navigate the edges of human perception. Similar to Hariman and Lucaites, Hales's focus, also with the context of US testing, concerns how mushroom cloud imagery relied on the representation of atomic explosions as involving spectacular unfathomable scales, which gave little to no indication of the irreversible carnage that was happening below the mushroom's stem. Key to his conception of the 'atomic sublime' was how mainstream media aligned mushroom

cloud images with nature. Discussing the photographs that circulated after the Trinity test and the Japanese bombings, Hales notes that *Time*, *Life* and *Newsweek* all likened the various atomic explosions as akin to natural phenomena. They used language such as 'its light equalled that of many suns ... white smoke leaped on a mushroom cloud ... a big mushroom of smoke and dust' (ibid.). Hales suggests that this language, coupled with the image's huge scale, created a type of 'atomic sublime' that ultimately aligned human-made destruction with phenomena from the natural world.¹⁰ Furthermore, it created a new 'atomic aesthetic' of terror and wonder for Americans. This aesthetic shifted responsibility from what was being witnessed to mere response (12). Equally, within the context of imagery associated with US Cold War era Moana Oceania based testing, a similar dichotomy was perpetuated, however this time mushroom clouds were situated within vistas of palm trees and pristine blue oceans.¹¹ In other words, the government and military endorsed imagery that prevailed during Moana Oceania based testing did little to show the actual realities of the impacts of these nuclear devices. Instead, these photographs maintained a Western racist imposed fantasy of untouched remote lands that were inhabited by 'primitive' local populations: bomb, people and land were all associated with nature thereby further divorcing any sense of moral responsibility.

I support Hales's framing of the mushroom cloud image, which as a form of representation is entirely misleading, evoking both fear and fascination in society. This dual perspective disconnects viewers of mushroom cloud imagery from the actuality of a nuclear weapon's phenomenal killing power by symbolizing scientific progress and geopolitical dominance. In short, this type of imagery abstracts what it documents. This background, framed by the vast proliferation of mushroom cloud image-icons, contextualizes Niwelińska's photographic series γ [gamma trace]. However, I extend Hales's position concerning the cultural resonance of mushroom cloud imagery, and propose that the abstracting 'atomic sublime' aesthetic that he is critical of may in turn be strategically employed for political recognition and reparation.

Similar to mushroom cloud imagery, Niwelińska's photographs also abstract the nuclear legacies they represent. However, γ [gamma trace] expands nuclear representation beyond the limitations suggested by the 'atomic sublime'. Visually, each 6 x 9 inch photographic plate consists of ghostly interplays of colour, light, tone and shadow. The soil – with its differing levels of radioactive toxicity – that has touched the sensitive emulsion has resulted in images where some areas are more translucent, while others have an ominous milky opacity. These images are utterly abstract, meaning there is no identifiable subject matter, and any sense of a nuclear context is only provided by the series' title. However, for γ [gamma trace], abstraction is a direct causal result of arguably what is the most destructive feature of nuclear weapons: ionizing radiation and its lasting effect. In other words, the images are a direct product of radiation. These photographs reframe abstraction beyond the limitations of Hales's 'atomic sublime', thereby emphasizing radiation's broader environmental and societal impact.

IONIZING RADIATION AND SILVER HALIDE CRYSTALS AS ARTISTIC METHOD

To better understand the ongoing impacts of nuclear weapons and their surrounding contexts, other modalities for seeing nuclear imperialism and its consequences are needed. Many artists, grappling with visualizing the continuing effects of ionizing radiation, be it linked to Cold War nuclear weapons testing or to recent nuclear powerplant accidents, have embraced the material properties of photographic emulsion to register its presence. For example, in the context of the 2011 Fukushima Daiichi nuclear powerplant meltdown, several Japanese artists experimented with imaging the impact of the disaster on local community lands and infrastructure.¹² Of note are the camera-less methods utilized by Masamichi Kagaya, Yoi Kawakubo (2014–19) and Shimpei Takeda (2012) to visualize the presence of ionizing radiation within the environment.¹³ As part of his series *Autoradiograph* (2012–ongoing)

Kagaya researched how surrounding fauna and flora were impacted by the high levels of radioactivity released into the atmosphere. Entering restricted zones, Kagaya collected samples of trees, discarded debris and small dead animals and placed them on radiographic imaging plates. Once processed the negative image contains a multitude of glowing white and soft grey blurry splotches that are set against a black background. These splotches combine to create the outline of whatever has been placed directly on the plate. The denser the outline and indication of an object, the stronger the presence of radioactivity.

Working with a similar process, Shimpei Takeda exposed 'black-and-white film to samples of contaminated soil collected in several historical sites in the Kanto and Tōhoku regions' (Davre 2019: 6). He then placed the soil and film in a light tight container for processing later. The resulting images, titled *Trace* (2012), look akin to a galaxy, however instead of stars the white marks are evidence of trace radiation within the sampled soil. When discussing his work Takeda (2013: 206) states that by 'visualizing [these] traces into visible form, the resulting images will speak to us beyond the photograph, and perhaps they will be a valuable asset and documentation for future generations'. Implicit in Takeda's statement is how these images hold an ability to evidence radiation, both now and for the duration of radioactivity's lifespan. Also working with radioactive ground matter, Yoi Kawakubo's photographic series *If the Radiance of a Thousand Suns Were to Burst at Once into the Skies* (2014–19) involves a series of colour photographs that are the result of large format negatives that were buried for several months in the Evacuation Zones surrounding Fukushima. Once processed and printed, the resulting images are awash with different merging colours, giving image to the different wave lengths present within radiation. Kawakubo's photographic methods, like Kagaya's and Takeda's, also 'testify to the presence of radioactive contamination at a specific time and a specific place' (Davre 2019: 10). Their artworks hold a direct relationship to Shevchenko's statement: 'this is what radiation looks like'.

All three artists have worked with film's inherent sensitivity to electromagnetic radiation

power of the sun, and their radioactive by-products were depicted as no less dangerous than our daily sunshine'.

¹¹ As part of the overarching settler-responsibility methodology that frames my research, I use the more Indigenous focused term of 'Moana Oceania', instead of the more settler-colonial oriented Pacific or South Pacific to describe this geographic region.

¹² As part of the post-World War II 'Atoms for Peace' (1953) programme, the US promoted the idea of nuclear power as a safe by-product of the technology developed to produce nuclear weapons. Starting with a speech of the same title by US President Eisenhower, the programme served as a form of Cold War propaganda and distraction to growing public dissent concerning the atomic bombings of Japan as well as the subsequent production and testing of bigger nuclear weapons. In the context of Japan, the US Atomic Energy Commission held a significant role in introducing peaceful uses of nuclear technology to Japan through this programme. In addition, in 1954 Japan and the US signed the Atomic International Agreement, facilitated by the Atomic Energy Commission (AEC), to collaborate on nuclear research and development, which enabled Japan to access American nuclear technology and expertise. The Tokai Nuclear Power Plant, operated by the Japan Atomic Power Company, became Japan's first commercial nuclear power plant to generate electricity in 1966. For a comprehensive summary on the introduction and resistance to nuclear power in Japan, see Etsuko Kinefuchi's *Competing Discourses on Japan's Nuclear Power: Pronuclear versus antinuclear activism* (2022).

¹³ See the exhibition 'Picturing the Invisible' (curated by Makoto Takahashi), first exhibited in 2021 at The Director's Gallery in London, which brings together artworks from seven artists working in the affected region. Their artworks aim to make 'visible the legacies of 3.11: the ghostly touch of radiation, lingering traumas, and the resilience of those communities rebuilding their lives in its wake'.

¹⁴ The Trinity test site, located on White Sands Missile Range in Yootó Hahoodzo (New Mexico), is not open access. The US Military host an 'Open House' twice a year. Visitors can sign up for escorted tours on the first Saturday in April and the third Saturday in October via the US Army website (2024).

to register ionizing radioactivity. These artists, like Niwelińska, employ auto-radiography techniques that were first developed by physicist Henri Becquerel in the late nineteenth century. Becquerel discovered that uranium salts emit invisible beta particles and gamma rays that penetrate the silver halide crystals of photographic emulsion. He discovered that when an object was placed between the emitted particles and rays and the emulsion-coated photographic plate, the interior mass of the object became visible. In other words, Becquerel's discovery used radiation to see through and inside of something, giving insight to the limits of human perceptibility and vision. In technical terms, the interaction occurring between invisible radiation and photographic emulsion produces a latent image that is only revealed once the exposed plate is chemically developed. As such, it is the latent image that functions as a record of how photographic silver halide crystals have been activated and altered by radiation. In the context of nuclear imperialism, this record becomes a form of socio-ethical representational evidence of not only the presence of ionizing radiation but also what it looks like.

Niwelińska's *γ[gamma trace]* is contextualized by the artworks of Kagaya, Kawakubo and Takeda. Their collective methods explore how to render the presence and damage of radioactive particles in surrounding flora and fauna. The silver halide crystals of their selected substrates received radiation that, once developed, rendered as phantom splotchy marks. These 'imprints are reminders that celluloid film is sensitive to environments operating beyond the human senses and that toxicity can surface in film' (Pringle 2014: 137). The means by which these marks have been created, via their forced inscription into the emulsion, highlights the realities of how ionizing radiation impacts human bodies, lands and oceans. In other words, the photographic film becomes a marker that demonstrates how radiation is able to penetrate human skin, bones and deoxyribonucleic acid (DNA), as well as the cells of plant, animal and marine life. 'Radiation is ontologically predisposed to breaching imposed limits, whether they are film frames, reactor units, or

remote test sites' and, of course, human bodies (Schuppli 2020: 64). In the context of film, silver halide crystals and radiation collude with each other to produce an image.

MATERIAL WITNESSING OF THE TRINITY TEST SITE: CAUSE AND EFFECT

Niwelińska's *γ[gamma trace]* has also worked directly with radio-autography methods by exploring the source of where nuclear technologies began – the Manhattan Project Trinity test site in Yootó Hahoodzo (New Mexico). In April 2017, Niwelińska visited the Trinity test site and made a series of onsite exposures using plates that had been coated with photosensitive emulsion.¹⁴ The plates were placed on the ground, where the sun and the ionizing radiation present in the soil together produced a series of exposures. Once processed, shadowy ghostly mottled traces of radiation appeared across the different plates. As indicated, these imaged traces are the result of radiation that has forcibly activated the silver halide crystals residing in the emulsion on the plates: radioactive soil and photographic emulsion have become synchronized matter.

The emulsion cannot be 'protected' as such from the activity produced by the electromagnetic waves, meaning it has no choice but to synchronize with the particles that are inscribing its surface. This synchronization functions as a type of coordinated performance, where the actions of one material literally combine with that of another. What is central to this performance is knowing how to read the resulting images when they go beyond recognizable nuclear iconography. These images ask for different forms of looking, interpreting and thus comprehending the 'nuclear'. It is this coordinated performance with its material connection to the Trinity test itself that establishes alternative methods to dominant mushroom cloud nuclear imaging tropes. Through their witnessing capacities, these images mobilize a counter-iconography by which to comprehend the ongoing and long-lasting impacts of nuclear-weapons testing and their surrounding ideologies of state domination and control. As such, what they perform is not only

material, but also conceptual – evoking modes of seeing as much as modes of comprehension. As Niwelińska (2017a) states, the radiation that has been imaged in the γ [gamma trace] photographs becomes a ‘method of recording and archiving the nuclear trauma’ that exists within the site. Yet they also function to materially witness how nuclear testing has irrevocably altered this site and others as part of the logic of not only the United States but all nation states’ Cold War era testing.

Across the expanded field of performance studies, witnessing is a pivotal area of scholarship with far-reaching application.¹⁵ Central to this article’s approach to witnessing is performance studies theorist Peggy Phelan’s proposition that ‘performance might provide a model for witnessing a historical real that exists at the very edge of the phantasmatic – events that are both unbearably real and beyond reason’s ability to grasp’ (1999: 118). In other words, performance is a medium by which to witness and represent historical events that defy straightforward logical understanding. She posits that certain events in history are so intense and profound – ‘unbearably real’ – that they exist ‘at the very edge of the phantasmatic’, hovering between reality and the realm of fantasy or the unreal. Events of this nature, which would no doubt include the testing of nuclear weapons, surpass ordinary comprehension, challenging reason’s ability to fully grasp them. For Phelan, performance, conceived as live event, serves as a potent model for witnessing as it moves beyond solely factual documentary accounts and embraces visceral, psychological and embodied experiences. This position is relevant to Schuppli’s thinking, which extends ideas of witnessing to the narrative potential and agency of materials. She is specifically concerned with the ways materials perform acts of witnessing (Schuppli 2020: 20).

Originating from common law legal terminology, material witness refers to a person who has information or evidence that is relevant to legal proceedings. Material witnesses are individuals who have witnessed a crime or have information pertinent to a case, and their testimony or evidence is deemed crucial for

the prosecution or defence. In this context, it is a material witness’s testimony that is of prime importance. Nonhuman entities such as DNA, documents, objects and other physical evidence are also considered material witnesses. Schuppli explores this latter conception of material witness by focusing on materials and matter ‘that have recorded trace evidence of the violence that generated their contexts’ (3). She focuses on how trace evidence of external events are ‘registered directly by changes in the material composition’ of media, thereby ‘producing a condition of informational enrichment that opens up the artifact to further analysis and critical reflection’: they are their own kind of live performative event (64). She takes the concept literally, meaning materials that actually witness, as opposed to merely functioning as metaphor. It is not a case of ‘this’ being like ‘that’, but rather ‘this’ is the direct result of ‘that’ – cause and effect, between material and event, are intimately connected, a coordinated performance. However, ‘matter becomes a *material witness* only when the complex histories entangled within objects are unfolded, transformed into legible formats, and offered up for public consideration and debate’ (18, emphasis in original). The political discourses that are set into motion by materials that witness is primary: the matter must do something by altering the visible and the knowable; it must provide evidence.

Photographic emulsion has built into its core the ability to function as a material witness. Regardless of what kind of electromagnetic waves film is exposed to, it will always be permanently altered through exposure. As stated, this relationship between the point of exposure and the film’s emulsion is a form of coordinated performance, a type of cause and effect. For γ [gamma trace], exposure is the result of residues of trace radiation that have inscribed themselves into the emulsion. It is perhaps not surprising that the ground surrounding the Trinity test site still contains active levels of radiation seventy-nine years post-detonation. Furthermore, the extended half-life of plutonium is understandable in the sense that its presence will persist far beyond human lifespans.¹⁶ Accordingly, how the γ [gamma trace] artworks

¹⁵ See theorist Caroline Wake’s ‘The accident and the account: Towards a taxonomy of spectatorial witness in theatre and performance studies’ (2013) for a critical summary on the role of primary, secondary and tertiary witnessing within performance studies scholarship.

¹⁶ Plutonium has a half-life of 24,100 years.

¹⁷ This phrase ‘for the good of mankind’ is what US Navy officials told Chief Juda of Bikinni (Bikini) Atoll as he was asked to inform his people that they would need to leave their homeland to enable US testing of nuclear weapons to occur in Aolepān Aorōkin Majeļ (Republic of the Marshall Islands). For a critical account outlining first-hand experience of the impact of US testing in Aolepān Aorōkin Majeļ, see Darlene Keju-Johnson’s ‘For the good of mankind’ (2003) in *Seattle Journal for Social Justice*.

¹⁸ See Camilla Pohle’s (2023) ‘US policy on Marshall Islands nuclear test compensation must change – China is watching’ for an analysis of the present US government’s position concerning reparations to the people of Aolepān Aorōkin Majeļ who were subjected to nuclear testing.

¹⁹ In 1990 US Congress established the Radiation Exposure Compensation Act so as to compensate veterans and downwinders impacted by US weapons testing and development. A controversial act due to those not included, activists have campaigned for decades for Yootó Hahoodzo (New Mexico) and Navajo Nation residents to be included. In July 2023 the act was expanded to include those impacted by the Trinity test, however these changes to the legislation were blocked at the House (McKeon 2023).

function as material witnesses shifts beyond their relationship to the Trinity test site solely. When viewing these artworks focus must be shifted away from reading what is visible – the ghostly traces registered via the emulsion – to instead how ‘a politics of matter can be produced in the present, which might in turn corroborate other findings, and even be constitutive of circumstantial evidence’ (66). This shift connects to ongoing efforts of nuclear justice and redress for the harm caused to individuals, communities and the environment as a direct cause and effect of nuclear activities.

These artworks hold the ability to not only demonstrate the presence of ionizing radiation at the Trinity test site, but also its existence in other locations that were subjected to US testing. For example, this relationship is particularly pertinent to Moana–Oceanic island nations that were given no choice to be used as test sites. Nuclear weapon testing occurred across Moana Oceania from 1946 to 1996. French, UK and US governments conducted a total of just over 300 atmospheric and underwater nuclear detonations. As stated, UK nuclear testing left large areas of highly toxic First Nations tribal land in Australia. Equally, French (occupied) Polynesia suffers ongoing radiation pollution and extraordinarily high cancer levels due to tests conducted by the French government. In a similar manner America subjected Aolepān Aorōkin Majeļ (Republic of the Marshall Islands) to sixty-seven tests, including Castle Bravo, the largest ever nuclear detonation (15 megatons of TNT). Framed through a rhetoric of ‘for the good of mankind and to end all world wars’, US Navy officials told Chief Juda of Bikinni (Bikini) Atoll to inform his people that they would need to leave their homeland to enable US testing of nuclear weapons to occur in Aolepān Aorōkin Majeļ.¹⁷ Like French and British testing, these tests exposed local oceans, flora, fauna and human bodies to intoxicatingly high levels – much higher than those of the Trinity test – of ongoing ionizing radiation that the US government still refuses to properly acknowledge or compensate.¹⁸ Large parts of the region still remain uninhabitable due to shockingly high levels of radioactivity.

In respect to this context, the γ [gamma trace]

artworks align with these related situations directly. For example, just as compensation and recognition for those affected by the Trinity test remain a current fight, the same situation is replicated in equally affected Moana–Oceanic US territories, as well as those colonized by France and the UK.¹⁹ Niwelińska’s images, with their coordinated performance between trace radiation and photographic emulsion, function ‘as a pure indexical manifestation of the place’s invisible, inherent trauma’ (Niwelińska 2017a: 16–17). Put simply, this performance holds the potential to imagine nuclear justice as an interconnected pursuit that intertwines with and enriches already existing information concerning these historical events. Although Niwelińska’s images are yet to be used in a legal context, they do provide forms of evidence, via the film’s undeniable altered state, that materially bears witness to both the development, testing and lasting impacts of nuclear weapons. Equally, for viewers of these artworks, there is a heightened tension between how the material agency of emulsion and radiation are essentially performing a type of spatio-temporal cause and effect. This tension is not premised in one illustrating the other, but rather is suggestive of the myriad narratives of experience concerning the ongoing health and environmental consequences of nuclear testing.

Reading γ [gamma trace] via Schuppli’s material witness methodology expands these artworks’ ability to contribute towards nuclear justice and reparation efforts. The coordinated performance between radiation and emulsion, registered on the plates, simultaneously witnesses both the past events of the site – the beginnings of the nuclear era – ‘as well as the “this is still to come” in the future – the ongoing event of contamination’ (Schuppli 2020: 75). In addition, this performance of synchronizing matter holds a direct material connection to not just the Trinity test site but by proxy to other nuclear test sites too. Niwelińska’s artworks function to build forms of visual literacy concerning what radiation looks like, which go beyond the discourses established through mushroom cloud iconography. Although – like mushroom cloud images – the artworks of γ [gamma trace] are also abstract, they alter the visible and the knowable

concerning the legacies of this history. They declare ‘this is how radiation looks’, and how, seventy-nine years later, its presence remains. When read in this manner, these images are able to materially witness much more than what their abstracted splotchy marks represent. They are their own visual language evoking much larger contexts of imperial nuclear control, state domination and the testing of weapons of unfathomable destruction on innocent peoples and places by largely settler-nation states. They are cause *and* effect.

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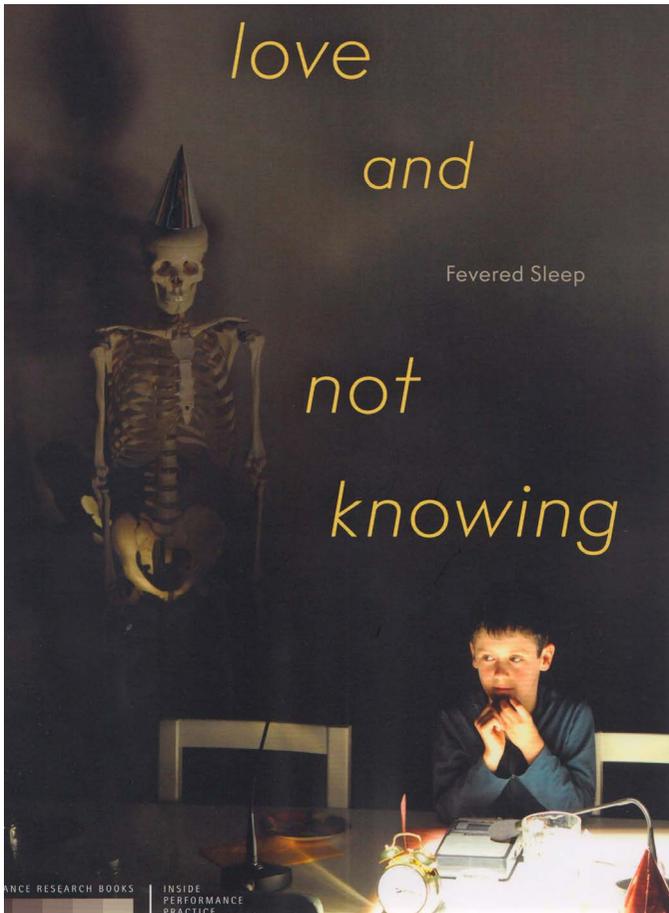
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