

TEMPORAL MATTER, SPATIAL WITHDRAWAL, HUMAN STEWARDSHIP: RADIOACTIVITY IN ART AND NUCLEAR WASTE REPOSITORY MARKING

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Abstract

This thesis investigates the intersection of conceptual art and nuclear semiotics. It explores how radioactive artworks can contribute to the systemic marking of geological disposal facilities (GDFs) for nuclear waste. Current strategies, such as those proposed by the Records, Knowledge and Memory (RK&M) initiative, predominantly advocate for visual and linguistic markers to warn and inform future generations. By contrast, this research posits a shift towards conceptual and post-conceptual art modalities and the integration of radioactive materials as an alternative approach to deep-time meaning-making.

Through a speculative methodology, this thesis examines six core artworks including pieces by Robert Barry, Taryn Simon, Trevor Paglen, and the collaborative duo Erich Berger and Mari Keto, that utilise radioactive elements as central components. The argument is structured around three primary actors within the nuclear waste narrative: time, space, and people. First, radiation is conceptualised as a temporal art material, employing the framework of 'slow violence' to advocate for an anachronistic approach over strictly linear intergenerational processes. Second, the spatiality of radiation is analysed through the dialectic of site and non-site, exploring how the spatial withdrawal of toxic materials fosters the nuclear sublime. Third, the thesis addresses the complex role of human stewardship, highlighting how rumour, myth-making, and radiophobia can drive a self-perpetuating cycle of social memory when institutional frameworks inevitably collapse.

Ultimately, the thesis argues that a successful radioactive art marker must entirely escape its art-historical contexts to function effectively as an artistic ecological intervention. By anticipating the inevitability of toxic drift, it concludes that the perpetual ontological vitality of radioactive matter provides a robust, self-signifying warning mechanism. This approach shifts the burden of deep-time communication from the fragility of human-to-human transfer to the enduring collaborative narratives of contaminated landscapes and human stewardship.

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Glossary

DAD	Decide, Announce, Defend
DOE	Department of Energy (US)
EURIDICE	European Underground Research Infrastructure for Disposal of radioactive waste in Clay Environment
GDF	Geological disposal facility
HLW	High-Level Waste
IAEA	International Atomic Energy Agency
ICAN	International Campaign to Abolish Nuclear Weapons
INES	International Nuclear and Radiological Event Scale
KIF	Key Information File
LLW	Low-Level Waste
MSSS	Magnox Swarf Storage Silo
NEA	Nuclear Energy Agency
OECD	Organisation for Economic Co-operation and Development
RK&M	Records, Knowledge & Memory
ROSATOM	(Russian) State Atomic Energy Corporation
RWM	Radioactive Waste Management
RWMC	Radioactive Waste Management Committee
SHIRE	Share-Imagine-Renew
SMR	Small Modular Reactor
SNL	Sandia National Laboratories
TEPCO	Tokyo Electric Power Company
VLLW	Very-Low-Level Waste
WIPP	Waste Isolation Pilot Plant

Introduction

I began this PhD in 2020 with 100 seconds left until midnight on the Doomsday Clock. At the close of writing in 2026, there remains only 85 seconds (the closest it has ever been). The clock was co-conceived of by J. Robert Oppenheimer, the ‘father of the atomic bomb,’ in the wake of the first atomic weapons test in 1945, with midnight representing global catastrophe.¹ The threat of nuclear disaster still looms heavily.

Nuclear waste is a problem. It is a product of both nuclear power generation and nuclear arms production.² The International Atomic Energy Agency (IAEA) reports 415 operational nuclear reactors, globally. The majority are in the big 5 producing countries: USA, France, China, Russia, and South Korea with a combined total of 271 operational reactors. A further 220 reactors exist globally that are in permanent shutdown, most awaiting or undergoing decommissioning.³ A further 72 reactors are under construction at present.⁴ All nine countries recognised as possessing (or believed to possess) nuclear weapons also operate a civilian nuclear power programme. The International Campaign to Abolish Nuclear Weapons (ICAN) estimates a global stockpile of a staggering 12,331 warheads. Russia and the USA are believed to operate over 90% of all nuclear weapons.⁵ All of these countries are producing the most dangerous High-Level Waste (HLW) as part of their civilian and militaristic nuclear

¹ Oppenheimer (1904-1967) led the development and testing of the first atomic bomb. His legacy as ‘the destroyer of worlds’ is contrasted by his subsequent resistance to military nuclear proliferation and expansion. The Doomsday Clock which he was co-founder of, serves as a warning of existential man-made threats.

² Other nuclear waste (ranging from Very Low-Level Waste (VLLW) to Low-Level Waste (LLW)) comes from industries such as the medical imaging industry and makes up around 94% of nuclear waste in the UK. Intermediate-Level Waste and High-Level Waste makes up around 6% of nuclear waste and is the most hazardous. Of the total amount of radioactive waste produced to date, and forecast to 2125 (4.9 million tonnes) by the UK, around 4.3 million tonnes is classified as hazardous. World Nuclear Association, ‘Radioactive Waste Management’, (2022). In 2018, the International Atomic Energy Agency (IAEA) reported ‘the current global inventory of solid radioactive waste is approximately 35 million m³, of which 28.5 million m³ has been disposed of permanently and a further 6.3 million m³ is in storage awaiting final disposal. International Atomic Energy Agency, Status and Trends in Spent Fuel and Radioactive Waste Management (Vienna: IAEA, 2018), p. 1. As of 2025, *all* of the UK’s radioactive waste is in interim storage and awaiting final disposal. Nuclear Decommissioning Authority, ‘UK Radioactive Waste Inventory 2022’, (2023).

³ A reactor is usually decommissioned when it reaches the end of its life. Reactors typically have an operational life of around 50 years. They then become less economically viable to continue running. The decommissioning phase primarily consists of reducing radioactivity at the site to safe(r) levels.

⁴ International Atomic Energy Agency, ‘Power Reactor Information System’, (2026).

⁵ International Campaign to Abolish Nuclear Weapons, ‘Nuclear Arsenals’, (n.d.).

industries.⁶ This HLW, which includes ‘spent fuel,’ is still highly radioactive and many ‘leftover’ radionuclides will remain dangerous for extremely long periods of time.⁷

Uranium-235, the most common radionuclide in power production has a half-life – the time it takes for the energy it emits to reduce by half – of 700 million years.⁸ This waste must be made safe, and it must remain safe for a very, *very* long time. This more-than human timescale is called ‘deep-time.’⁹ Each country that produces nuclear waste is ethically and legally responsible for disposing of it within their own borders.¹⁰ Whilst waste can be processed in another country, making it ready for more permanent storage, the IAEA Code of Practice mandates strict controls over who can receive what based on the receiving country’s ability and capacity to safely manage that waste. This Code of Practice therefore excludes under-resourced territories such as Antarctica from receiving nuclear waste.¹¹

Transboundary movement is, however, common, and whilst to a certain extent it is technically possible to send nuclear waste to another country for permanent disposal, unsurprisingly, no country has yet signed up as an international nuclear waste dumping ground. As such, responsibility falls back to the waste-producing state to correctly dispose of their own waste.

Most countries that have embarked upon a strategy for storing nuclear waste have opted for permanent underground storage facilities commonly referred to as geological disposal facilities (GDFs). These sites are chosen based on the predictability of future geological stability and the unlikeliness of geomechanical or hydrogeological risks that may lead to toxic drift. Historically, in the 20th century, multiple governments forcefully operated a ‘Decide, Announce and Defend’ (DAD) strategy when seeking GDF sites.¹² This technocratic approach was vehemently resisted by the communities that were forcefully expected to shoulder the burden of living with toxic waste. When US Congress amended the 1982

⁶ Radioactive waste is categorised by its volatility. Even non-nuclear nations produce radioactive waste – primarily through research and medical imaging, but these are considered Low-Level (LLW) or Very Low-Level waste (VLLW) and typically do not require such extreme measure to encapsulate and contain their radioactivity.

⁷ ‘Spent fuel’ is somewhat of a misnomer. It is fuel that is no longer capable of sustaining nuclear fission efficiently, but is by no means ‘used up,’ or ‘spent’ in terms of the radiological danger it poses to organic life.

⁸ U-235 decays by alpha particles which means that the energy it emits can be blocked by materials as thin as paper or skin and is consequently quite safe to handle. However, if it is inhaled or ingested, it is extremely dangerous to health.

⁹ *Deep-time* is so far in the future it has no frame of reference. We cannot comprehend or envision the changes that will occur in a time so distantly in the future. It contrasts the comparable insignificance of human timescales. In the context of nuclear industries, deep-timescales coexist with temporal ethics and the associated intergenerational injustice of present-day actions on future generations.

¹⁰ However, some countries (such as Australia which does not produce nuclear power or weapons but is a source of uranium ore) are generally exempted from their involvement in ‘waste’ production when exported out of the country.

¹¹ International Atomic Energy Agency, Code of Practice on the International Transboundary Movement of Radioactive Waste (Vienna: IAEA, 1990).

¹² Mika Kari, Matti JKojo, and Markku Lehtonen, ‘Role of the host communities in final disposal of spent nuclear fuel in Finland and Sweden’, *Progress in Nuclear Energy*, 133 (2021).

Nuclear Waste Policy Act in 1987, they bypassed the law that required multiple sites to be assessed and evaluated for their suitability to host a GDF. Instead, Yucca Mountain in Nevada was designated as the *only* place that would be considered for a GDF.¹³ The people of Nevada dubbed this the ‘Screw Nevada Bill’ as the state had no nuclear power plants of its own and was seen as being a nuclear waste dumping ground.¹⁴ However, being comprised of almost entirely federally owned land, Nevada has a long nuclear history having been the primary testing ground for US nuclear weapons during the Cold War. The opposition to the Yucca Mountain repository by the people of Nevada resulted in the defunding of the project in 2010 under the Obama administration at which point construction was halted.

A similar community resistance to the DAD approach occurred in Gorleben, Germany in 1977. As a small rural village, the sparsely populated area was considered ideal for the construction of a reprocessing plant and a HLW permanent repository in an existing salt mine. Gorleben became the site of enormous protests that aimed to block movements of trains bringing in shipments of radioactive waste. The diverse forms of protest and oppositional tactics warrant a further thesis in themselves, but ultimately, after decades of resistance, in 2020 Germany’s Bundesgesellschaft für Endlagerung (Federal Company for Radioactive Waste Disposal) finally removed the salt mine at Gorleben from the list of potential disposal sites.

In 2006, the UK’s Secretary of State for Environment, Food and Rural Affairs, David Miliband, stressed the unpopularity and inefficacy of the DAD approach by branding it ‘Decide, Announce, Defend, Abandon.’¹⁵ The DAD approach has been criticised for being politically driven, not scientifically driven. Sites were chosen because they were viewed as ‘convenient,’ not because they were proven to be geologically suitable.¹⁶ In the past twenty years or so, positive community engagement at the outset has now become the determining factor in placement for many countries seeking to locate a GDF.

A community that elects to host a GDF in their vicinity faces not only a degree of biological risk, but the potential for engrained stigmatisation. Cultural risks may include impact on

¹³ United States Congress, 'H.R.2967 - Nuclear Waste Policy Amendments Act of 1987', (1987).

¹⁴ James Davenport, 'The Federal Structure: Can Congress Commandeer Nevada to Participate in its Federal High Level Waste Disposal Program?', *Virginia Environmental Law Journal*, 12 (1993), p. 540.

¹⁵ David Miliband, 'Radioactive Waste Management Report. Hansard: House of Commons Debates, vol. 450, col. 1519', (2006).

¹⁶ Yucca Mountain is located on the ancestral lands of indigenous peoples. The usage of the land by the US government is still contested by the Western Shoshone Nation. The 1863 Treaty of Ruby Valley – an agreement between the US and the Western Shoshone people – agreed usage of the native land by the US, not ownership. As such, indigenous groups were vocal in the opposition to the proposed Yucca Mountain repository. Charles Joseph Kappler, *Indian Affairs: Laws and Treaties Vol. 2 (Treaties)*, (Washington: Government Printing Office, 1904), pp. 851-853.

regional identity, turning natural spaces into dumps; disruption of indigenous lands and sacred sites; and the ethical injustice that is imposed on future inhabitants of the area who cannot consent to the handing over of land to toxic landfill. Living with toxic threat and risk anxiety, even if not directly biologically affective, is psychologically damaging. Economic conflict within the community may also increase. Those who value the short term benefit of infrastructure funding and job creation are likely to oppose those who fear the environmental risks. With that, property values can decline, and the post-closure local economy is also likely to decline as jobs are lost.

This legacy of multi-generational stigmatisation is not unique to nuclear waste, nor can it be addressed in a vacuum isolated from broader patterns of industrial discard. In *Discard Studies: Wasting, Systems, and Power*, Max Liboiron and Josh Lepawsky reframe traditional notions of waste as unwanted byproducts by foregrounding the value/devaluing of places and people and the associated sociopolitical dynamics.¹⁷ Through this lens, nuclear waste and the nuclear industries clearly share similarly oppressive regimes of persistent toxicity, whether a community chooses to host a GDF or not. Socioeconomic factors of less advantaged, or underfunded/overstretched councils may contribute to the need to step forward as a potential GDF site. The act of volunteering may not be as altruistic as it appears.

On the surface, radioactive waste may appear to be materially exceptional to other kinds of waste. It does not remain chemically stable like asbestos for example. It is by its very nature, unstable. Its toxic influence extends beyond its confines as it emits radiation into its surroundings over extremely long periods of time. As a result, it is treated with more hesitance and care. More funds are allocated to its disposal compared to other kinds of waste. Yet, treating radioactive waste as completely distinct may be problematic. Where promises of deeply-regulated safeguarding systems are made, a sense of culpability and responsibility is portrayed by governing bodies. However, this culpability and responsibility extends to a comparative hair's breadth of time on the deep-time scales that must be considered. It is this technocratic exceptionalism that risks sanitising the slow violence that has already occurred and will continue occurring into deep-time.

As Liboiron argues in *Pollution is Colonialism*, pollution is not simply a system of environmental mismanagement, but representative of colonial land relations and the assumption that certain territories (often indigenous lands, rural, or low-income places) are naturally available for resource extraction, governmental acquisition, and permanent toxic

¹⁷ Max Liboiron and Josh Lepawsky, *Discard Studies: Wasting, Systems, and Power*, (Cambridge, MA: The MIT Press, 2022), pp. 61-96.

disposal.¹⁸ The targeting of Yucca Mountain and Gorleben highlights this dynamic. Whilst this thesis focuses on the unique energetic qualities of radioactive materials, it recognises that nuclear waste is not isolated from other forms of waste. Nuclear waste is the hyper-concentrated expression of a global discard infrastructure that relies on the outsourcing of systemic harm to those less capable of resisting it. It is precisely because GDF siting is bound up with these deep histories of injustice and systematised dumping that siting initiatives are deeply-protracted and often reach a state of paralysis.

However, not locating and securing a GDF site prolongs the use of surface storage infrastructure for nuclear waste. Surface storage (and sub-surface storage) is vastly more vulnerable to leakage and is viewed only as a temporary measure. The continued utilisation of temporary surface storage infrastructure passes responsibility onto future generations with no decline in urgency that something more permanent must be done with it. The current, and widely-upheld view, is that we must deal with our nuclear waste now, in the present, and the best place to move it to is permanent underground repositories.

When operating and functioning as intended, storing nuclear waste in a geological facility confines toxicity and poses statistically negligible health risks to those on the surface. When containment fails or is breached (either intentionally or unintentionally) the risks become significantly elevated. Radiation leaks that are transported into the water table or soil bioaccumulate and pose a serious risk of internal contamination by consumption. Inhalation and ingestion of fission byproducts like iodine-129 (with a half-life of over 15 million years) are mistaken by the human body for stable iodine causing thyroid cancers. Strontium-90 chemically mimics calcium and is absorbed directly into bones and teeth causing bone cancer and leukaemia. If leaks or breaches occur, the consequences could be catastrophic.¹⁹ Therefore, safe containment in secure geological facilities is paramount, and a broad consensus is towards marking these facilities with a high amount of detailed information.

The problem that is the concern of this thesis is how to *meaningfully* mark these facilities once they are filled with waste, backfilled with concrete and sealed shut to prevent human intrusion. The remit of this academic enquiry is called *nuclear semiotics* which investigates the problem of conveying and transferring intelligible information about the dangers of a GDF for 10,000 to 100,000 years in the future.²⁰ The difficulty of this is that we have no

¹⁸ Max Liboiron, *Pollution is Colonialism*, (Durham and London: Duke University Press, 2021), pp. 7-9.

¹⁹ The effects of radiation sickness are more difficult to quantify and dependent on timeframes of the breach or leak, and to what extent. Acute radiation sickness is improbable but possible.

²⁰ The time period of 10,000 to 100,000 years is typically what nuclear semiotics defines as deep-time. Yet, the anthropogenic products of nuclear industries can persist a great deal further than this into the future. Therefore, the definition of deep-time in nuclear semiotics circles may be deemed as being somewhat arbitrary.

existing analogues that can be drawn upon that have successfully conveyed information beyond a few thousand years. In other words, we have little to no frame of reference for successful communications from far enough in the past that we can apply to the future.

To mark a GDF is to provide it with an aesthetic. Aestheticising the nuclear is notoriously difficult.²¹ Atomic blasts have the iconic – and now synonymous – mushroom cloud. But after the spectacle of the explosion, the long, drawn-out effects of radiation are much more difficult to visualise. Personally, I have long had an interest in British Cold War aesthetics. From the serene design of the 1976/1980 *Protect and Survive* booklet (figs. 1.1(a) and 1.1(b)) to the classic innocence of Hilda and Jim Bloggs in the 1986 animated film, *When the Wind Blows* (fig. 1.2). The British have a long-standing history of disseminating illustrated advice that minimises the severity of the situation when it comes to the prospect of nuclear warheads heading to our shores. The stoic stiff upper-lip mentality so often associated with 20th century British decorum lends a unique aesthetic to Cold War media. This was my experience of nuclear aesthetics up until 2010.²² Having already established an interest in the nuclear as a teenager, the 2010 film *Into Eternity* was a window into a problem I had never considered up until this point: what to do with nuclear waste. The documentary explores Finland's GDF solution, Onkalo.²³ Director Michael Madsen explores the possibilities of how to convey the dangers of the contents of the underground repository in a message to the future: 'No esteemed deeds are commemorated here. You should not have come here. You are heading towards a place where you should never go.'²⁴ *Into Eternity* had sparked a new interest in me: nuclear semiotics.

²¹ In the early 20th Century, the craze for newly discovered radium as a 'cure-all' led to the radium-infused products from makeup to drinking water. Radiation was deemed something to be embraced, or as something miraculous; something marketers encouraged us to put on and in our bodies for 'health benefits'.

²² Nuclear aesthetics, whilst not a concretely defined term, is the broad inter-disciplinary concern of 'making the invisible visible' regarding nuclearity. It includes everything from the techno-utopian 'atomic' design trends of the mid-20th century, to the visualisation of ruinous landscapes after nuclear disasters.

²³ *Onkalo*, meaning 'hiding place.'

²⁴ *Into Eternity*, dir. by Michael Madsen (Denmark, 2010). This message was originally conceived of by Sandia National Laboratories in 1993 for the Waste Isolation Pilot Plant in New Mexico.



FIG 1.1(a). Protect and Survive booklet cover (Ca. 1974). 1.1(b). Interior page.

Nuclear semiotics discourse began in 1981 with the Human Interference Task Force – a multi-disciplinary team from both STEM and Humanities backgrounds tasked with addressing the semiotic problem of marking the proposed Yucca Mountain GDF in Nevada, USA.²⁵ A similar, smaller initiative to assemble multi-disciplinary ideas was also conducted by *Zeitschrift für Semiotik* in Germany around the same time.²⁶ A further study was conducted by Sandia National Laboratories (SNL) in New Mexico on behalf of the US Department of Energy (DOE). Visualising the imperceptible became a whole industry in the 1980s and 90s, but with it came the problem of how to provide a message to the future that could reliably be decoded by anyone between now and 100,000 years in the future. In 1993, SNL produced an ‘Expert Judgement’ report outlining the basic principles for marking a proposed GDF called the Waste Isolation Pilot Plant (WIPP).²⁷ Research in the 20th century was guided by imagined possible future scenarios, which led to many suggestions that have

²⁵ Initially designated as the primary site for High-Level Waste (HLW) storage in the US in 1987, controversy and public disapproval led to the project being halted in 2010.

²⁶ Institute for Language and Semiotics, ‘And for all eternity: Communication over 10,000 years: How do we tell our children's children where the nuclear waste is?’, in *Journal of Semiotics*, (Tübingen, Germany, 1984).

²⁷ Kathleen M. Trauth, Stephen C. Hora, and Robert V. Guzowski, *Expert Judgment on Markers to Deter Inadvertent Human Intrusion into the Waste Isolation Pilot Plant* (Albuquerque, NM: Sandia National Laboratories/United States Department of Energy, 1993).

been subsequently panned in the ensuing decades for being too esoteric.²⁸ In 2020, the Europe-based Nuclear Energy Agency (NEA) published a final report after a decade of research by their initiative: Preservation of Records, Knowledge and Memory (RK&M) Across Generations. This Euro-centric report – the first of its kind – includes some basic principles from previous research by SNL. The report provides a ‘Toolkit’ of interdisciplinary mechanisms that should be used as a systemic approach to devising markers for a GDF. One of these Toolkit mechanisms is Art (appendix 1.2).²⁹



FIG 1.2. *When the Wind Blows*, dir. By Jimmy T. Murakami, (UK, 1986). Still depicting preparations for a domestic shelter.

Criticism of the RK&M Art Mechanism is the basis of this thesis.³⁰ It is my view that there is scope to improve the recommendations that have been made by reshaping and broadening the analogues that have informed the suggestions made in the Toolkit. The report identifies the potential for the integration of art with archives and museums, and supporting documents in publications. The report further states that art has the power to engage local communities and ‘may relay cultural knowledge, information or awareness from one

²⁸ Radioactive cats, or ‘RayCats’ that would glow when close to a source of radiation being a notable example. Proposed by philosophers, Françoise Bastide and Paolo Fabbri.

²⁹ Nuclear Energy Agency, Preservation of Records, Knowledge and Memory (RK&M) Across Generations (Paris: 2020). The Toolkit identifies broad categories, populated with more specific mechanisms. The categories are: Dedicated record sets and summary files; Memory institutions; Markers; Time Capsules; Culture, education and art; Knowledge management; Oversight provisions; International mechanisms; and Regulatory framework.

³⁰ I will be capitalising *Art Mechanism* to aid the distinction between direct reference to art as defined by the Toolkit, and discussions about art as a broader practice.

generation to another or aim to communicate directly to the future.’³¹ In addition, art was identified as having the potential to stimulate the ‘visualisation of the immaterial and invisible.’³² However, these recommendations come as a result of the report’s interpretation of art as being predominantly *visual* in nature, this being the key area of my criticism.³³



FIG 1.3. Richard Pousette-Dart, *L'atomo. Un Mondo Unico*, 1947, oil on linen, 128 x 136 cm, Solomon R. Guggenheim Foundation.

The nuclear as art subject emerged shortly after the explosive entrance of atomic bombs into global culture in the 1940s. Early representations of the nuclear bomb in art often depicted the immediacy of the bomb through mushroom cloud forms (e.g., Richard Pousette-Dart, *L'atomo. Un Mondo Unico*, (1947)) (fig.1.3) and nuclear technology (e.g., Enrico Baj, *Fire! Fire!*, (1963)), (fig. 1.4).³⁴ Whilst these artworks are important to the history of art in, and of,

³¹ Nuclear Energy Agency, 'Preservation of RK&M', pp. 144-146.

³² Nuclear Energy Agency, 'Preservation of RK&M', p. 144.

³³ The Toolkit defines 'Art' as including: 'public art, visual arts (drawing, painting, sculpture, photography, video, filmmaking, internet art), socially engaged art, design, craft, architecture, music, performing arts (dance, theatre) and literature inspired by nuclear (waste) culture.' However, the report itself draws more heavily from visual references than any other artform. Nuclear Energy Agency, 'Preservation of RK&M', p. 144.

³⁴ The nuclear, specifically radiation was already present in artistic expression in the late 19th Century following the discovery of radiation. A recent exhibition at Musée D'Art Moderne, Paris titled '*L'Âge atomique, les artistes à l'épreuve de l'histoire*' (Oct 2024-Feb 2025) presented the historical relationship between nuclearity, the atomic, radiation, and artists. The exhibition showed the divergence in representation between mystical abstraction, and infrasensory conceptualism. However, it was not until after 1945 that representations of the bomb emerged in art.

the atomic age, their visuality limits the scope for broadening the Art Mechanism in ways I posit as being beneficial for tackling the problem faced by deep-time semiotics. These works serve as analogues for pictographic representation and nuclear disaster made visual, but their limited modality eschews durational conceptualisation of radiological contamination. The mid-century tendency towards the depiction of the spectacle also hinders the protractedness of half-lives that stretch into deep-time. To explore further possibilities for art as a communicator of nuclear waste we must turn to new, less visual approaches.



FIG 1.4. Enrico Baj, *Fire! Fire!*, 1963, oil paint and Meccano on fabric, 1286 x 972 mm, Tate, London.

Contemporary art for the nuclear age has often turned to more conceptual forms, tending to shy away from the immediacy of disaster (perhaps because this is now dwindling from memories of direct experience) and moving towards the register of time and protractedness.³⁵ Kyveli Mavrokordopoulou and Ruby de Vos in the 2018 *Nuclear Aesthetics* issue of the *Journal for Visual Art, Visual Culture, and Architecture* state that ‘the field of

³⁵ For example: Simon Hollington & Kypros Kyprianou’s *The Nightwatchman*, 2008 took the form of an immersive narrative installation that played on nuclear fear from the 1980s to the 2000s. Jon Thomson & Alison Craighead’s *Temporary Index*, 2016, features a number of digital counters that indicate the amount of time that must pass before different nuclear waste sites around the world are to be deemed ‘safe.’ Amongst many other examples, these show an increasing divergence away from purely visual art formats and towards conceptual and experiential modes.

nuclear aesthetics [...] often privileges questions of invisibility and incomprehensibility.³⁶ They continue; '[but] if [art] holds any potential to critically address and negotiate the nuclear, it should disregard the oft-encountered maxim of art just "making visible the invisible."³⁷ We cannot speak to nuclearity without including time as an actor in the long-unfolding of atomic narratives.³⁸ However, nuclear aesthetics must also accept that time operates in various modalities – clock faces and numbers, tenses in language, aging, just as a few examples.³⁹ No single aesthetic approach can fully encompass the visuality and concept of time. As this thesis focuses on the potential of under-explored modalities, I will position conceptual art as a uniquely placed artform for addressing and aestheticising the temporality of nuclear deep-time. Time often plays a more prominent role in conceptual art than it does in other modalities. Durational qualities are foregrounded by many conceptual artists, sometimes going so far as to acknowledge time as a medium as much as it is a quality. Conceptual art can more broadly define or blur spaces than visual forms are typically able to. It draws the percipient's attention to their surroundings.⁴⁰ It is not pictographic; it is immediate and present but may simultaneously be open-ended. These are qualities that are both useful and appropriate for addressing the qualities of radiation through artistic intervention. These qualities address Mavrokordopoulou and de Vos's dictum that 'visualising' the nuclear is not enough. Time in art, as both a quality and medium, diverges from visuality as an experience towards a durational experience. Durational experiential encounter through conceptual forms and interventions presents a more affective and appropriate approach than visual forms – active rather than passive engagement. These are important considerations for the point of divergence I will make from current RK&M recommendations.

Recent discourse suggests that radiation as a hyperobject (Timothy Morton's term that describes the incomprehensibility of radiation's massive distribution through time and space) in the field of sublime aesthetics and in combination with documentation is a

³⁶ Kunstlicht, *Nuclear Aesthetics*, (Amsterdam: Journal for Visual Art, Visual Culture, and Architecture, 2018), p. 9.

³⁷ Kunstlicht, *Nuclear Aesthetics*, p. 7.

³⁸ 'Nuclearity' is a term that broadly describes a number of concepts in the nuclear industries; from nuclear energy production to living in a post-atomic world and many things in between. It is very useful shorthand descriptor borrowed from Gabriel Hecht. Gabrielle Hecht, 'The Power of Nuclear Things', *Technology and culture*, 51 (2009), p. 3.

³⁹ The visualisation of the flow of time is also very different across cultures. In most European languages, time flows horizontally left to right. One would typically look back in time and forward to the future, facing the future. In China, time flows vertically when referring to months (upper and lower months referring to last month and next month). It also flows horizontally but the past is in front because one is able to look at the past as it has already happened, but one cannot see the future because it is behind.

⁴⁰ 'Percipient': A useful term I have borrowed from artist, Douglas Huebler for the subject of a conceptual work of art. The use of this term allows me to speak more to the experience of the invisible than the observance of the object. Crucially, it hinges on modes of mediation to aid perception. The importance of this will be thoroughly explored throughout this thesis. Coelewijn Martinetti, *Seth Siegelaub: Beyond Conceptual Art*, (Amsterdam: Stedelijk Museum Amsterdam, 2016), p. 110.

powerful approach to rendering the invisible visible.⁴¹ Artists and technologists Yanai Toister and Nimrod Astarhan argue for the use of the electromagnetic spectrum (which includes radio waves emitted by radioactive waste) in conceptual art to push the boundaries of the visible.⁴² Toister and Astarhan position conceptual art as a conduit for rendering the invisible perceptible (if not visible), an argument that this thesis will also contribute to.⁴³ Yet, the RK&M report clearly favours visual artforms and eschews conceptual or less tangible forms.⁴⁴ The assumed reason being conceptual art's tendency to adopt linguistic forms of knowledge transmission which is seen as suitable for only short- to medium-term communication, but not for long-term.⁴⁵ However, as I will demonstrate, conceptual art practice, and to some extent land art practice, mirror the systemic, multi-format approach that RK&M advocates for. Therefore, this thesis will draw on a new set of art analogues and ideas to broaden the scope for decision making.

Support for radioactive materials as (or in) markers is controversial, but nevertheless, it is a recurrent suggestion in nuclear semiotics discourse. At a 2012 RK&M workshop, media theorist Wolfgang Ernst proposed that radiation might be both the medium and the message; 'the half-time values of radiation decay of uranium itself may serve as a long-time nuclear counter which – communicated *as* and *by* radio waves – is the message of the nuclear medium.'⁴⁶ Ernst positions the temporality of radiation as a signification of time that must be spent waiting before any interaction can take place by people in the future. For Ernst, the medium provides the message in the form of a countdown clock to 'safety' that can be reliably decoded at any point in its future using mathematics. The temporal properties of radioactive material will form the basis for discussion in the next chapter. Ernst's suggestion for the usage of radioactive materials is not an isolated case. In 1993 it was suggested by Team A of the WIPP markers panel that 'one could consider the display of small amounts of

⁴¹ Sven Lütticken, 'Radio-Activity', in *Don't Follow the Wind*, ed. by Nikolaus Hirsch and Jason Waite (Berlin: Sternberg Press, 2021), pp. 125-132. The term 'hyperobject' is borrowed from Timothy Morton to describe an object so large that it cannot be fully comprehended. Timothy Morton, *Hyperobjects : Philosophy and Ecology After the End of the World*, (Minneapolis, MN: University of Minnesota Press, 2013).

⁴² Yanai Toister and Nimrod Astarhan, 'Spectral Choreographies: Electromagnetism after Conceptual Art', in *Proceedings of Politics of the Machines - Rogue Research 2021*, (2021).

⁴³ This thesis will take the definition of 'conceptual art' to be art that prioritises the idea over its physical properties.

⁴⁴ The Final Report specifically refers to William Verstraeten's *Metamorphosis 2003-2103*. Hans Codée and Ewoud Verhoef of the Central Organisation for Radioactive Waste in The Netherlands (COVRA) reportedly had discussions with just one artist (Verstraeten) when approaching the problem of conveying heat loss at their surface level waste treatment and storage building (HABOG). At a 2014 RK&M conference, three artists presented posters on the problem. These were, again, principally visual in form. Nuclear Energy Agency, 'Radioactive Waste Management and Constructing Memory for Future Generations Proceedings of the International Conference and Debate 15-17 September 2014 Verdun, France', (Verdun, France: OECD, 2014), (pp. 107-135).

⁴⁵ RK&M definitions: short-term – until closure of the facility, with full oversight; medium-term – after closure, for as long as oversight is exercised; long-term – after closure, when oversight is lost. Nuclear Energy Agency, 'Constructing Memory', p. 9.

⁴⁶ Nuclear Energy Agency, 'The Preservation of Records, Knowledge and Memory (RK&M) Across Generations: Improving Our Understanding', (Issy-les-Moulineaux, France: OECD, 2013), (pp. 44-47).

clearly marked quantities of low-level radioactive materials with long lifetimes' as a suitable approach to minimising intentional disruption of a surface marker.⁴⁷ In the wake of the complex unfolding of the post-Fukushima catastrophe, philosopher Jean-Luc Nancy urges us to 'remain exposed, and let us think about what is happening.'⁴⁸ For Nancy, continuing to remain exposed to the conditions that led to nuclear disaster, rather than a TEPCO-style return to normality, is beneficial for finding meaning.⁴⁹ These post-disaster conditions emerged from our techno-natural entanglements; our vulnerability as living beings can be a locus of meaning and a site of understanding these disastrous entanglements. Applied to art marker considerations, Nancy encourages us to not conceal the ramifications of our nuclear-producing activities but to expose ourselves to them, so that this meaning-making can be inferred to future generations also. 'Thinking' is an important consideration in Nancy's statement. It preferences active contemplation of radiological signification which I believe conceptual art is well placed for promoting.

Philosopher Günther Anders in his 1986 address, *Ten Theses on Chernobyl*, reminds us of the complexities of making the invisible comprehensible, and states, 'we must try to understand the invisible as if we had it right in front of us, and educate our fellow men with respect to this understanding in the fear that it implies.'⁵⁰ Fear, and its co-conspirator threat, are powerful mechanisms in deterrence. The RK&M report casts some doubtfulness on the longevity of fear as cultures change: 'the fear of radiation may become viewed as outdated superstition, just as the fear of the gods did in the case of the pyramids.'⁵¹ However, there is still an argument to be made for the potential of radiological threat as a communication method, particularly when the ramifications of intrusion are made manifest through the invisible power of radiation.

Art historian Theresa Deichert, writing about art born from post-Fukushima disaster conditions and materials, argues that the presence of radioactive contamination is required to draw attention to the conditions it has created.⁵² If we are to confront it and understand it, it cannot be swept under the rug. Understanding radioactivity may fall short through linguistic and visual communications methods. Echoing Nancy and Anders, Deichert

⁴⁷ Trauth, Hora, and Guzowski, 'Expert Judgment on Markers', p. F95.

⁴⁸ Jean-Luc Nancy, *After Fukushima: The Equivalence of Catastrophes*, (New York: Fordham University Press, 2015), p. 8.

⁴⁹ TEPCO (Tokyo Electric Power Company), the company responsible for the clean-up of contaminated materials after the Fukushima Daiichi nuclear power plant meltdown, were regarded as being not forthcoming with the truth and the remediation process. See Theresa Deichert, 'Contested Sites, Contested Bodies: Post-3.11 Collaborations, Agency, and Metabolic Ecologies in Japanese Art', *Journal of Transcultural Studies*, 11 (2021), p. 78. And, Anna Volkmar, 'Why We Need Nuclear Art', (Leiden: Leiden Arts in Society, 2016), (p. 117).

⁵⁰ Günther Anders, 'Ten Theses on Chernobyl', *Ecologie & Politique*, 1 (2006).

⁵¹ Nuclear Energy Agency, 'Preservation of RK&M', p. 69.

⁵² Deichert, 'Contested Sites, Contested Bodies', p. 94.

supports the view that understanding radioactivity and, more importantly, its effects, can be deepened through radiological experience. Professor of Communication Studies at Concordia University Peter van Wyck explores the notion of threat as communicator in great depth. Reminding us of nuclear toxicity's need for a signifier: a Geiger counter, or a cancer.⁵³ He continues:

The monument [for a GDF] must always [...] allow the past to be present in the form of a threat to life. The penitence cannot fully consign the threat to a past, to any past.⁵⁴

Whilst threat and radiological experience are not synonymous, they operate on the temporal scale of signification – threat may be observed in ecological and environmental changes, radiological experience may be more embodied. The register depends on exposure, a product of time and dosage. Finally, anthropologist Rosemary Joyce recounts an anecdote from curator Joshua Abbey who led a community group tour around the 'Universal Warning Signs: Yucca Mountain' exhibition. The group reportedly said, 'regardless of what sign they put up there, the most effective sign will be the dead bodies of those foolish to ignore whatever sign was put in place.'⁵⁵ The type of radiation we may wish to employ as a mode of signification and warning determines the level of risk and the duration of experience we aim to provide as a deterrent. This will be explored in the coming chapters.

As can be seen from these examples, there is an ongoing postulation both from academics and the public as to whether the presence of a radioactive threat on the surface of a GDF would (or could) be a suitable marker and/or deterrent. This thesis will argue in favour of an art marker that utilises radioactive materials. This stance will aim to provide alternatives to pre-existing, primarily visual modes of artistic representations of radioactive danger. To form this argument, I will be using existing radioactive artworks as analogues. As such, the research question for this thesis is: When combined with radioactivity, how might conceptual and post-conceptual approaches to art offer alternative modes of meaning-making and knowledge transfer over deep-time?

The core artworks I have opted to include in this thesis are as follows:

⁵³ Peter C. Van Wyck, *Signs of Danger: Waste, Trauma, and Nuclear Threat*, (Minneapolis: University of Minnesota Press, 2005), p. 29.

⁵⁴ Van Wyck, *Signs of Danger* pp. 123-124.

⁵⁵ R.A. Joyce, *The Future of Nuclear Waste: What Art and Archaeology Can Tell Us about Securing the World's Most Hazardous Material*, (Oxford University Press, 2020), p. 215.

Robert Barry

0.5 Microcurie Radiation Installation (1969)

Radiation Piece; Uranyl Nitrate ($UO_2(NO_3)_2$) (1969)

Radiation Installation; Cesium 137 (1969)⁵⁶

Trevor Paglen

Trinity Cube (2015)

Taryn Simon

Black Square XVII (2015)

Erich Berger & Mari Keto

Inheritance (2016)⁵⁷

These six artworks were chosen for their clear usage of radioactive materials as key or core components. They are not *about* radioactivity; they *are* radioactive – a crucial characteristic for their deployment as examples of artistic usage of radioactivity for the purposes of developing the remit of the Art Mechanism. These six artworks each use radioactive materials with half-lives varying from ~10 years, to longer than the universe is old.⁵⁸ Some of these artworks are concealed, whilst some have been dispersed into the environment. In these cases, documents and mediators are deployed to draw the percipient's attention to their presence. Other artworks are overtly contained inside radiation-shielding materials or in specialist locations for storing radioactive materials. These artworks come with specific directions on how to care for and manage the dangers to health that they present to their custodian. Each artwork will contribute different approaches and facilitate new considerations towards using self-signifying radioactive materials as art markers in the context of RK&M. A number of supporting artworks will also provide important case studies, particularly for Robert Barry's *Uranyl Nitrate*, illustrating the effects of updating RK&M around these artworks.

⁵⁶ At the very close of writing of this thesis, Robert Barry produced another radiation piece similar to *0.5 Microcurie Radiation Installation*, titled *Radiation Piece: Copper Uraninite ($Cu[UO_2(PO_4)]_2(H_2O_{12})$)* (2025). It was a 'one day piece' for Art Basel, Paris in October 2025. Curator Mathieu Copeland buried a small piece of tobernite of 'mild radioactivity' in the Parc de La Villette in Paris on Barry's behalf 'for several minutes on September 22nd before removing it' in line with safety parameters. The piece would certainly have added to the discussions in this thesis but unfortunately, it arrived into Barry's oeuvre too late to be meaningfully integrated. Dale Berning Sawa, 'At Art Basel Paris, Experimentalists and Their Big Ideas Are Celebrated', *The New York Times*, (2025).

⁵⁷ *Inheritance* is acknowledged as an example of 'Art' in the Toolkit, but seemingly little consideration was paid to it beyond this acknowledgement. Nuclear Energy Agency, 'Preservation of RK&M', p. 146.

⁵⁸ Berger & Keto's *Inheritance* incorporates thorianite, principally composed of thorium-232, with a half-life of approximately 14 billion years. The universe is estimated to be 13.8 billion years old.

At this stage it would be remiss of me to not make a special mention to James Acord, the artist and only private individual to ever be granted a licence to own and handle controlled radioactive materials.⁵⁹ His *Monstrance for a Grey Horse* requires special mention as it was originally intended to be a granite sculpture inspired by the longevity of ancient cave paintings and designed as a marker for nuclear waste sites.⁶⁰ Acord's intention was to have a central core in the sculpture to house a canister of uranium. Reportedly, Acord eventually settled for a core of ground up Fiestaware – a 1930s ceramic that featured a uranium oxide glaze – but his intention for the live uranium core was always the goal. It is unclear as to whether the Fiestaware canister is still (or ever was) enclosed, but if so it is 'symbolic of real nuclear material' and of very low radioactivity.⁶¹ I would have dearly liked to have included *Monstrance* into this thesis, especially given Acord's interests in Radioactive Waste Management (RWM), but the final form of the sculpture meant it fell short of the stipulations for inclusion.⁶²

Approach

Communicating invisible danger of buried nuclear waste is not just *a* problem, but *the* problem. It is the focus of RK&M. The problem has far-reaching ramifications if not properly addressed and regulated. *The Joint Convention of the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management* adopted in 1997 was the first legal instrument to address the safety of RWM on a global scale. As of February 2024, there were 90 contracting parties.⁶³ However, at present, there remain only two countries that are legally obliged to employ a marker strategy for GDFs – USA and Finland. Marking GDFs is in the interest of the global population. Marking is widely regarded as being ethically necessary and provides the information necessary for future generations to keep themselves and their environments safe. RK&M regards multi-disciplinary approaches to marking to be the most

⁵⁹ Acord (1944-2011) lived and worked at the Hanford Nuclear Reservation for many years, working at the intersection of nuclear science and art. He obtained his licence as a Radiation Safety Officer to handle and own radioactive materials and is the only private individual ever to obtain one. His intention was to build a 'Nuclear Stonehenge' at the Hanford site, turning it into a sculpture park to warn future generations not to drink the water or grow crops in the area. James Flint and others, *Atomic : James Acord, Mark Waller, Carey Young*, (London: The Arts Catalyst, 1998), pp. 7-20.

⁶⁰ An exact year for this piece is not known. Acord had worked on the piece for over a decade and eventually sold it to a persistent buyer, Joey King, in 2000, allegedly without the intended radioactive core.

⁶¹ Southwestern University, 'Southwestern Acquires Unusual Sculpture', (2011).

⁶² Fiestaware and uranium glass have featured in a number of artworks. But whilst radioactive, it is of little to no concern to health, even in a domestic setting. (Ken and Julia Yonetani, *Crystal Palace: The Great Exhibition of the Works of Industry of all Nuclear Nations* (2013) uses uranium glass in chandeliers, and Robert Williams and Bryan McGovern Wilson's *Ghost Stones* (n.d.) which re-cast in uranium glass stones taken from the coast in Cumbria that had been contaminated by the Windscale fire).

⁶³ International Atomic Energy Agency, *The Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management* (Vienna: IAEA, 2024).

viable. Whilst there can be no ‘solution’ to the nuclear semiotics problem – a despondent refrain in scholarly writing, and a universally acknowledged limitation posed by the problem itself – there is a consensus that art, in combination with the fostering of a cultural nuclear heritage, can contribute to the systemic approach of GDF marking.⁶⁴

At times, this thesis may seem overly optimistic given the consensus that the problem cannot knowingly be solved. In the face of ‘philosophical melancholy’ and the ever-present ‘apocalyptic tone,’ rife in epoch dialectics and nuclear pessimism, this thesis should not be viewed as being *blindly* optimistic.⁶⁵ I am aware of the insurmountability of the problem of how to implement a suitably durable marker strategy that nuclear semiotics faces. Semiotic strategies are invariably rooted in cultural specificity and exclude others from accessing information. This poses a problem not only for decoding a message on a temporal scale, but in a broader geographic culturally diverse field. However, how to suitably mark a GDF is not just a problem for nuclear semiotics; it concerns all of humanity.⁶⁶ Nevertheless, I approach my research with hope. I must assume that solutions to nuclear semiotics problems are possible.⁶⁷ That is not to say I will present answers, but that I will make iterative progress in an under-explored area of nuclear semiotics research. My approach to this comes in the form of a speculative methodology, a methodology that was adopted for the WIPP marker studies by SNL. This methodology allows for the incorporation of the ambitiousness associated with the WIPP designs, some of which have fed into more restrained approaches in RK&M recommendations.⁶⁸ It further allows for the pushing of boundaries in the formulation of human and non-human relations. This imaginative and hopeful approach is similarly adopted by Robert Nixon in *Slow Violence and the Environmentalism of the Poor* which this thesis draws heavily upon. Nixon asserts the benefits of ‘imaginative writing,’ stating that it ‘can help make the unapparent appear, making it accessible and tangible by humanising drawn-out threats inaccessible to the immediate senses.’ The imperceptibility of these

⁶⁴ It is very possible that semiotics may not be the most appropriate discipline for tackling the problem. (Biology approaches, genetic markers and self-replicating warnings may offer some answers, for example). However, whilst I aim to expand thinking into under-explored areas, I must stay within the constraints of current RK&M practice which principally seeks answers from the techno-social relationship between material and technological durability of information carriers and the long-term societal and cultural durability of messages – of which the latter is the remit of nuclear semiotics. Nuclear Energy Agency, ‘Preservation of RK&M’, p. 57. Furthermore, there can be no ‘solution.’ We are not capable of seeing into the future, only speculating about it. To that end, there is no certainty to any proposed markers, none of which must (or may) be deemed ‘solutions.’

⁶⁵ Jean-Luc Nancy, *The Sense of the World*, (Minneapolis: University of Minnesota Press, 1997), p. 191. Jacques Derrida, ‘Of an Apocalyptic Tone Recently Adopted in Philosophy’, *Oxford Literary Review*, 6 (1984), p. 3.

⁶⁶ Highlighting the need for more culturally diverse approaches.

⁶⁷ Although I fully accept that Art alone is not a viable mechanism, nor is nuclear semiotics as a solo discipline likely to produce viable solutions. This is a multi-disciplinary problem. But I do not approach this as a materials scientist, or biological engineer; I approach this from my own knowledge base in nuclear semiotics as a contribution to tackling the problem as part of a wider multi-disciplinary effort.

⁶⁸ The WIPP proposals for the signification of danger included landscapes of enormous concrete thorns, ‘forbidding blocks,’ and granite slabs that made land use next to impossible through the constriction of space and the absorption of heat.

threats is due to them being 'geographically remote, too vast or too minute in scale, or are played out across a time span that exceeds the instance of observation or even the physiological life of the human observer.'⁶⁹ Speculation is fabulously imaginative but should not be confused with being overly optimistic or based on un-grounded ideas. I will aim to ground my suggestions for new approaches to Art RK&M in what I perceive to be enduring likelihoods such as social interactions and human-landscape relationships.

This speculative and imaginative approach will be supported by case studies and will include anecdotes derived from human-radiation experiences. These are important in formulating new questions and areas for further study in the final chapter of this thesis. RK&M has often looked to analogues for evidence of suitable directions for knowledge transfer. To be applicable to this study, and to meaningfully interrogate the proposed Art Mechanism in the RK&M Toolkit, I must adopt similar strategies. The aim of this research is to examine the art history of the aforementioned radioactive artworks and present them as analogues with speculative futures with a view to broadening the remit and/or function of the Art Mechanism in nuclear semiotics discourse and GDF marker design. These speculative futures – or realities – may or may not exist independently of human thought or conceptual access; this will be explored in depth throughout the thesis where the perceived importance and centrality of the human is repeatedly addressed. The function of analysing these artworks as analogues will be to contribute research into under-explored modes and channels of knowledge transfer within the remit of the Art Mechanism that will ultimately aid in warning and informing future people about the dangers posed by buried nuclear waste.

This thesis addresses the end of the chain in the nuclear power industry – disposal. However, scholarly debate on the visibility of the nuclear industry is not limited to nuclear semiotics, despite the majority of focus in this specialism. Rosemary Joyce and Gabrielle Hecht address the extractivist beginnings of the nuclear energy industry.⁷⁰ Sam Collins and Sho Murayama contemplate the future of nuclear culture through the architecture and infrastructure left behind after the decommissioning phase at the end of a power plant's life.⁷¹ The decommissioning phase alone is typically over 100 years for a nuclear reactor. Needless to say, the nuclear industry operates on extremely extended, extra-human timescales. Disposal and its oversight – by far the most protracted stage of the nuclear industry – is the focus of

⁶⁹ Rob Nixon, *Slow Violence and the Environmentalism of the Poor*, (Cambridge, Mass.: Harvard University Press, 2013), p. 15.

⁷⁰ Joyce, *The Future of Nuclear Waste*. Gabrielle Hecht, *Being Nuclear: Africans and the Global Uranium Trade*, (Cambridge, London: MIT Press, 2012).

⁷¹ S. Collins and S. Murayama, 'Nuclear Sanctuary', (Thesis Programme, The Royal Danish Academy of Fine Arts, 2020).

this thesis. Disposal (or RWM) is where nuclear semiotics tends to reside and is a popular topic for artists. Curator Ele Carpenter is perhaps the most eminent facilitator of interdisciplinary discourse between art and nuclear culture.⁷² The 2017 exhibition *Perpetual Uncertainty* at Z33 in Belgium, curated by Carpenter, brought together an international perspective on nuclear culture.⁷³ The artworks were broad in scope, ranging from visual to post-conceptual approaches that thematically addressed deep-time communication and the nuclear vernacular. Carpenter also leads artistic and curatorial enquiry into nuclear culture through a research group; contributors to which are regularly cited throughout this thesis.⁷⁴ Carpenter takes the nuclear as a defining feature of the Anthropocene and what it means to live in a time of contamination.⁷⁵ The Anthropocene proposal (without nuclear specificity) alerts us to human impacts as the dominant driver of global environmental change.⁷⁶ Pollutants and industrial activities are pinpointed as the drivers of change.⁷⁷ For Carpenter, the Nuclear Anthropocene perspective foregrounds the role of nuclear contamination replacing evidence of human inhabitation. She states;

When thinking about deep timescales, we tend to think beyond the human, and to see the world from a non-human essentialist perspective; and nowhere is this more powerful than in the desolate exclusion zones where the contaminated evidence of human inhabitation is slowly being removed. [At the Fukushima Exclusion Zone] the presence of radiation has evacuated the human population.⁷⁸

The view that anthropogenic radioactive contamination is the defining, and most importantly, obdurate marker of our planetary influence is critical to arguments I will make in this thesis. I will also align with this definition of the Anthropocene, as many others have done so within the research group as it sets the stage for non-human perspectives – the focus of chapters 3 and 4.

To navigate this landscape of permanent planetary contamination, my research is situated within the transdisciplinary framework of the environmental humanities. By bringing cultural, philosophical and aesthetic critique into the realm of the STEM dominated fields within the nuclear industries, environmental humanities perspectives can reframe deep-time

⁷² Nuclear culture can be defined as the concern of society's perceptions (often manifesting as anxieties) of militaristic and domestic nuclear technology. The Campaign for Nuclear Disarmament (CND) may be viewed as a part of nuclear culture in Britain, as may the Doomsday Clock.

⁷³ Other similar key environmental and nuclear-focused exhibitions include: *Critical Zones. Observatories for Earthly Politics* (ZKM, Karlsruhe, 2020); *The Coming World: Ecology as the New Politics 2030-2100* (Garage Museum, Moscow, 2019); *After Year Zero: Geographies of Collaboration since 1945* (HKW, Berlin, 2013); *The Anthropocene Project. A report* (HKW, Berlin, 2013-2014)

⁷⁴ The Nuclear Culture Research Group.

⁷⁵ Ele Carpenter, *The Nuclear Culture Source Book*, (London: Black Dog Publishing, 2016), pp. 14-15.

⁷⁶ As opposed to previous 'natural' drivers of change such as volcanic activity and asteroid impacts.

⁷⁷ P. Crutzen, 'Geology of Mankind', *Nature*, 415 (2002), p. 23.

⁷⁸ Carpenter, *Nuclear Culture*, p. 14.

nuclear storage not as a mechanical engineering problem to be solved, but as an existential narrative and ethical crisis.

Incorporating an environmental humanities methodological approach alongside the speculative, allows this thesis to disrupt traditionally anthropocentric modes of communication. Instead of treating the environment as an inert container for hazardous waste, this framework recognises the active, vital agency of the landscape and the radioactive material itself. By so doing, this thesis positions conceptual art modalities and toxic legacies as entangled messages that can be co-authored by non-human actants in an ongoing narrative.

Thinking on nuclear culture has been further guided by cultural historian Robert Jacobs who writes at length on the marginalisation of peoples affected by nuclear accidents and testing. In *The Dragons Tail: Americans Face the Atomic Age*, Jacobs observes how post-1945 Americans were shaped by the atomic age.⁷⁹ To explore the potential of a radiological experience as an art marker, this thesis relies heavily on firsthand experience with nuclear culture. How people live with what Robert Nixon calls ‘slow violence’ is critical to gaining an insight into the social functions of a radioactive art marker across deep-time. Nixon similarly focuses on the ethical and empathetical lived experiences of nuclearity, shifting away from the political and scientific lens so often associated with the atomic age. Both Jacobs and Nixon are concerned with the invisibility of nuclear-affected peoples, a critical point of interest for any communities who might be tasked with the custodianship and stewardship of a GDF, whether or not they elected to do so. The visualisation of these peoples, and their trauma is an issue raised by both and is threaded throughout my research.

Crucially, Nixon’s notion of ‘slow violence’ cannot be considered in isolation from his fundamental analysis of socio-environmental inequality and the oppression of marginalised and indigenous peoples by governmental and technocratic bodies. In drawing from Nixon’s framework, this thesis resists a depoliticised reading that limits slow violence to a mere temporal or aesthetic function of radioactive decay. Instead, this thesis recognises that the long, attritional unfolding of radiological risk and harm is a product of colonialism that acts upon the environment, landscape and the socio-economically vulnerable. Most importantly, drawing from Nixon’s *Environmentalism of the Poor*, it is a key finding that slow violence is a deep-time burden of toxicity that is systematically outsourced to the disenfranchised.

⁷⁹ Robert A. Jacobs, *The Dragon’s Tail: American Face the Atomic Age*, (Amherst and Boston: University of Massachusetts Press, 2010).

Memory is an important consideration for Nixon and Jacobs who explore the social traditions of knowledge transfer. Similarly, Peter van Wyck explores the trauma of nuclearity in the body, the mind, and the environment. His writing explores the topic of what it means to live in the fundamentally altered atomic age – the Nuclear Anthropocene.⁸⁰ Van Wyck directly speaks to the semiotic problem of radiation by engaging the concept of the slow unfolding of its narrative into culture and the landscape. Van Wyck advocates for a new approach to the ethical injustice of slow violence through ‘witnessing’ as a response to the transfer of trauma.⁸¹ Van Wyck arrives at similar ethical considerations to Nixon and Jacobs – all three foregrounding the importance of giving a voice to those who experience invisible radiological trauma. I also share this ethical concern regarding radiological trauma which is problematised by its long unfolding. The asymmetry of the ethics of the other and the responsibility of our actions toward them will be an important consideration in this thesis given the controversiality of a suggested radiological art marker.

Discourse on art in nuclear culture and semiotics has gained a lot of attention in the 21st century. Of specific note is Anna Volkmar, an arts researcher based in The Netherlands who in 2020 completed her PhD thesis titled ‘Muddling Through Wicked Complexity.’⁸² Volkmar questions how art addresses societal problems related to nuclear technology through the lens of art history, cultural studies, and philosophy. As such there is a great deal of crossover between my research and Volkmar’s, particularly in the function of art as a shaper of culture as well as institutional critique. Where my research diverges from Volkmar’s is the objective of influencing policy. Volkmar’s focus is much more attuned to how art helps us to process nuclear legacy, whereas my research diverges towards the practical applications of art and its potential functions in the nuclear waste industry.

This thesis will draw heavily on existing research into the conceptual art document, and Robert Smithson’s ‘non-site’ theory. Critique of the document and its role in locating the art in conceptual art is important in exploring ‘mediation’ in the proposed radioactive art marker. Analysis of these criticisms of conceptual art and the role the document plays in accessing ‘dematerialised’ art will guide the development of the argument for a radioactive art marker.⁸³ I draw from curator Seth Siegelaub in my discussions on the role of the

⁸⁰ The Nuclear Anthropocene as a proposal for our current geological epoch is defined by the chemostratigraphical signals of anthropogenic radioisotopes since 1945. It is not, however, limited to simply geology. Just as the proposed alternative, ‘Capitalocene’ takes a more social approach to the definition of our current epoch, Nuclear Anthropocene encompasses the cultural impacts of nuclear technologies: inequality of colonial regimes; displacement of communities and peoples or ‘sacrifice zones’; ecological mourning.

⁸¹ Peter C. Van Wyck, ‘An Archive of Threat’, *Future Anterior*, 9 (2012). Van Wyck, *Signs of Danger* pp. 53-80.

⁸² Anna Volkmar, ‘Muddling Through Wicked Complexity: Why We Should Look at Art When We Talk About Nuclear Power’, (Universiteit Leiden 2020).

⁸³ ‘Locating’ the ‘real’ art in conceptual art is regularly contested. Some argue that the document can be construed the art, others not. The argument that locates the art in the ‘idea’ is mostly upheld.

document. His curatorial practice in the 1960s and 1970s that led to the exhibition of conceptual works in catalogue format freed conceptual artists to work in increasingly intangible and imperceptible mediums.⁸⁴ Discourse on the non-site stems from a theory posited by artist Robert Smithson.⁸⁵ It is a term that will be useful for discussing remote artworks and furthering existing discourse on the ontology of the art object.

I will argue in this thesis for the seemingly impossible separation of art from its art-historical contexts. The function of this will be to circumvent the fluctuations of taste and politics and allow for a more dynamic and democratic unfolding of an art marker over deep-time. I will adopt Volkmar's notion of 'care' to shift art's institutional context into the hands of community care. In the context of conceptual art's circumvention of the art market and the benefits that this separation will provide to longevity, I draw from Boris Groys. Groys has frequently interrogated art's entanglement with power and the boundaries between the artist, the curator, and the audience. In *Art Power*, Groys challenges the systems of artistic representation and is critical of art's ability to exist outside of the institutional structure of interpretation and influence.⁸⁶ Whilst I fundamentally agree with Groys, I will extend this thinking into the speculative realm. No answers are likely to be found as to how art can exist outside of its systems, but I will posit the benefits of achieving this.

The concept of an artwork that exists imperceptibly, outside of the systems of art institutions and knowledge reconfigures the understanding of the ontology of the artwork. The germ of my research originally stemmed from the speculative realism of Object-Oriented Ontology (OOO). Whilst this school of philosophy has not been woven into my arguments as much as I had originally expected it to be, it has still been influential in guiding my research and theorisation.⁸⁷ Timothy Morton's 'hyperobject' concept has been instrumental in my thinking and has been beneficial in linking radiation, ecological thought, art, and culture.⁸⁸ Where OOO and hyperobjectivity have been criticised for their hypocrisy, this has been a useful area of OOO for me to build upon.⁸⁹ The difficulty associated with the decentring of anthropos will be thematic in my writing and we will regularly return to opposing schools of thought as we continue. I will take a new temporal approach to the involvement of anthropos, phasing involvement in and out over deep-time scales. I will also more deeply incorporate materials into the hyperobject concept than Morton has done previously, focusing on the ontology of

⁸⁴ Martinetti, *Seth Siegel*.

⁸⁵ Jack Flam, 'Robert Smithson: The Collected Writings', (California: University of California Press, 1996), (p. 364).

⁸⁶ Boris Groys, *Art power*, (Cambridge, Mass.: MIT Press, 2013).

⁸⁷ Principally led by Graham Harman, *Object-Oriented Ontology : A New Theory of Everything*, (UK: Pelican, 2018).

⁸⁸ Morton, *Hyperobjects*.

⁸⁹ Criticism often focuses on OOO's decentring of *anthropos*, but human affect being the crux of hyperobjects.

the materials themselves and not merely the abstract concept of radiation. Whilst it is not my goal to provide a great deal more work on grounding Morton's concept, it may be a by-product of this thesis.

In the context of speculative realism and semiotics, Quentin Meillassoux's concept of the 'arche-fossil' raises pertinent questions around deep-time analogues, and meaning that goes beyond human access. Meillassoux's 'arche-fossil' counters the correlationist stance that states we cannot know or conceive of things independent from human witnessing or thinking. For Meillassoux, the arche-fossil argument 'designates an event *anterior* to terrestrial life and *hence anterior to givenness itself*.' Meillassoux continues, 'this is why the arche-fossil does not merely refer to an un-witnessed occurrence, but to a non-given occurrence.'⁹⁰ The arche-fossil exists and has a reality that is completely independent of human access, which correlationism struggles to resolve in its argument. It is not the failing of the object, but the failing of the correlationist to apprehend this vitality that exists outside of this anthropocentric view. An argument can be made that where nuclear semiotics asserts that no analogue exists for communication beyond a few thousand years, this is due to the inefficacy of semiotics, not objects. The arche-fossil (and objects) can and do have realities that exist *anterior* to human witnessing and perception. However, that is not to say that arche-fossils are applicable to deep-time communication from one living being to another – a stipulatory constraint of nuclear semiotics. Radioactivity in the nuclear semiotic lens, is an anthropogenic product, not an arche-fossil that stands outside of human relation. Anthropogenic radioactive materials are active objects whose reality is as cultural as it is deeply temporal. Meillassoux views the mathematical anterior life of radioactivity as an *a priori* ontological reality. This I do not dispute in the context of *natural* radiation. Anthropogenic radiation from nuclear industries, on the other hand, is tightly bound to human witnessing and cultural production. It is not indifferent to us, and instead its deep-time reality proves that our cultural activities in nuclear power production, nuclear warfare, and GDF construction, are permanently entangled. It is with this view that we must shift from an anterior world *before* humans to a textual and constructed reality, that serves as a warning of what anthropogenic radioactivity and toxicity means for our descendants. It is this fundamental difference between natural radiation and anthropogenic radiation that, to a significant extent, excludes the arche-fossil from being a suitable critique of the arguments I will make in this thesis.

⁹⁰ Quentin Meillassoux, *After Finitude: An Essay on the Necessity of Contingency*, (London: Continuum, 2008), p. 20.

Ontological thinking is furthered by Wesley Cray's concept of the 'imbued artifact.'⁹¹ In a stark contrast to Meillassoux's view of the arche-fossil as a raw, ancestral material, Cray presents the imbued artefact as an object that has been intentionally invested with specific cultural or artistic functions or meaning. Cray's thinking is of particular importance when facing a speculative future where the loss of knowledge or memory that an object has been 'imbued' with artistic meaning and has thus been transformed into an art object. The likelihood of an artwork being remembered as art for the full 100,000-year duration is extremely unlikely.⁹² Meillassoux would argue that in this knowledge loss scenario, the perpetuity of artistic intent is an anthropocentric delusion. Cray offers an alternative insight that imbuement becomes a quality of the object and does not depend on the continuity of human memory. Cray's view regarding the autonomy of art is less rigid in its ontology than the speculative realists, allowing for contextual placement to influence interpretation. I will further develop this argument in relation to the selected artworks and their supporting documents and non-sites and how they contribute to memory, knowledge and (re)interpretation of forgotten art objects.

To conclude the discourse on documents and ontology I will frequently draw from art historian Nathalie Zonnenberg.⁹³ Her writing and institutional critique primarily focuses on conceptual and post-conceptual art. With Boris Groys as an influential reference, she navigates thinking around the legacy of conceptualism on the role of the institution through a curatorial perspective. Her emphasis on language and systems over aesthetics has been influential in my approach to conceptual art in nuclear semiotics. Her writing on institutional power in art further develops Groys's arguments and lays the groundwork for my speculation over the role of art institutions in the initial stages of an art marker's life.

William Fox, art critic and cultural geographer, writes extensively on the art document and experience of remote land art.⁹⁴ Along with art historian Erin Hogan, I vicariously experience their journeys of art discovery where I was not able to do the same.⁹⁵ The role of anecdotal experiences with imperceptible art and with art in remote locations is of great importance to this thesis. These anecdotes contribute to case studies through accounts of journeys, pilgrimage, directions, difficulties, people met, and the responses of communities. Combined

⁹¹ Wesley D. Cray, 'Conceptual Art, Ideas, and Ontology', *The Journal of Aesthetics and Art Criticism*, 72 (2014), pp. 235-245.

⁹² Of course, we cannot even fully substantiate 'likelihood' at this stage, given the complete lack of analogues from which to draw upon.

⁹³ Nathalie Zonnenberg, *Conceptual Art in a Curatorial Perspective: Between Dematerialization and Documentation*, (Amsterdam, Netherlands: Valiz, 2019).

⁹⁴ William L. Fox, *Michael Heizer: The Once and Future Monuments*, (New York: The Manacelli Press, 2019).

⁹⁵ Erin Hogan, *Spiral Jetta: A Road Trip through the Land Art of the American West*, (Chicago: The University of Chicago Press, 2008).

with further direct experiences and searches conducted by artists Ines Marita and Tacita Dean, and art historians Mathieu Copeland and Peter Eleey, I have been able to build a case study of how Robert Barry's art has been lost and rediscovered in a way I do not believe has been conducted before. The importance of this as a modern analogue directly relates to any recommendations I will make for the improvement of the RK&M Art Mechanism in the final chapter.

Finally, in 2025 fellow speculative thinker and human geographer, Thomas Keating produced a Key Information File (KIF) for the Spent Nuclear Fuel Repository at Forsmark in Sweden.⁹⁶ This is the most recent addition to deep-time communication, published at the conclusion of this thesis. The purpose of the KIF is to communicate to the layperson in an intelligible way a description of what the Swedish nuclear repositories are and do. Working within the field of nuclear semiotics, Keating and co-author Anna Storm also provided a set of instructions that should facilitate future updates. The similarities and differences in their approach to mine will be discussed in the final chapter.

Interrogating the intersection of art and nuclear semiotics is a growing area of research with many facets to be explored. Whilst it has often been postulated, it is clear that radiation as a signifier of itself has been significantly underexplored. My contribution to this interdisciplinary topic will be specifically in this postulated area of radioactive art. By recruiting six conceptual and post-conceptual artworks that use radioactive materials the aim is to provide them as analogues that may contribute to the validity and efficacy of the use of radioactive materials in meaningfully marking a GDF. Ultimately, it is hoped that this thesis will challenge the existing dominance of visual art modes for the art marker and lay the groundwork for addressing people of the future through modalities that lack form and are more conceptual.⁹⁷

Chapters

This thesis will be split into three parts, each representing the actors involved with radiation and GDF marking: time, space, and people.

⁹⁶ Thomas Keating and Anna Storm, Key Information File: Essential Information on the Spent Nuclear Fuel Repository in Forsmark, Sweden (Linköping: 2025).

⁹⁷ The RK&M report observes the strength of 'contemporary visual art [to be] its concern with critical awareness of visual culture, landscape, architecture exploring conceptual and invisible concerns such as radiation and geological disposal.' Nuclear Energy Agency, 'Preservation of RK&M', p. 145. What the report fails to acknowledge is conceptual art's suitability to address those same conceptual and invisible concerns.

The first chapter will explore radiation as a temporal art material. I will challenge the RK&M report's view of time and employ a more anachronistic view. Temporality will be introduced as a material property of radioactive art, an argument for which will be bolstered by the use of Robert Nixon's notion of slow violence. I will use two art examples – Taryn Simon's *Black Square XVII* (2015), and Erich Berger and Mari Keto's *Inheritance* (2016) – to illustrate intergenerational processes already recommended in the RK&M Final Report, reframed in the context of the Art Mechanism.

Spatiality is the focus of the next chapter, delving into the power of proximity, withdrawal, and concealment in maintaining interest. I will use two examples of Robert Barry's work to investigate the requirement for mediators to confer radiologically contaminated spaces, and how documents can influence the percipient's experience of withdrawn contaminated spaces. Furthermore, I will investigate the risks to perceived authenticity when invisible art materials require mediators.

We will then look at the role of people and communities as custodians and stewards of radioactive artworks. I will explore how an oscillation between forgetting and remembrance can be beneficial and how this affects the autonomy of a radioactive artwork once it has been forgotten. I will postulate various approaches to 'maintenance,' including rumour, myth-making, measurement, and renewal, in the context of waste management. Finally, I will delve into further speculation and posit the life of a radioactive artwork once its institutional support has long since gone, and the role the landscape might play in the distant future.

These three areas of research will culminate in the final chapter, 'Towards a Revised Art Mechanism.' Here I will combine thinking across each area and provide further considerations with a view to expanding the possibilities of non-visual art approaches to RK&M and refining the purview of the Art Mechanism.

Reflections

The pursuit of this project came about from a fascination at Masters level in artworks that have the potential to kill. The use of radioactive materials by artists such as Robert Barry led me down a path of nuclear semiotics, speculative methodologies, and deep-time thinking. I envisaged this project initially with the chosen six artworks in mind and with a consideration towards how they might be 'completed.' The autonomy of art and whether it was art after it

had been forgotten about (particularly true for imbued objects) further led me down a nuclear semiotics enquiry. Could art survive *as art* for millennia? Is there a need for art to be perceived as art in the future? Could art simply serve the purpose of relaying information? Could art simply be functional? If so, how? This quickly led me to consider the applications of art in deep-time communication with radioactive materials at the heart of that approach. The fact that a number of academics had already suggested this only for it to be rebutted as unethical was, to my mind, an intriguing line of enquiry.

My thesis title changed early on from *Environmental Intervention in Conceptual Art in the Age of the Anthropocene* when I theorised that radiological environmental intervention could serve a purpose beyond its artistic intent, that of communication. I tightened my focus from ‘Anthropocene’ to ‘Nuclear Anthropocene’ to further assert manmade radionuclides in strata as an indicator of deep-time anthropogenic influence on epochs ahead of us.⁹⁸ The thesis title was then refined to *Radiation and Intergenerational Custodianship: Completing Artworks in Deep-Time*. This change reflected my perception that radioactive art could facilitate the intergenerational approach that has often been a focus of nuclear semiotics. As the project progressed, it became evident that intergenerational processes only go so far, and that the interplay of contamination, landscape, mythology and storytelling are important to knowledge preservation as the life of an art marker’s physical presence ends. This led to the final title: *Temporal Matter, Spatial Withdrawal, Human Stewardship: Radioactivity in Art and Nuclear Waste Repository Marking*. These title changes reflect my increasing observance and refinement of the shifting material affect of radioactivity on its actors over deep-time.

My methodology has always been speculative as has become the standard in nuclear semiotics. I have often described this thesis as a futurology of art, as opposed to a history of art, speculating on the possible perspectives and functions of art across its lifetime into deep-time. This approach has freed me to postulate arguably unethical considerations, and to explore the notion of allowing uncontained (or scarcely contained) radioactive materials to act as a potential marker that pre-empts the all but unavoidable leakiness of a GDF over deep-timescales – serving as a small-scale warning of future environmental disaster. I hope

⁹⁸ The specificity of anthropogenic influence is important. It speaks to the role of modern man-made waste and pollutants in breaking, or significantly adversely affecting, Earth’s biogeochemical cycles. This is not exclusive to byproducts of the nuclear industries. The ‘chemosphere’ of contaminants and pollutants that infiltrate ecologies all over the globe evidences the devastating impact of anthropogenic waste in environmental systems and natural processes. This ranges from (but is by no means limited to) microplastics re-emerging in plastiglomerates (rocks formed with molten plastics); the persistence of modern synthetic pesticides in soils, and ocean acidification as a result of fossil fuel use. Earth systems are not equipped for metabolizing these anthropogenic materials, and their influence and persistence is not only evidence of our existence but can also communicate our activities to future generations.

that this thesis has paved the way for further research in the way it was intended, speculative or not.

1.

Temporality: Radiation as Temporal Art Material

Linearity Vs. Anachronism

Marking a GDF involves an inherently procedural, step-by-step, linear view of time. The use of envisioned possible futures was the basis for reasoning for proposed solutions to marking a GDF since the inception of nuclear semiotics in the 1980s.⁹⁹ Today in the 2020s, the linear trajectory of time shapes proposals and devised solutions for GDF marker design.¹⁰⁰

Specifically, intergenerational processes are heralded as offering some stability and reliability for knowledge transfer.¹⁰¹ Intergenerational processes are inherently linear, with knowledge-objects and aide-mémoires being passed forever forwards into the future. Yet discourse grows around the benefits of a non-linear view of time and temporality.¹⁰²

Radioactivity is a messy, entangled phenomenon that stretches rigid concepts of ‘past,’ ‘present’ and ‘future.’ Radiation and its decay are on a clearly defined, calculable trajectory into the future. Time, for radiation, is mathematical and is readable in a very precise measure of half-life.¹⁰³ Radiation forms the basis for our understanding and the calculation of time. The age of the universe can be calculated through radiological decay.¹⁰⁴ We use cesium-133 to set our clocks by. However, radiation outside of controlled situations like the vacuum of space and in atomic clocks, is much more definable by its influence on other things. Radiation can (and must) be understood as a result of its inter- and intra-actions.

⁹⁹ The WIPP enlisted a panel of multi-disciplinary experts to imagine possible futures and modes of intrusion as a means to imagine to whom they must communicate. Stephen C. Hora, Detlof von Winterfeldt, and Kathleen M. Trauth, *Expert Judgement on Inadvertent Human Intrusion into the Waste Isolation Pilot Plant* (Albuquerque, New Mexico: Sandia National Laboratories/United States Department of Energy, 1991), pp. III1-III9.

¹⁰⁰ At least a predominantly Western/European view of temporal linearity.

¹⁰¹ In the RK&M Final Report it is noted that intergenerational transfer is ‘judged to be of particular importance in light of the exceptionally long time horizons radioactive waste management needs to address.’ Nuclear Energy Agency, ‘Preservation of RK&M’, p. 16.

¹⁰² Both Rosemary Joyce and Vincent Ialenti discuss non-linear temporal perspectives at length in the context of radioactivity. Joyce, *The Future of Nuclear Waste*, pp. 244-247. V. Ialenti, *Deep Time Reckoning: How Future Thinking Can Help Earth Now*, (Cambridge, Mass.: MIT Press, 2020), pp. 58-65.

¹⁰³ A half-life is defined by the amount of time taken for an unstable radioisotope to decay by exactly half. Each radioisotope has its own half-life, defined by its own rate of decay. But each half-life is a constant and is mathematically precise.

¹⁰⁴ In 1913, Arthur Holmes pioneered the application of uranium-lead decay to calculate the age of the Earth. He revised this estimate throughout his career but crucially, Holmes fundamentally set the stage for the shift from radiation as a localised curiosity, to an existential planetary clock. The pre-1945 aesthetic of radioactivity as a technophilic wonder (glowing watch hands for example) to some extent form a critical resource for GDF marking strategies. Long before radioactivity was weaponised or industrialised for power, the public’s relationship with radiation was highly marketed, establishing it as wondrous and revolutionary to everyday life. Real-life experiences soon provided evidence to the contrary (‘Radium girls,’ women and girls who painted watch hands in the 1910s and 1920s suffered the fatal consequences of this technophilic relationship). Arthur Holmes, *The Age of the Earth*, (London: Harper & Brothers, 1913).

These are in direct contrast to the linearity of radioactive time. Inter- and intra-actions are complex and blurry and resonate long after the spectacle of the disaster.¹⁰⁵ A rise in childhood cancers in Belarus following the Chernobyl disaster; the shunning of Japan's *Hibakusha* ('bomb-affected people'); radioactive contamination operates on many timescales, affecting people long after the release of radiation – biologically as well as socially.¹⁰⁶ Here we are reminded of the ethical necessity to mark a GDF. Its contents may be rendered harmless to people for hundreds of generations over millennia. Radiation may be contained for a significantly long period of time by a GDF. Nevertheless, radiation may – and likely *will* – leak, become exposed, or re-enter the environment, physically and/or culturally.¹⁰⁷ Therefore, the production and disposal of radioactive waste must always maintain ethical considerations of the other. We must see *all* future generations as existing at once, affected equally, whether by contamination or responsibility. We must anticipate them as already being when we devise solutions for building and marking a GDF.

It is therefore preferable to take an anachronistic view of nuclear semiotics. That is to say that linear time perspectives impose limits on the temporally interconnected nature of multiple human and non-human actors. An anachronistic view encourages us to view all those who are affected in discordant timelines and their non-synchronous experiences of nuclearity. We should be critical of 'modern' present-day 'solutions' to GDF marking relative to both the past and the future, lest the solutions become dated when they arrive in the future. Present-day solutions must always be present in the future if they are to be perceived correctly and understood. Solutions or approaches must be appropriate in all timelines and temporalities in order to escape the critical view by future generations that their ancestors were more primitive and unlearned than they are in the future.¹⁰⁸ It is in this sense that I observe the standard definition of anachronism – the inappropriateness of something in the period in which it is observed – but I expand this into anachronistic *thinking*: devising something to feel appropriate to whichever time period in which it is observed.

¹⁰⁵ 'Intra-action' is a term borrowed from Karen Barad that describes the emergence of things as a product of their 'intra-actions' with each other. Karen Barad, *Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning*, (Durham: Duke University Press, 2007), p. 33.

¹⁰⁶ Not to mention the infinite non-human inter- and intra-actions with radiation and radioactivity.

¹⁰⁷ Facilities such as HADES in Belgium that conduct research into geological disposal of HLW in a specific type of clay do not question *if* radioactivity spreads into clay, but *to what extent*. Whilst their computer modeling reports promisingly diluted concentrations, migration of contamination is viewed as a near certainty. EURIDICE: European Underground Research Infrastructure for Disposal of nuclear waste in Clay Environment, 'The HADES Underground Research Laboratory', (n.d.).

¹⁰⁸ Of course, this involves a significant degree of arrogance in a marker's design. Not only that, to escape the gravitational pull of the sum of time and progress, we must position ourselves as the truly lofty beings we consider ourselves to be – that all our descendants must be pupils and that we are the apotheotic commanders of the nuclear age. Unfortunately for us, cults tend not to survive very long.

The steps to achieving this include the need to consider the temporality of different things, and to refute the anthropocentric or human timescale.¹⁰⁹ As Timothy Morton states, ‘from grasses to gorillas to gargantuan black holes, everything has its own time, its own temporality.’¹¹⁰ The temporality of language, of culture, of generational custodianship, of geology, of concrete, of spent reactor fuel – these must all be considered separately on different timescales. They must also be considered from their own perspectives as objects themselves. ‘The future emerges *directly from the objects we design*’ says Morton.¹¹¹ He continues:

So designers should be careful what they design. Maybe they need to think at least on a number of temporal scales when they design something. A plastic bag isn’t just for humans. It’s for seagulls to choke on [...] A Styrofoam cup isn’t just for coffee, it’s for slowly being digested by soil bacteria for five hundred years. A nuclear device isn’t just for your enemy. It’s for beings 24,000 years from now.¹¹²

Rosemary Joyce encourages us to think like archaeologists of contemporary culture and ‘to view the past, present, and future as mutually constituted, but not deterministically shaped, always providing for emergent understandings that transform how we embrace the material worlds of which we are a part.’¹¹³ Where material science views physical endurance as a product of technological advancement, Joyce views it differently:

Those things that last usually, if not always, do so in ways that exceed human intention. They may perversely violate intentions. They are irreducibly historical and only marginally subject to prediction.¹¹⁴

Waste is an example of archaeologically interesting and revealing materials. It reveals a great deal about who people were and how they lived in the past. Waste also endures in ways we perhaps do not intend it to. The household variety is thrown away, then transported further away to where it is buried (amongst other processes). The prevalence of plastics in the vast majority of global culture at present results in waste pervasively exceeding our intention. The problem of plastic is no longer ‘just’ a garbage patch floating in the Pacific Ocean, microplastics are now ‘ubiquitous in nature,’ found in drinking water, food, and the air, even

¹⁰⁹ I reiterate my acknowledgement that different cultures observe temporality differently. Definitions of the present may expand far wider than a comparable Western notion, encompassing ancestors as very much a part of the present. However, RK&M takes a Eurocentric view, so I align my anachronistic thinking with the dominant present-day views of past, present and future in Western Europe.

¹¹⁰ Timothy Morton, *All Art is Ecological*, (Penguin Books, 2018), p. 33.

¹¹¹ Morton, *All Art is Ecological*, p. 62. (Morton’s emphasis)

¹¹² Morton, *All Art is Ecological*, p. 63.

¹¹³ Joyce, *The Future of Nuclear Waste*, p. 14.

¹¹⁴ Joyce, *The Future of Nuclear Waste*, p. 204.

crossing the blood-brain barrier.¹¹⁵ Likewise, nuclear waste persists in ways that were not necessarily conceived of when nuclear weapons testing began, nor when nuclear energy production henceforth evolved. It becomes enmeshed with the landscape and its inhabitants. Once nuclear waste escapes its anthropogenic confines, its temporal story is freed from its graphitic control and enters a new narrative with everything it touches in all directions.¹¹⁶ We must therefore reframe GDF marker design to include different temporalities of the interconnected landscape and its components, both natural and anthropogenic. Observing and accounting for the embodied lives and narratives of radioactive isotopes at all stages of their migration and decay is the ethically just approach to GDF marker design.

Half-lives of radiation

The proposal for the adoption of radioactive materials as a marker, whether in art or not, is rooted in temporal meaning – it bears a consistent, unwavering message. Ernst referred to the use of radioactive materials as a message serving as ‘a long time nuclear counter.’¹¹⁷ Their enduring temporality is matched by the durability of the radiation as message. The meaning behind the message may not always be clear over deep-timescales, but evidence should always be present in its surroundings. Radiological contamination is a curious thing. As we see with Jim and Hilda Bloggs in the film *When the Wind Blows*, radiation is an abstract threat that can be difficult to understand. The film shows the aging couple’s struggle to comprehend their own experience of radiation sickness. Despite preparing their home for an impending war with the Soviets, the couple are seemingly unaware of the invisible threat of radiation following a nearby nuclear bomb explosion, dismissing bleeding gums as ‘ill-fitting dentures.’¹¹⁸

We are often told that bananas and aeroplane flights expose us to radiation but we see no ill effects. We are targeted with x-rays at the dentist, but we do not suffer bleeding gums as a result. Our understanding of day-to-day exposure to radiation is that it is something we live with, and that on occasion we willingly expose ourselves to increased levels of. At what point do those levels become dangerous? We know that reactor meltdowns are dangerous and have the potential to pose a threat to health that expands over continents from their point of

¹¹⁵ Ioniță-Mîndrican CB Ziani K, Mititelu M, Neacșu SM, Negrei C, Moroșan E, Drăgănescu D, Preda OT., ‘Microplastics: A Real Global Threat for Environment and Food Safety: A State of the Art Review’, *Nutrients*, 25 (2023).

¹¹⁶ The reaction of the fuel in nuclear reactors is controlled (in part) by graphite rods.

¹¹⁷ Ernst further describes the repository itself as a “hot” nuclear clock’. Nuclear Energy Agency, ‘Improving Our Understanding’, p. 46.

¹¹⁸ *When the Wind Blows*, dir. by Jimmy T. Murakami (United Kingdom, 1986).

origin. Yet up until the Russian invasion of Ukraine in 2022, tourism to the Chernobyl exclusion zone (officially known as the 'Chernobyl Nuclear Power Plant Zone of Alienation') was not only possible but a booming industry in Kyiv following the 2019 HBO mini-series, *Chernobyl*.¹¹⁹ This confuses any notion of safety we may have with 'controlled' exposure, like dental x-rays, and 'uncontrolled' exposure like the contaminated land around Chernobyl.

Our examples of where to find radiation and how we can or cannot (or should not) expose ourselves to it are not only confusing but conflicting. Where is the middle ground? What examples between a visit to the dentist and a reactor meltdown can the layperson identify as the threshold for the level of threat that they should be concerned about being hazardous to their health? Where does Robert Barry's *0.5 Microcuries* of radiation emitted from a sample of barium-133 sit on the threat scale? Not only is it difficult to comprehend how dangerous – or not – radiation is, but also for how long it remains dangerous. On the x axis we find the level of danger in relation to the y axis of time. For some sources of radiation that threat can diminish in hours, others a decade; for other sources, the threat will not perceptibly diminish at all over the course of our lifetime. Not only are we unsure of *how much*, but we must also figure out *what kind* of radiation it is; alpha or beta particles, or gamma waves. Lacking the instrumentation and knowledge of nuclear scientists, non-specialists 'remain literally senseless to radiation, dependent in everyday life on biological, not machinic, insights' states art historian Sven Lütticken.¹²⁰

Peter van Wyck similarly confirms Lütticken's statement:

[...] nuclear toxicity operates outside of the register of sight. It requires a mediation in order to be disclosed. That is, a relay into a signifying semiotic regime: a Geiger counter to render it sonorous or audible, or a body or tissues to be transformed by the absolute invisibility of (alpha) and (beta) particles and (gamma) radiation; in other words, nothing renders it visible, it can only relay into the order of the visible via the production of signs (signals, sounds, symptoms).¹²¹

If radioactive materials are to be used as a self-referential marker, their invisibility presents a problem – the necessity for a mediator. Immediately it seems the potential for the self-signification of radioactive materials is not possible. The effects of radioactivity at low dosage are too slow to signify themselves. The selected artworks are not radioactive enough to cause acute radiation sickness and so arguably are incapable of signifying themselves – at least not on the short timescale of gallery-visitor contexts. At low doses, the radioactive materials need

¹¹⁹ *Chernobyl*, dir. by Johan Renck (USA/UK, 2019).

¹²⁰ Sven Lütticken, 'Shattered Matter, Transformed Forms: Notes on Nuclear Aesthetics, Part 1', *e-flux journal*, 94 (2018), p. 37.

¹²¹ Van Wyck, *Signs of Danger* p. 29.

mediation in order for us to know they are radioactive and are acting upon our bodies, something evidenced by their provision in all of the selected artworks. Mediators of the selected artworks signify contamination of both space and of the viewer. They also infer the characteristics of withdrawal and/or concealment by the virtue of needing to be conveyed through a mediator. The radiation oscillates between presence and withdrawal – we are told it is here but we are unable to sensorially detect it. An encounter with a radioactive artwork forces us to believe (or not) what its mediators tell us. Alternatively, we can look for signs in a radioactive artwork's surroundings; what has changed or what looks out of place due to the contamination caused by the radioactive energy emitted from the artwork? A spike in environmental change (often for the worse, caused by the damage to DNA for example) following a radiological contamination event followed by a steady reduction may indicate the half-life, and danger of the radioactive material. However, it is rarely this simple. Different beings experience the temporality of radiation at different rates. Transgenerational effects and genomic instabilities manifest differently in different biota. In the absence of mediators, these differing bioaccumulations may all be signs that can be read in the future (or they may be utterly confusing – we cannot be sure yet).

Evidence of contamination is rarely linear, especially when contamination is (or becomes) uncontained. 'Toxic drift' is often written about in nuclear semiotics literature; it is the propensity for hazardous materials to leak, defy containment, and to drift across space and time.¹²² In the rigorously controlled environments that we have devised for the 'safe' containment of nuclear waste, the register of time exists in the very predictable linear decay of radioactivity – forever reducing in its energetic emissions. Outside of the control of a GDF, when radiation 'drifts,' time is no longer on the same register as it was on the inside. As radiation drifts and enmeshes with the environment and with other biological forms, registers of radiation emerge from everything it encounters. The different registers infer different temporalities of radioactive violence. A dandelion experiences radioactivity very differently to a sparrowhawk. Once the artists' radioactive mediators are no longer present, our experience of radioactivity is prolonged, becoming protracted and durational. We must wait and observe more subtle and indistinct signs. There is a case to be made for both overtly mediated and unmediated radioactive art in both controlled and uncontrolled examples of radioactive sources. There are benefits in all cases that can more fully explain the presence of radioactive materials, though ethics can certainly differ.

¹²² Nixon, *Slow Violence*, pp. 2-3. Van Wyck, *Signs of Danger* p. 4. Andy Weir, 'Deep Decay: Into Diachronic Polychromatic Material Fictions', *PARSE*, (2016), pp. 68-69.

A novel approach to nuclear semiotics that addresses anachronistic ethics and temporal affective differences certainly counters the RK&M report's rigidity towards linear decay and knowledge transfer. A half-life is quantifiable and measurable, but its mediation is not. The intra-actions of radioactivity emerge haphazardly, and seemingly erratically. The messiness caused by toxic drift is all but guaranteed. Let us devise approaches that incorporate the inevitability of enmeshed environmental contamination.

The Slow Violence of Radioactive Art

Whilst it is true that some radioisotopes decay in a matter of seconds, when we think about radiation – particularly ionising radiation – we often think of it as a long, protracted danger that exists for extended periods of time.¹²³ For GDFs, this is exactly the type of radiation that RWM and RK&M aim to contain and protect future people from. The dangers posed in the present day by a substantial proportion of radioactive waste destined for GDFs will still be almost just as dangerous in 100 years, even 1000 years. It is only in *deep*-time that we begin to see the reduction of dangers to a level approaching suitable for human proximity. Understanding the nature of these persistent dangers is imperative at all points in time from now to 100,000 years in the future. I argue that radioactive art as part of the systemic GDF marker system can aid in both conveying the protractedness of radiation and just as importantly, provide the *experience* that is missing in the informative approach.

For this discussion on the protracted nature of radiation and radioactive art, I will borrow Rob Nixon's term, 'slow violence.' Nixon uses this term in his environmentalism rhetoric which I believe is suitable for considering the temporal and intergenerational effects of radioactive art. Nixon defines the concept as:

[...] a violence that occurs gradually and out of sight, a violence of delayed destruction that is dispersed across time and space, an attritional violence that is typically not viewed as violence at all.¹²⁴

¹²³ Thorium-218 decays on the scale of nanoseconds (10^{-9} seconds), for example. Others decay in yoctoseconds (10^{-24} seconds). On the other end of the scale, tellurium-128 has the longest half-life of any radioisotope at 160 trillion times greater than the age of the universe. The UK's radioactive waste awaiting disposal is primarily made of up of Intermediate Level Waste (62.24% by volume), and Uranium (24.94% by volume). Uranium-235, most commonly found in nuclear reactors has a half-life of approximately 704 million years. Nuclear Waste Services, '2022 Inventory for Geological Disposal: Summary', (2025).

¹²⁴ Nixon, *Slow Violence*, p. 2.

Being 'out of sight' is a recurring theme in radioactive art. These pieces are removed from people so as not to inflict harm; they are stored for retrieval, stored for monitoring, or simply waiting for time to pass before they can be brought back out again when it is safe to do so.¹²⁵

Nixon's definition of slow violence is rooted in temporality. *Gradual, delayed, dispersed* and *attritional* are terms that point to the *longue durée* of violence processes. What Nixon elucidates is that violence that occurs across long expanses of time is difficult to perceive by virtue of its slowness and its long unfolding. The effects of that violence are incremental and 'attritional'. They are not perceived in the same way as they would be in the concept's implied antithesis, *quick violence*. Car crashes, explosions, murder; these occur quickly. We see the effects immediately, even if there are long-term effects after the event. The event in quick violence is full of spectacle, something which is lacking in slow violence. In slow violence, the effects are hard to pinpoint as change is gradual, stretched out over time. It is hard to say at any given moment what the actual effect(s) of slow violence may be. We are unlikely to be able to directly point at the violence and instead be reduced to speaking about it in general terms as opposed to specifics. Life may appear to continue quite normally whilst slow violence works away attritionally at its subject.

However, as Nixon emphasises, this attritional slowness is experienced unequally. The delayed and dispersed nature of slow violence means that its victims and casualties are a product of asymmetric socio-environmental distribution – a burden predominantly experienced by the poor. Any community that either volunteers or is burdened with the stewardship of radioactive art, also become victims of this inequality. These communities are left to navigate this slow, un-spectacular poisoning are rarely those who reaped the benefits of nuclear power production. Yet, their visibility as nuclear-affected people is diminished by the inherent slowness of radiation, further emphasising their vulnerabilities as recipients of toxic heritage and legacies.

Fernand Braudel forms a basis for this long-term, invisible process thinking with his introduction of the term '*longue durée*'.¹²⁶ Braudel's term is a contrasting response to François Simiand and Paul Lacombe's opposing durational approach to history, *episodic history (histoire événementielle)*.¹²⁷ Where episodic history focuses on short durations of 10,

¹²⁵ The purpose of retrieval in the future is entirely speculative, though it may be that the materials used for storing the waste (copper jackets for example) may be of value; it may be that pools of water that glow blue (Cherenkov radiation) are believed to hold mystical powers; or the archaeological curiosity of uncovering a long-lost civilisation's waste may be the impetus.

¹²⁶ Fernand Braudel and Immanuel Wallerstein, 'History and the Social Sciences: The *Longue Durée*', *Review (Fernand Braudel Center)*, 32 (2009).

¹²⁷ Braudel and Wallerstein, 'The *Longue Durée*', p. 174.

20, or 50 years, Braudel was interested in the long unfolding of almost imperceptible changes.¹²⁸ The *longue durée* is to *histoire événementielle* what slow violence is to quick violence. Similarly, the RK&M report's approaches to linear time and intergenerational knowledge transfer are akin to *histoire événementielle* where an anachronistic approach akin to the *longue durée* offers a different perspective. There is certainly a place for both approaches in GDF marking, and evidence of both will be found in the radioactive art examples throughout this thesis.

Using Nixon's framing, radiation and therefore radioactive art are slowly violent. Radiation is embodied, particularly the most damaging gamma radiation as is emitted by nuclear bombs and power plant disasters. It is viscous – to borrow a Timothy Morton term – it sticks to the body and is inescapable.¹²⁹ Those that survive bombs and meltdowns face a battle with the inescapable radiological violence that acts upon their bodies at a cellular level that ensues after the spectacle of the atomic event. Nixon identifies the breadth of this inescapability as ranging from the cellular to the transnational to beyond the horizon of imaginable time.¹³⁰ It is a multi-dimensional threat that is experienced not only spatially but also temporally of which both dimensions are inextricably linked. The threat of inescapable violence encourages humanity to place the danger as far away as possible. When nuclear power plant disasters occur, the spectacle of quick violence is experienced by very few people compared to the 'downwinders' caught in the unspectacular, long unfolding of the slow violence that follows. Arguably, the placement of nuclear power plants away from densely populated areas minimises the quick violence and emphasises the effects of the slow violence, amplifying its invisibility by hiding its source. Bomb tests and nuclear waste storage sites have typically been executed in uninhabited or 'virtually uninhabited' areas so that human proximity is less of a concern. Those 'virtual uninhabitants' and those whose land has been commandeered for testing are written off as minor collateral damage.¹³¹ Virtually uninhabited areas have historically been preferred by nuclear armed nations for weapons testing, typically with the view that temporal violence is of little consequence in these isolated locations.¹³² This is true

¹²⁸ Braudel and Wallerstein, 'The Longue Durée', pp. 176-177.

¹²⁹ Morton, *Hyperobjects*, p. 1.

¹³⁰ Nixon, *Slow Violence*, p. 47.

¹³¹ Examples include the 'downwinders' of the Trinity Test in nearby counties. However, the Radiation Exposure Compensation Act, 1990 provided financial compensation to those who contracted specific diseases as a result of US weapons testing. The programme expired in 2024 but was reinstated under the second Trump administration to extend to 2027. So far, as of February 2026, the US Department of Justice has awarded over \$2.7 billion to more than 57,000 claimants. U.S. Department of Justice, 'Radiation Compensation Exposure Act', (Washington, DC.: U.S. Department of Justice, 2025).

¹³² 'Uninhabited' does not always mean completely devoid of human presence. It has frequently presented as 'virtually' uninhabited. US nuclear testing in the Pacific Islands contaminated the land of what Nixon calls 'virtual uninhabitants.' These were indigenous peoples who were dismissed as being of little consequence to affect, that it was ethically just. Nixon, *Slow Violence*, p. 152.

whether the testing occurred on home soil or, as was more prevalent, in comparably less densely populated regions of the globe like Pacific islands.

This slow violence burdens the environment and the local ecology in the name of humanity. The environment must endure often repeated contamination events for no benefit other than ensuring other nuclear powers who are doing the exact same thing to their own environments do not bomb populated areas.¹³³ Tests and releases of radiation are conducted in distant places because of the fear of embodied nuclear violence. This fear of bio-radiological experience is what I believe makes slow violence a suitable concept to discuss the materiality of these artworks. We will see in the coming chapters that radiophobia (the fear of radiation – whether real or perceived) is a powerful motivator to avoid the embodied experience of radiation. This fear is especially notable and useful when considering the need for these radioactive artworks to exist in exclusion and isolation, the need for safety testing, for documentation, and for alternative modes of access.

This is of course an anthropocentric view. It privileges the human experience of radiation as being more of a concern than the experience of the interconnected web of beings and ecosystems that may also be affected by radiation release. This anthropocentric privilege is made clear by the proposed naming of the current epoch: ‘Anthropocene.’¹³⁴ Alternative proposals exist – namely the Capitalocene – but nuclear activities can be used to clearly define the Anthropocene.¹³⁵ Defining the present epoch is primarily of stratigraphic concern. Humanity is responsible for the radioactive toxicity of the Marshall Islands, and the Nevada desert, and for the hollowing out of mountains to store nuclear waste, to be then backfilled with concrete. Humans are responsible for this evidence of a change of epoch. Capitalism is just one anthropocentric part of the larger determining factors.¹³⁶ This anthropocentrism is perhaps, then, inescapable in the shadow of the toxic legacy we will leave behind for millennia that was caused over just the past 80 years.

¹³³ The Arms Control Association estimates the total number of tests worldwide to be 2,056 between 1945 and 2017. Arms Control Association, 'The Nuclear Testing Tally', (2025).

¹³⁴ Anthropocene being derived from ‘*anthropos*,’ or humans.

¹³⁵ Where the Nuclear Anthropocene diverges from just *Anthropocene* in its specificity of influence, Capitalocene diverges from simply ‘human activity’ as a cause of planetary crisis towards capitalism as the driving force. Jason W. Moore, *Anthropocene or Capitalocene?: Nature, History, and the Crisis of Capitalism*, (Oakland, CA: PM Press, 2016); Donna Haraway, 'Anthropocene, Capitalocene, Plantationocene, Chthulucene: Making Kin', *Environmental Humanities*, 6 (2015); Critical Art Ensemble, *Aesthetics, Necropolitics, and Environmental Struggle*, (New York, NY: Autonomedia, 2018); Heather Davis and Etienne Turpin, 'Art in the Anthropocene: Encounters Among Aesthetics, Politics, Environments and Epistemologies', (London: Open Humanities Press, 2015).

¹³⁶ I further argue that epochs are measured in deep-timescales of hundreds-of-thousands to tens-of-millions of years. Whilst the influence of humans may prove to leave their mark in the strata to warrant a new Anthropocene epoch, I have my doubts that capitalism will have such a lasting influence.

For me, the term *Nuclear Anthropocene* is the most appropriate term for naming our present epoch (which if adopted would undoubtedly be shortened to simply *Anthropocene*).¹³⁷ Where other definitions struggle to identify a definitive date or even century that pinpoints a change in the strata, the Nuclear Anthropocene takes the incredibly specific time and date of 16th July 1945 at 5.29am (GMT-7) as its start point – the first atomic bomb test.¹³⁸ This date changed not just the strata of the globe in very measurable ways but has changed the composition of every single human body since shortly after that day. Strontium-90 is present only in the teeth and bones of people alive from this date. We absorb strontium-90 every day until we die thanks to nuclear testing and so is a very accurate way of ascertaining a date of death for bodies after 1945.¹³⁹ The presence of caesium-137 in art and wine is now a standard measure for detecting forgeries in auction houses as it does not exist in pigments or wine prior to 1945. This is economics at work using the Nuclear Anthropocene. Man-made radionuclides will forever be a stratigraphic marker of our presence and a significant influence on the makeup of the earth. We continue to embody the fragments of nuclear tests that happened generations before us, and generations after us will continue to do the same. It is a violence that occurred on an unprecedented scale in a devastating moment that persists with unending viscosity and pervasiveness.¹⁴⁰ This is where episodic history gives way to the *longue durée*. The temporality of that violence is embodied in all of us through anthropogenic materials that were created in that epoch-defining instant. It ties us all to that defining day in July 1945, irrespective of when we were born. The evidence of our existence and the argument for the centrality of anthropos is not only in the soil but, in a very meta way, embodied in us. All this being said, I do not fully subscribe to the centring of anthropos in this thesis. Whilst the Anthropocene is useful as a framing device for materiality in the global narrative, it is a necessary evil considering the remit of RWM. Protecting future humans is the prime directive of RWM and marker design. The centring of anthropos is inescapable in this regard. We are both responsible for the problem and the victims of our own actions.¹⁴¹ We dig into the strata to protect our descendants from dangerous anthropogenic materials. In so doing, the inevitability of toxic drift affects so

¹³⁷ The press release for the nuclear-focused exhibition *Perpetual Uncertainty* curated by Ele Carpenter defined it as art about the 'Nuclear Anthropocene.' The shortening of Nuclear Anthropocene to Anthropocene is not enough for some theorists. Justin McBrien would go further to say that the Nuclear Anthropocene is actually the *Necrocene*. (Moore, *Anthropocene or Capitalocene?*, pp. 116-137.)

¹³⁸ The long-sixteenth century as a basis for both Anthro- and Capitalocene debates in some circles, for example.

¹³⁹ Agency for Toxic Substances and Disease Registry, 'Public Health Statement: Strontium', (2004) <<https://www.atsdr.cdc.gov/ToxProfiles/tp159-c1-b.pdf>> [accessed 2 Feb 2025] (p. 3).

¹⁴⁰ Morton, *Hyperobjects*. For clarity, the Trinity test was the first devastating moment that changed the world forever. There have been over two thousand nuclear test explosions since 1945, continuing to the most recent in 2017 by North Korea (at the time of writing).

¹⁴¹ Although, the extent of 'we' is contestable. 'We' as a species are responsible, but that same 'we' does not and should not include non-actors in the culpability of the damage that has been caused. To the same extent, 'we' as victims cannot be evenly distributed either. 'Downwinders' are much more victims than those who live in places that have not experienced the ravages of uranium mining or bomb testing.

many more beings and ecosystems than simply humans. Nevertheless, for RWM and RK&M, the protection of anthropos always comes first. Knowing what we know about ourselves in the present, we fear for the inquisitiveness of our descendants and so we use language, warnings and systems that speak directly to people, not to any other thing.

Returning to Nixon, one of his main observations is that slow violence is characterised by the difficulty in visualising it. To be able to devise approaches that visualise the temporal unfolding of slow violence is advantageous for nuclear semiotics; it draws our attention to deeply-projecting atrocities and crises. This ‘visualising the invisible’ is a concern shared with nuclear heritage and culture.¹⁴² The lack of spectacle (or the ongoing effects that endure long after the spectacle) often means that slow violence lacks an aesthetic. In a world of 24/7 news populated by imagery, slow violence is comparatively spectacle deficient. This temporal issue resonates with Timothy Morton’s concept of the *hyperobject*.¹⁴³ Morton’s term refers to objects that may be visible or invisible; present or far removed. They can be so vast in size and scale that they are impossible to perceive in their entirety. They may unfold so greatly over long expanses of time that we are unable to experience them in their full temporal unfolding. Their vast size means we frequently find ourselves living inside hyperobjects but never fully experiencing them because of their sheer vastness.

Morton refers to radiation as having the qualities of a hyperobject. Its viscous nature evidenced by ‘the more you try to get rid of [it], the more you realise you can’t get rid of [it].’¹⁴⁴ Awareness of radiation emerges from the realisation that you cannot escape it by virtue of its penetrative, altering effects. Morton continues: ‘A gamma particle is a wonderful example of a profound confusion of *aisthesis* and *praxis*, perceiving and doing [...] In illuminating things, it alters things: flesh, paper, brains.’¹⁴⁵ It is only through the long, delayed effects of slow violence that we become aware of it; time passes before thyroid cancers appear as a result of radiation exposure, a reminder of the silent, attritional viscosity of radiation. Perhaps the confusion Morton speaks of explains why the archetypal imagery we *do* see in the media portrays the long-term effects of radiation disasters through disabled children. As a child in the mid-90s my experience of the Chernobyl disaster – an event that occurred the year before my birth – was through images of the children of Belarus who were suffering birth defects and cancers caused by the toxic drift from radioactive contaminants.

¹⁴² Nuclear heritage and nuclear culture differ from nuclear semiotics. Nuclear culture is the concern of society’s perceptions of militaristic and domestic nuclear technology. Nuclear heritage is the remit of historical legacy left by the nuclear industries.

¹⁴³ Even when something appears spectacular, Morton states it has a ‘false immediacy.’ Morton, *Hyperobjects*, p. 48.

¹⁴⁴ Morton, *Hyperobjects*, p. 36.

¹⁴⁵ Morton, *Hyperobjects*, p. 39.

My school brought groups of children from Belarus over to the UK for one month a year as ‘relief’ from living in a radioactive environment. Their bodies, their cellular structure, altered by an event that took place before they too were born. The aestheticisation of slow violence is so often embodied, and the long, drawn-out embodied effects of radiological disaster are not spectacular. Those that are affected by nuclear disaster are unlikely to be those that originally benefitted from the existence of the nuclear reactor. The Belarusians did not benefit from the power created by the Ukrainian reactor, but as ‘downwinders’ they bore the consequences of its existence in immeasurable ways.

Toxic drift affects ‘downwinders’ temporally as well as spatially. As with slow violence, it is a violence inflicted on the other, whether elsewhere, or in another time. Toxic drift does not only come from nuclear accidents but will also occur in RWM systems. Toxic drift can occur through nuclear fallout from bombs; it can be caused by water leaching from failed welds in temporary nuclear waste storage pools.¹⁴⁶ It is a near inevitability, despite how safely the radioactive waste is ‘contained’ in a GDF that natural disasters occur, engineered barriers corrode, water tables shift, and material certainty declines over millennia.¹⁴⁷ Toxic drift, exceeds our expectations and predictions much in the way Rosemary Joyce has already observed. The only thing we can predict is that it will happen. More importantly, we should *not* assume that it *will not* happen. Containment is therefore only temporary and may only serve to protect the environment and people from the worst of the effects of radioactive contamination. Similarly to the hyperobject, toxic drift evidences the non-locality of radiation and how it permeates the environment, entangles itself with beings, ecologies, and manifests itself again through contact and absorption. Where slow violence is continual from a single event, even though it may manifest in different ways, toxic drift is latent, manifesting later in the narrative of the GDF and the radioactive waste. It is a delayed violence, one that may not be predicted, or expected long after memory of a GDF has faded. It reemerges silently. It is a concealed threat.

We should therefore view toxic drift not as a conceptual framework for understanding nuclearity and radiation as with slow violence and the hyperobject, but instead, as an

¹⁴⁶ Multi-layered barriers are a standard for RWM. These range from canisters in immediate contact with the waste to (for a number of proposed GDFs) surrounding clay that provides low permeability for transport by water. Nevertheless, each country has their own acceptable and unacceptable levels of hydrogeological transport of radioactive substances. Whether they can meet those standards for the full 100,000 year duration remains unknowable at present.

¹⁴⁷ The Magnox Swarf Storage Silo (MSSS) at Sellafield in the UK has been known to be ‘leaking radioactive water into the ground since 2018 [...] enough to fill an Olympic-size swimming pool approximately every three years.’ UK Parliament Committee of Public Accounts, ‘Decommissioning Sellafield: Twenty-Eighth Report of Session 2024–25’, (UK Parliament, 2025). Nor is this an isolated case. The Hanford Site in the USA has reportedly had significant and persistent issues with leaking tanks for decades. Leaks at both Hanford and Sellafield are believed to be a result of aging infrastructure.

inevitability. It should be considered as a future property of the narrative of the waste contained in a GDF – a latent anachronistic message, re-signifying itself from deep underground, and decodable as unusable, hazardous land. Viewed in this anachronistic way, we can take this future property as already existing. Paul Virilio states:

Unless we are deliberately forgetting *the invention of the shipwreck* in the invention of the ship or *the rail accident* in the advent of the train, we need to examine the hidden face of new technologies, before the face reveals itself in spite of us.¹⁴⁸

Following Virilio, toxic drift was invented the moment the GDF was invented. It may not happen until thousands-of-years in the future but it is a latent feature all the same. And whilst it may not be an event that affects us now, we must consider the ethics of its inevitability for people in the future.

Van Wyck similarly states:

Failure is programmed into the product from the moment of its conception [...] And yet these are local catastrophes. They happen somewhere to someone and are caused by something. The contemporary technological accident does not follow this specification.¹⁴⁹

The hyperobject, slow violence and toxic drift combine to affect those in different times and places, long after *our* culpability has ceased. Art that imagines the reemergence of radioactivity into the landscape through toxic drift opens up anachronistic possibilities. It can constitute an episodic history relative to the long, slow history that unfolds as only minute changes occur over deep-time. *Histoire événementielle* over deep-time need not be 10, 20 or 30 years when the timeline is 100,000 years of very little change. A reemergence, a change of state, a seepage in 1000 years serves as a slow reminder to future people of the dangers beneath their feet in a very real and visceral way. In this way, the property of inevitability in radiation and GDFs can aid in its own system of self-signification, archive-making, myth-making, and aestheticisation. Anachronistic thinking forces us to envisage this period of the GDF and radioactive waste's narrative, and those that it will affect. Rather than diminishing leakiness, art can be a mechanism that works alongside it, a means by which the GDF is marked from within, and art directs us to observe and acknowledge this.

The first artwork I will leverage to further these temporal discussions is Taryn Simon's *Black Square XVII* (2015). It is clear that whilst radioactivity is inherently linear in its half-life

¹⁴⁸ Paul Virilio, *Open Sky*, (London: Verso, 1997), p. 40.

¹⁴⁹ Van Wyck, *Signs of Danger* p. 12.

decay, radiation – particularly contamination – is not. Morton views it as inescapable and sticky; Nixon views it as pervasive and attritional. Despite its omnipotence following the Trinity Test in 1945, we humans require a mediator to ascertain the information required to determine *how* contaminated, and *which* radioisotope(s) are present and the risks they pose. According to the RK&M report, art can be one such mediator. But to go beyond the visual mode of representation, some artists have embraced radioactive waste as an additional layer of mediation. Taryn Simon in particular directs us to have patience, to wait, and to inform future generations 1000 years in the future to complete her work.

Taryn Simon, *Black Square XVII* (2015)



FIG 2.1. Taryn Simon, *Black Square XVII*, 2015, concrete, void for artwork 80 x 80 cm, Garage Museum of Contemporary Art, Moscow. Installation view at Garage Museum, Moscow.

Taryn Simon's site-specific, two-part artwork is located at both the Garage Museum in Moscow, and at the Radon nuclear waste disposal plant in Sergiev Posad, Russia. The first, accessible part at the Garage Museum is a niche set into the concrete fabric of the building itself (fig. 2.1). The niche is an 80cm cubic void that awaits reunification with the second part, the black square (cube) of vitrified nuclear waste – currently in storage at the waste

disposal plant – in ‘no less than one thousand years.’¹⁵⁰ The cube is ‘composed of medium-level, long-term nuclear waste containing organic liquids, inorganic liquids, slurries and chemical dusts from a nuclear plant in Kursk, and from pharmaceutical and chemical plants in the greater Moscow region.’ Sealed inside the cube, within a two-ply steel capsule, is a letter to future generations written by Simon which will be irretrievable without destroying the cube.¹⁵¹ However, aside from x-raying through the black glass of the cube (or whatever comparable imaging technique is appropriate in a thousand years’ time), there is no visual clue that there is a message encased within. To ascertain this knowledge, supporting documents must also survive, or the information passed on verbally.

Simon collaborated with the Russian State Atomic Energy Corporation (ROSATOM) to produce the cube using the vitrification method – a widely used method of stabilising volatile waste. Given the long history of nuclear tensions between the US and the former Soviet Union/Russia, this is a provocative collaboration.¹⁵² The cube is then encased in steel and concrete and stored in a chamber at Radon.¹⁵³ After approximately 1000 years radiation emissions should have dissipated to safe enough levels for human interaction and exhibition. It is anticipated that the cube will be placed in its niche in the year 3015.

Simon clearly sets out a durational quality of the artwork, directly influenced by its materials’ potential to cause harm – the decrease of which leads to an anticipated act of ‘completion’ (more on this shortly). There is an overt sense of reliance on future generations, institutional museum systems, and in the assurances of the longevity of the nuclear waste repository in Simon’s piece. In one sense, the message enclosed within the cube can be seen as the ‘point’ of the art, relying on the stability afforded by the waste repository to nurture the cube and deliver it into the future after its decay into maturation. The systems of the nuclear industry are the conduit for the message, ensuring a safe courier and a delivery point. The gallery is the receiver of the reliquary of the message, its stability signified by the strength of the concrete receptacle. However, the two institutions are far from mutually compatible. The waste repository is designed for longevity; the museum is unlikely to benefit from the same. Whilst the cube component may survive, there are doubts as to whether the niche will have a similar fate.

¹⁵⁰ Garage Museum of Contemporary Art, ‘Taryn Simon: Black Square XVIII’, *Garage Gazette*, (2015), p. 13.

¹⁵¹ Carpenter, *Nuclear Culture*, p. 111.

¹⁵² For brevity, this thesis will not dwell on political nuclear tensions.

¹⁵³ The radioactive waste disposal plant at Sergiev Posad is not a deep GDF. It is a near-surface storage facility surrounded by clay-rich soil.

In the absence of evidence of its existence, we are led to believe that the cube exists only because the niche (and the artist) say it does. The hazardous component exists far away, out of access. This only serves to heighten our awareness of radiological dichotomies: presence and absence, visibility and invisibility – and elucidates our general lack of understanding of nuclear waste processes, and therefore our reliance on institutions to take care of these things for us; to protect us. The East/West nuclear tension only highlights the dichotomy of trust and mistrust that hangs in the air as an ever-present nuclear tension.¹⁵⁴ The lack of indexical input by the artist merits no distinguishing feature of Simon's vitrified cube from the no doubt, many similar vitrified cubes also in storage. In 1000 years it may be virtually or completely indistinguishable from the other waste. It may be indistinguishable already. If it is at all identifiable as the art piece in 3015, the question arises: will anyone still remember that the cube is an artwork? Even more so, will anyone remember, or feel the compulsion of responsibility to reunite the cube with the niche (if it still survives) and 'complete' the artwork. *Black Square XVII* draws our attention to the different temporalities of objects that Morton described earlier. The existence of the *Black Square XVII* vitrified cube a thousand years from now seems to be all but guaranteed. It is our duty to store this kind of waste, and it is also our duty to leave it undisturbed, waiting until it is safe before any future interaction with it.¹⁵⁵ The museum operates on a different temporality. Its survival in the year 3015 seems much more doubtful. As such, 'completion' becomes problematic and Simon uses this tension to comment on the protractedness of nuclear waste by using it as a temporal material.

Referencing the 1915 Kazimir Malevich piece of the same name, Simon's piece is of the same dimensions as Malevich's original suprematist painting and commemorates 100 years since its inception. Malevich stated 'the cube is no longer a geometric body. It is a new object wherein we try to portray eternity.'¹⁵⁶ Simon echoes these words with this piece. The materials contained within and constituting the cube will be dangerous for centuries, far beyond any preconceived idea we may currently have of what civilisations may succeed us by the time the materials become safe again. In the lens of Suprematism, the black square and cube are symbolic of death, and as per Malevich's requests before his death in 1935, a cubic monument was erected above his tomb. The vitrified cube is perhaps emblematic of the suprematist evocation of death. Whilst it is arguably not a universally understood symbolic

¹⁵⁴ Further highlighted by the denial by ROSATOM of Taryn Simon to enter the facility, instead requiring all her instructions to be carried out by proxy. Angela Brown, 'Obscuring the Index', (Gagosian, 2017).

¹⁵⁵ I speak of human interaction. It is highly probable that robotic interaction may be more likely in the future, whether this be for safety inspections or for investigative purposes.

¹⁵⁶ Quoted in R. C. Williams, *Artists in Revolution: Portraits of the Russian Avant-Garde. 1905-1925*, (Bloomington & London: Indiana University Press, 1977), p. 124. Likely from an unpublished Malevich manuscript dated January 25, 1924 titled 'Iz knigi o Bezpredmetnosti.'

form, it nods to the concept manifested a century earlier. This can be viewed as an episodic approach to knowledge transfer. A commemorative date was an opportunity to revitalise Malevich's form, renewing its meaning into culture 3-4 generations hence. However, just as the message sealed within *Black Square XVII* cannot be observed without the assistance of x-rays, the same is true for the way we now understand Malevich's *Black Square* today. X-rays of the painting have revealed two other colourful earlier paintings underneath and an inscription in Malevich's handwriting.¹⁵⁷ I find it interesting that this doubling of radiation will be required to even ascertain the existence of the message. Conversely, the perceived value of the piece may become a roadblock to any people of the future ever receiving the message. As a vessel for the transfer of knowledge, the artwork's value (or perceived value) quickly becomes problematic.

To further complicate things, there is already evidence that 'people of the future' are struggling with the time-capsule-as-art format. Stephen Kaltenbach's time capsules are a good example of this to which he laments, 'people aren't following directions.'¹⁵⁸ Kaltenbach's steel cylinder time capsules which feature clearly engraved instructions, such as *Time Capsule (OPEN AFTER JAN. 1, 2000 A.D.)*, 1969 (fig. 2.2) have drawn attention to issues of ownership and art value which may prevent the fulfilment of intentions or instructions issued by the artist to future generations.¹⁵⁹

¹⁵⁷ Danny Lewis, 'X-Rays Unveil Hidden Paintings Beneath an Avant-Garde Classic', (Smithsonian Magazine, 2015).

¹⁵⁸ Peter Eleey, 'Thursday', in *The Quick and the Dead*, ed. by Peter Eleey (Minneapolis: Walker Art Center, 2009), pp. 31-56 (p. 42). In conversation with the author.

¹⁵⁹ Kaltenbach's ongoing Time Capsule series are characterised as minimalist steel capsules, engraved with instructions or statements on the exterior: 'Open After My Death,' 'Open Before My Retrospective at the Tate in London,' 'Nothing of Great Value' are some examples. They are deliberately frustrating, by implying an inner contents that can (or should) be revealed, but pose a dilemma to art conservators as they cannot be opened without being destroyed.



FIG 2.2. Stephen Kaltenbach, *Time Capsule (OPEN AFTER JAN. 1, 2000 A.D.)*, 1969, stainless steel, 6.4 x 6.4 x 20.3 cm, Allen Memorial Art Museum, Oberlin OH.

In an interview about *Black Square XVII*, Simon states:

It's a record of how record plays into discovery. In creating a record of it through talking about it with you, and through writing about it—will those records last? Will they stay attached to the objects from which they were born? And will the intention survive, or will it just be this unknown thing that's never cracked? And, is it too beautiful to crack? Or at that time too valuable to crack? So [it's a] battle between accessing the letter and preserving the work of art...¹⁶⁰

Art value is evidently problematic for the fulfilment of instructions. Having not been opened (and thereby not fulfilling Kaltenbach's wishes and instructions), doubts are raised as to whether instructions left by artists to 'complete' works will be fulfilled. Both Simon and Kaltenbach expose the issue of value outweighing curiosity. We cannot be sure that the artist is being truthful about the contents they claim to have secreted inside their art objects. If we believe them, we risk destroying a valuable or beautiful thing for no reward if it transpires there never was anything inside to begin with. Similarly, we must question if we will get

¹⁶⁰ Emily McDermott, 'Taryn Simon's Black Mass', (Interview Magazine, 2015).

more joy from opening the artworks and finding out the truth or whether the ambiguity is part of the allure. The likelihood of ‘completion’ of Simon’s and Kaltenbach’s pieces is nevertheless questionable. We will return to the deeper complexities of art value in a later chapter.

Taryn Simon’s *Black Square XVII* is ambitious with its emphasis on responsibility. The responsibility lies with the Garage Museum of Contemporary Art in Moscow. There is a reliance on the continuity of perceived responsibility of the gallery and its management and curators to complete the work. In around 1000 years, there is an expectation of the gallery to reunite the radioactive cube of vitrified waste (that has been stored in a GDF) with the corresponding niche that has been made in the concrete fabric of the building. Responsibility is therefore in the survival of the trifecta of the niche, the gallery, and in the understanding of the need to perform the completion action in the future. The survival of the radioactive cube is almost implied as a certainty given the institutional control of the GDF. Ownership or responsibility for the artwork is, however, less clear. Is the radioactive cube in its present radioactive state classified as nuclear waste and therefore under the restrictions and controls that entails? Or is it an artwork first and foremost, and therefore privileged in some way? Its designation asserts the differing institutions with differing responsibilities and modes of care. It may be that after 1000 years of transmutation that the artwork designation is assigned, and until that point, it is merely a material awaiting its application. With these questions arise the difficulties of ascertaining custodianship and stewardship, and its status as an art object or a material, and whether the act of ‘completion’ and reunification is the beginning or the end of the artwork.

Regardless of assumed roles, being the custodians of the work goes beyond the responsibilities of maintenance, conservation, and preservation that are expected of a gallery. It prompts some sort of ‘shared authorship’ over such a long duration – to borrow Nathalie Zonnenberg’s terminology.¹⁶¹ Boris Groys laments the necessity for the role of the curator in conceptual artworks to provide a contextual framework for interpretation.¹⁶² The artist is no longer the sole author of the story of the piece, instead the gallery is co-author if the act of completion is to be achieved due to the separation of the public-facing niche, and the other half of the work. It may be perceived as the niche being ‘incomplete’ until 1000 years has elapsed. As an empty space, the niche may be of perceivably little or no value, limiting its potential for longevity. To some, its emptiness may simply indicate the absence of the artwork. Shared authorship is then yet another balance between the nuclear industry and

¹⁶¹ Zonnenberg, *Conceptual Art in a Curatorial Perspective*, p. 21.

¹⁶² Groys, *Art Power*, pp. 43-46. A finding shared by Wesley Cray which will be explored in the next chapter.

the museological industry, with the curator – presumably – as the mediator of meaning until completion. This is a heavy burden on the curator.

Art historian Camiel Van Winkel argues that the curator is the conduit for information transfer, including the responsibility of interpretation and recommunication – they become ‘authors’ of the work in the present day.¹⁶³ Groys would go further to say that as a post-conceptual artwork *Black Square XVII* cannot operate without the interpretive support of the art institution.¹⁶⁴ This is clearly true for the niche, formed into the fabric of the building as it is, but epistemologically the lines are blurred. Nevertheless, there is a significant burden placed on the curator to ensure accuracy, which, as a means of social transfer is subject to fluctuations and changes in understanding and meaning as time goes on. The role of curator in the institutional sense is temporary and certainly comes with no guarantees of information and knowledge transfer. It is quite probable that the curator’s successor is free to make their own interpretations, irrespective of what conclusions and meanings outgoing curators may have arrived at. Shared authorship is a wicked complexity for *Black Square XVII* and other radioactive artworks; a necessity for both physical and conceptual survival, yet very likely to muddy the waters of interpretation.

Shared authorship is, however, unavoidable over such long durations of the selected works and need not be dominated by one or two institutions. In fact, shared authorship reflects the systemic approach of multiple actors feeding into GDF RK&M. From the perspective of RK&M, a narrative must be formed for these radioactive artworks, a story of multi-generational handling, care, measurement, and so forth. In other words, a history must be written, one that can be developed over time and added to by each generation in a shared authorship. With *Black Square XVII*, the reward to its custodian and stewards is selfless for the next 30-40 generations, presenting significant issues with the likelihood for the completion of the work. It could be argued, however, that the history of the gallery has the potential to become entangled and enmeshed with the work. An entangled narrative may aid survival of both the gallery niche and the memory/knowledge of the need to complete the work in the future. The issues with this are sadly plentiful and likely to overwhelm any possibility of completion in this regard. The gallery is likely to change hands, be reused, be demolished, replaced, looted, subject to the effects of political unrest and so forth. These are not unique to the politics of Russia but to any country or state over a period of a thousand years. An unmistakably bleak cloud of absurdity casts doubts over whether Taryn Simon’s

¹⁶³ Camiel van Winkel, 'During the Exhibition the Gallery Will be Closed: Contemporary Art and the Paradoxes of Conceptualism', (Universiteit van Amsterdam, 2012), p. 215.

¹⁶⁴ A statement he applies broadly to all conceptual and post-conceptual artworks.

artwork components can be unified and the message retrieved. Time, value, custodianship, instructions: these all complicate completion in immeasurably compounding ways. Perhaps what Simon shows us is the idiocy of such an endeavour; that RK&M is unachievable, and Simon lays out the reasons why. If so, *Black Square XVII* provides us with a starting example of problems that can occur with the Art Mechanism and ways these problems that are peculiar to this mechanism alone can be overcome, or circumvented.

Temporally, *Black Square XVII* poses an interesting alternative approach to GDF marking through the use of radioactive art. The niche serves as a reminder, demanding completion in the future. The missing piece, the radioactive component, illustrates the need to be kept away without posing a threat to health until it is safe to be reunited. Simon's referencing of Malevich's past avant-garde approach in a (presently) modern and unexpected use of materials stretches time through the art's durational quality by involving people 1000 years in the future to complete it. In some respects, *Black Square XVII* circumvents the troubled maxim of 'making the invisible visible' by concealing the danger but reminding us to retrieve, reveal, and marvel at the transformed and transmuted block in centuries to come. The act of radiation signifying itself is removed for the most part of the cube's lifetime. Instead, the viewer is left to imagine what this cube looks like, and where it is stored until such time has elapsed that it is safe to reveal it once again. The void is the site of this mental conceptualisation. Time must therefore be seen as a series of revisitations by multiple actors, creating dialogues between the past, present and future.

The artwork and its message exist across multiple temporal zones, highlighting the speculative future ahead of it – will the repository survive as intended? Will the gallery be present in 1000 years? If not, will the niche be conserved? If so, where? There is also no guarantee that the message contained within will be interpretable in 1000 years.¹⁶⁵ The message speaks directly to people who are unknowable to us in the present, linking the 21st century to the 31st century with no intermediary. Shared authorship is only produced by the *lack* of the hazardous waste and the passing of information that it must be reunited with the void. Therefore, mediation only occurs for the empty space that awaits the radioactive cube to effect completion. The radioactive cube receives no such mediation given its temporal and spatial withdrawal. A lack of mediation goes against the RK&M Final Report's recommendation for intergenerational processes that dictate frequent transfers of information but does align with the temporal stretching of episodic history to fit with slow violence. Radiation and radioactivity may only need to reemerge once every thousand years

¹⁶⁵ Nor was I able to ascertain whether the message was written in English or translated into Russian via the Russian government's imposed proxies.

to provide an experience and re-establish interest, such as Simon caters for. To explore a greater frequency of intergenerational revisitation, I now turn to Erich Berger and Mari Keto's *Inheritance* (2016).

Erich Berger & Mari Keto, *Inheritance* (2016)



FIG 2.3. Erich Berger & Mari Keto, *Inheritance*, 2016, concrete, copper, brass, glass, gold, fur, amber, leather, silver, thorium, thoriumite, uraninite, Private Collection.

Inheritance is unique in its position within the selected works as it is the only artwork to actively encourage short-term (by RWM standards) intergenerational custodianship. The piece consists of multiple parts. The radioactive component is a set of heirloom-quality jewellery items made using radioactive stones found by the artists at an auction. The stones had been diamond cut (which is highly unusual considering the dense opacity of the stones rendering them unable to refract light in the same way that a diamond would). Also included are tools for measuring the radioactivity of the stones: an electroscope, rod with fur to charge the electroscope, a time piece modelled after a Fenjaan Water Clock, timer for recording time, and instructions with rituals. The components are stored in a stacking concrete

container to minimise external exposure to radiation. Supporting documents exist separately but include an autoradiograph of the jewellery pieces (fig. 2.3).

Inheritance differs from *Black Square XVII* on the temporal plain. *Black Square XVII* is akin to the interstellar Voyager probes, ejected out into deep-time and space with a message that has only a slim chance of being delivered and with no determined recipient. *Inheritance* on the other hand ushers in careful oversight, regular rituals, and enters the domestic realm rather than being moved far away for safety. The stark difference of location between the two artworks (which will be thoroughly considered in the following chapter) is of significant importance to RK&M. For Simon's piece, records (the R in RK&M) are imperative to the survival of knowledge and memory. With the cube stored out of sight and behind barriers, memory is likely to fade quickly on the 1000-year time scale. Knowledge can be maintained to some degree but the potential for this knowledge to become more spurious increases over time. The importance of Simon's statement that her interviews about the artwork actively contribute to the records should not be underestimated. Save for the niche in the gallery wall, the records are what point to the far away radioactive object, with a task to complete far in the future. For *Inheritance* this space and time is contracted to the other extreme. Safety is now catered for, not through distancing but careful measurement and oversight. The hazards of radiation enter the home with the potential to harm not only us, but our entire lineage into the future. 'Safety' is construed very differently between *Inheritance* and *Black Square XVII*; the former wearing its protective layer of concrete, conveying stability and overtly insulating the radioactivity inside from anyone in its presence. The latter is removed from access, transported away so that we do not have to deal with it ourselves or on a personal level. One demands individual responsibility, the other is reduced to industrial processes of which we have no control. The radioactive object as a domestic object is a provocative interjection into the vague public perception of what radiation is. It ushers in that refrain of *how much is too much?* Berger and Keto assure the custodians of the art object that they are safe from radiation by the overt provision of insulating material barriers. However, they encourage each generation that finds themselves in the position of care of the art object to expose themselves, removing the radioactive jewellery, and conduct ritualistic measurements of the radioactivity. One day, the reward will be to wear the jewellery, a talisman of decay and ritualistic oversight.

Quality plays into the longevity of *Inheritance*, earning its status as an heirloom and warranting generational transfer. With this transfer of wealth comes a transfer of provenance and tradition. Berger and Keto's inclusion of rituals as part of the instructions encourages repetition and knowledge transfer, making the transfer memorable and

meaningful but also leaving room for changes in language to remain intelligible as time moves on. These processes evoke a more social, short-term approach to knowledge transfer when compared to the denial of contact with the object as prescribed by Simon for *Black Square XVII*. The short-term, social approach is identified in the RK&M report as vital to the integrity of deep-time communication.¹⁶⁶ Here we find the contrast of volatility and stability. Whilst the short-term approach addresses knowledge loss through frequent repetition, it is more volatile, with potential for a lack of integrity on a shorter timescale. In contrast, *Black Square XVII* does not make any provision for knowledge exchange, and instead projects straight out into the future without mediation. The message may arrive intact, but will it be decipherable? The intergenerational process is preferred by RK&M. However, Robert Jacobs casts doubt:

We can imagine a scenario in which future human beings are implored to convey this knowledge to those who come after them, to update the data into newly developing or changing languages, but that means we have to rely on them to willingly follow our instructions for thousands of years, or longer. Even if we imagine that we could convince people to do this, like in the commonly played childhood game of “telephone,” in which a series of children whisper a statement from one to another, the message rarely travels through ten iterations before it is far removed from the initial content. We would be compelling our descendants to play telephone with a loaded gun.¹⁶⁷

The comparison between a message so compelling that it must be told, with a game for children where much of the fun is changing the message in amusing ways (even if that is not the point of the game) does not address the severity of the former and the inconsequentiality of the latter. Furthermore, the message is whispered in the game of telephone, not conveyed as clearly as possible as would arguably be performed by future generations tasked with the transfer of information regarding a GDF. However, Jacobs makes a valid point. Change is inevitable, especially as language evolves. This is both an opportunity for continuity but also a threat to meaning. We are beginning to build a picture of the benefits and drawbacks of these temporal approaches to projecting messages into the future through the episodic approach of *Inheritance*, and the *longue durée* of *Black Square XVII*. Change and adaptability are important to maintaining meaning, and this is most easily done with supporting documents which can be readily updated.

In *Inheritance*, the supporting objects and documents for measuring the radioactivity of the jewellery are designed to be changed, updated and replaced. Redundancy is factored into the

¹⁶⁶ Nuclear Energy Agency, ‘Preservation of RK&M’, pp. 18, 32, 56.

¹⁶⁷ Robert A. Jacobs, *Nuclear Bodies: The Global Hibakusha*, (New Haven: Yale University Press, 2022), p. 231.

piece particularly where language and resources are concerned.¹⁶⁸ Whilst my research will show that the allowance for entropy is an important consideration when projecting an object or idea into deep-time in order for it to be understood at its intended destination time, *Inheritance* also intends for some components to remain unchanged. In my interview with Mari Keto about her piece, we discussed the entropy of jewels where each of us provided opposing examples of heirloom jewellery. Where my own grandmother's engagement ring was passed down to my mother which she subsequently damaged, the ring was reworked and the diamonds reset in a new configuration to suit my mother's tastes and lifestyle. This example reflects significant changes in just one generation of transfer. Another example is of the Black Prince Ruby in the British Imperial State Crown which is documented to have been used on multiple different crowns in its over 650-year life, but also features a ruby 'plug' which fills a whole at the top of the Black Prince Ruby where it is believed it was once drilled to be worn as a pendant. Changes in fashion and taste in addition to changes of use as it is passed from generation to generation are almost guaranteed, and not even the highly valued British Crown Jewels are safe from modification. Yet Keto took the comparatively less re-worked Danish crown jewels as inspiration for stability in design.¹⁶⁹ The difference in analogues from which we drew evidences cultural differences highlighting the potential need for an emphasis on the local when it comes to GDF marker and art marker design. This observation will be returned to in later chapters.

Whilst some components are designed to remain stable, and others encourage the custodian to update them if necessary, Keto and Berger also chose components that already exhibit stability. The water clock is the best example of this, with examples of similar simple water clocks dating as far back as 6000 years.¹⁷⁰ Analogues that exhibit stability, i.e., a lack of change, or where knowledge has remained consistent, are extremely important to the study of 'nuclear aesthetics.'¹⁷¹ Not only this, but simplicity is also key here – requiring easily understandable, replicable materials to form the device. An aversion to complexity is beneficial to achieving reproducible, ritualistic results and measurements. The RK&M report relies heavily on identified characteristics of stability in analogues for formulating its proposals and recommendations. It is this multi-factored, systemic approach to entropy and stability that is found in *Inheritance* that makes it valuable to my study of knowledge transmission with a view to completion.

¹⁶⁸ For example, if water is no longer available to power the clock, another liquid can be substituted and still achieve an accurate result.

¹⁶⁹ Despite having been 'redesigned in relation to the demands of age' in 1746, the present form has remained so since the 1840s. The Royal Danish Collection, 'The Crown Jewels', (n.d.).

¹⁷⁰ Harrison J. Cowan, *Time and its Measurement: From the Stone Age to the Nuclear Age*, (Cleveland, OH: World Publishing Company, 1958), p. 58.

¹⁷¹ The concern of making visible the invisibility of radiation. Also, of imagery representing the spectacle of the atom bomb.

In both *Inheritance* and *Black Square XVII*, there is a strong emphasis on time and its measurement. Time must be allowed to elapse before safety can be determined. For Simon's piece, the inference is that responsibility for retrieval of the radioactive component falls to institutions. Whereas with *Inheritance* the responsibility is on the custodian who must accurately and intentionally permit the transfer of information through record keeping and verbal transmission to the next custodian. Both artworks use radiation and its decay as a time-keeping device. The measurement of elapsed time, even if the inception point is lost or forgotten, can be reestablished by the measurement of decay. In *Black Square XVII* the institutional responsibility requires little to no labour. The absurdity of the achievability of 'completion' is part of Simon's institutional critique. However, in *Inheritance* labour is encouraged by every generation; to measure and record. It is obvious why the RK&M report favours intergenerational transfer. It seems more plausible than simply projecting an instruction into deep-time and hoping/assuming it will arrive, intelligibly and actionably. *Inheritance* emphasises the implication on future generations, not merely of material heirloom gain, but of responsibility, care, and the danger of our present-day nuclear waste-producing actions.

The success of RK&M preservation cannot be judged by whether RK&M will last for thousands of years. This remains impossible to predict or demonstrate. It can only be evaluated in an ongoing manner, as it depends on whether or not it establishes the relevance and responsibility in the minds and attitudes of waste producers, regulators, implementing agencies, other stakeholders and the general public today, and whether that need and responsibility is understood and passed on to the next generation.¹⁷²

The RK&M report directly speaks to the measure of success being the understanding of responsibility at any and every point in the future. This is an important consideration, as it would view the approach in *Inheritance* to be much more favourable than in *Black Square XVII*. The physical form of the radioactive materials and the status ascribed to them directly influences how they encourage handling and care. An ascribed value is a motivating factor in *Inheritance*, whereas *Black Square XVII* is more akin to waste. Therefore, an argument should be made for a radioactive art marker that demands a level of care, that separates itself from the waste that is stored below it in a GDF. Custodianship and stewardship demand responsibility and are likely to fulfil the RK&M criteria for success.

That being said, both artworks highlight the instability and unreliability of human stewardship of nuclear materials. The episodic approach in *Inheritance* is threatened by

¹⁷² Nuclear Energy Agency, 'Preservation of RK&M', p. 89.

toxic drift in the domestic setting. The risk of embodying the radiation is much higher. This highlights the irony of increased oversight potentially exposing us to more harm than if we had chosen to forget about it and leave it undisturbed. *Black Square XVII* all but refutes social oversight in favour of the Malevichian abyss of time. The risk of forgetting is much greater in this abyss. Both works offer differing strategies for aestheticising the nuclear: visibility and withdrawal. For *Inheritance* the aesthetic is an intrusion on domestic rhythms; for *Black Square XVII* any visibility is merely conceptual, signified by absence not presence. Toxic drift haunts both works, both measured and unmeasured – our proximity or distance being the mediator of our nuclear sublime experience of the artworks. The porosity of bodies, homes, spaces – all susceptible to this toxic legacy – cannot escape the *longue durée* of the materials used in these artworks. Intergenerational processes collide with the *longue durée*, foregrounding toxic drift as both a metaphor and material threat. Where one artwork translates radiation into lived experience and a toxic burden of custodianship, the other encrypts it into the void, the other, the elsewhere: forgettable, but with a reminder to retrieve its secret message.

Entropy

The function of all this waiting that these radioactive artworks are encouraging us to do, is to simply allow time to pass before interacting with them. They present as ‘incomplete’ artworks requiring final acts of completion that are determined by the reduction of radiation.¹⁷³ This is also the goal of marking a GDF: to create a series of messages and signifiers that encourage us to have patience and to wait until it is safe to enter, should we wish to do so. For these works to be completed, entropy must occur in sufficient measure as to render the materials, or in some cases, the setting in which the artwork is stored, safe to be handled or entered. The rate of entropy for different radionuclides varies significantly from tiny fractions of a second, to many trillions of times longer than the universe is old. These artworks cover a gamut of half-life timescales, from around 10 years as with *0.5 Microcurie Installation*, to billions of years as is the case with the uraninite in *Inheritance*. Decay is a feature of these works – they must decay to achieve completion. The narrative of these works is played out slowly, with more future ahead of them than they have past. With the exception of Barry’s *0.5 Microcurie Installation*, the decay of these pieces is measurable but essentially meaningless on generational timescales. The radiation being emitted by most of these pieces

¹⁷³ The penalty for premature completion, either by greed or by misinterpretation or misinformation is radiation exposure resulting in ill health or death. It is very clear that completion is determined only by radioactive decay itself.

will not reduce in any practical amount to effect completion. Therefore, the significance of these pieces is not that they might be completed in the here and now, but to pass on the information from generation to generation so that they may be completed one day in the distant future. The most meaningful work is not done by the final custodian but all the custodians tasked with ensuring that one day, the works *can* or *might* be completed.

To do this a balance of entropy must occur between that which is required to reduce the potential for harm, and the resistance (or careful management) of the entropy of knowledge about the piece. I draw specifically from Robert Smithson's usage of the term 'entropy'.¹⁷⁴ Smithson takes the second law of thermodynamics as his basis for his concept describing entropy as a process of irreversible loss of energy. For Smithson, this must be embraced, much in the same way that trainwrecks were invented with the advent of the train, the inevitable entropy of an artwork must be part of the process of making art.¹⁷⁵ For these artworks, entropy is what occurs long after the artistic act. It is a long unfolding, a diminishment, represented by imperceptible drift in both radioactivity and understanding. However, the existence of some of these radioactive works in isolation accelerates the likelihood of knowledge loss, increasing the potential for memory to fade, and knowledge to be forgotten. Here we find the parallel requirements for thinking in both 'episodic' and 'long-duration' timeframes, and how episodic (or intergenerational) processes can achieve knowledge transfer for the *longue durée*, or into deep-time.

This is not to say entropy is the enemy of knowledge, in fact quite the opposite. Entropy is a requirement for successful knowledge transfer into deep-time. The word entropy comes from the Greek *tropē*, meaning *transformation*. Radionuclides do not simply become less radioactive versions of themselves; they decay into daughter isotopes. Cesium-137 (as used in Barry's *Radiation Installation; Cesium 137*) decays into barium-137m and finally barium-137. (As a brief aside, there is an interesting anomaly of radioactive art in that the title may not reflect the current state of the materials. For example, Barry's *Radiation Installation; Cesium 137*, stopped being cesium-137 sometime around the year 1999 (accounting for the 30-year half-life of cesium-137) at which point the equilibrium of the material was in favour of barium-137.¹⁷⁶ However, this also serves as a baseline for measurement, determined by ratios of daughter and parent isotopes. I find this a fascinating quirk of the examples that

¹⁷⁴ Entropy as a dispersal of energy is to be further understood by its irreversibility.

¹⁷⁵ Flam, 'Collected Writings', pp. 11-21.

¹⁷⁶ It is important that this thesis remains grounded in art, not particle physics. For the purposes of understanding half-lives, all that is really needed to be understood is that the change to a daughter isotope from a parent isotope is not instant at the point of its stated half-life. Instead, atoms decay at random, and the half-life expresses the 'decay constant,' i.e., when it can be said that half of the atoms will have decayed. It is by this process that we can accurately measure time.

state the radioactive material used.) It is this transformative entropy that is required for knowledge transfer, a sentiment echoed by many researchers in the fields of nuclear semiotics, nuclear culture, and nuclear heritage.¹⁷⁷ If knowledge is to be projected into deep-time, it must be periodically transformed if it is to be maintained. These transformations must be conducted at regular intervals in which the previous iteration can be understood but updated so as to account for small variances in knowledge and language. And so begins what Thomas Sebeok described as a 'relay system.'¹⁷⁸ Concerned with transmitting information about nuclear waste sites 10,000 years into the future, Sebeok proposed breaking down those 10,000 years into 300 generations, and any message or information be 'designed for only three generations ahead'.¹⁷⁹ Similarly for Robert Smithson, entropy is a linear, irreversible process. It is a transformative process moving towards equilibrium.¹⁸⁰ His art, as Jack Flam also states in his reading of Smithson, is a dichotomy of being unnatural but forever persisting towards nature through the medium of time.¹⁸¹ For Smithson, change is inescapable, and indeed, should be embraced. To complete these artworks, change must occur, but to do so, paradoxically, they must also be maintained.

In *Inheritance*, each generation experiences the radioactive jewellery differently, and each generation must pass on the heirloom in a greater state of decay. Paradoxically, (although there is no control over this) to successfully care for *Inheritance* is to pass it down to the next generation knowing that it has decayed. Radioactive decay is constant, mocking the absurdity of human notions of care by virtue of its slowness.¹⁸² Additionally, entropy must be cultural as well as physical. The rituals and practices of monitoring and measuring the artwork are subject to flux and change in ways that are wildly unpredictable in comparison to the predictability of the radioactive decay of the jewellery. To 'complete' *Inheritance*, one (and all) must *endure* their familial inherited responsibilities. Completion is not only marked by the act of wearing the jewellery but by the endurance of familial social structures to adapt and change to effect transmission of the object and its meaning over millennia. Entropy in the realm of deterministic temporal trajectories is likely to erode meaning. *Black Square XVII* is much more at risk of knowledge loss because of the projection of the message directly to 1000 years in the future and. Difficulties emerge from its unsuitability for adaptation,

¹⁷⁷ Respectively: Thomas A. Sebeok, *Communication Measures to Bridge Ten Millennia* (BMI/ONWI--532), (Columbus, Ohio: U.S. Department of Energy, 1984); Hans Codée and Ewoud Verhoef, 'What's the Story? Using Art, Stories and Cultural Heritage to Preserve Knowledge and Memory', in *Radioactive Waste Management and Constructing Memory for Future Generations*, (Verdun, France: Nuclear Energy Agency 2014). Gustav Wollentz and others, 'Toxic Heritage: Uncertain and unsafe', *Heritage Futures: Comparative Approaches to Natural and Cultural Heritage Practices*, (2020).

¹⁷⁸ Sebeok, 'Communication Measures', p. 26.

¹⁷⁹ Sebeok, 'Communication Measures', p. 26.

¹⁸⁰ Flam, 'Collected Writings', pp. 301-309.

¹⁸¹ Flam, 'Collected Writings', p. xiv.

¹⁸² At least for the radioisotopes in question. Some radioisotopes decay extremely quickly. But those are not the focus of this thesis.

further complicated by its institutional custodianship. *Inheritance*, on the other hand, embraces an entropy that brings about adaptability and change. Whilst this approach comes with its own risks, it allows for the knowledge to be continually made current and suitable for the time in which it is interpreted – becoming appropriately anachronistic.

It may be more prudent to employ the radioactive half-life as metaphor to better understand the entropic transmutation of materials and knowledge in these two artworks. Just as one unstable isotope decays into another, the rituals and language that feed into our knowledge of these artworks must change into other things too. Becoming ever fractionally less of the old thing and more of the new thing where the old knowledge dims and the new knowledge emerges, just as the radioactive decay does not abruptly transform. Together, these artworks serve as examples of the extremes of nuclear aesthetics. They are artistic interventions into time, forcing us to wait, be patient, and measure, but in an ever-fluctuating realm of threat as radioactivity declines but toxic drift increases. The half-life is not only the metric of decay but the allegory of fragility and absurdity of human custodianship, reminding us that the artist's material choice will survive but entropy must be balanced between loss and change in respect of knowledge.

Conclusion

Anachronism in art allows us to speak to multiple times at once. It is not simply speaking to one time in the future, but all times in the future. Crucially, anachronistic thinking encourages us to observe materials and devise concepts that will be appropriate at all stages in the future.¹⁸³ We are not conveying a message directly to 10,000 or 100,000 years from now; we are conveying the message to everyone who exists in that timeline. Aligning with RK&M, a message must be decodable at any and every stage if it is to be deemed successful. Radioactive materials and their radioactivity provide a potential solution to maintaining this consistency of decodability by being unwaveringly predictable in their decay and by benefitting from being mathematically accessible.¹⁸⁴ The radioactive artworks in this chapter exist outside of the normal register of time. They exist now, but they also exist in

¹⁸³ Any concepts that we do devise are of course still rooted in our present perceptions of intelligibility. We cannot see into the future to be sure that anachronistic thinking achieves its goal and fulfils its purpose. However, after observing *Inheritance* and *Black Square XVII*, we can take the view that the slow temporal unfolding of radioactive materials in combination with the high entropy and adaptability of knowledge through repetition and ritual may offer some glimpses into speculative futures where material and knowledge achieve a degree of predictability by being both linear and entropic respectively.

¹⁸⁴ An assumption is therefore formed that mathematic principles remain constant, and that mathematics is consistently regarded as a noble and insightful pursuit in explaining the world around us. However, there are certainly imaginable scenarios where science and mathematics could be regarded as heretical.

unimaginable futures whilst simultaneously existing in speculative futures. Anachronistic thinking encourages us to devise appropriate forms and modes of communication that are suitable and appropriate to all timelines. Radioactive materials afford a degree of consistency and stability that as yet, has been underexplored as a mode of communication.

Radioactive artworks are not subject to the same rates of decay as more visual art forms. They demand a level of care that denies or severely limits handling. As such, they decay primarily by their energetic release, and less so by physical decay caused by exposure. As they age, having released a larger proportion of their radioactive energy, interaction becomes more tolerable. Radioactivity limits interaction, but the inverse is true as radioactivity decreases. The decrease of radioactivity over time increases the possibility of proximity and interaction. Advanced age is not a signifier of fragility and caution for these radioactive artworks, it is an invitation for greater interaction. Following Smithson, we can imagine these radioactive artworks as ‘ruins in reverse,’ immediately inaccessible at their point of inception, becoming more accessible and less ruinous as they mature towards their inert state.¹⁸⁵ This suggests that there is more life and narrative that awaits these radioactive artworks in deep-time. It further suggests that memory and knowledge may fade quite quickly for their earliest custodians in respect of the volatility of the materials; but that it may increase over time as they near any preconceived ‘completion event.’ With this in mind, we should devise narratives for art markers with lives that evolve and build, rather than reduce as time continues. A radioactive art marker’s signification can therefore be decoded one of two ways – on the somatic level, through interaction, registering as cancers and illness; or on the empirical level, decoded mathematically as a countdown to relative safety. A Smithsonian notion of entropy is an integral byproduct of these radioactive artworks. It is this entropy that increases interaction, countering knowledge loss through increasing approachability. We can envisage this entropy as a system and force that shapes, changes, adapts and transforms cultural meaning as well as material properties. This entropy is more necessary for episodic transfers of knowledge than it is for deep projections into the *longue durée*.

The proposal for radioactive materials to act as a marker of a GDF is put to the test in *Inheritance* and *Black Square XVII*. They provide differing models of knowledge transmission through radioactive artworks in anachronistic and linear temporalities respectively. In *Inheritance*, the value of, and entitlement to the jewellery that future generations may perceive is mitigated by the threat of radiation. Patience must be exercised,

¹⁸⁵ Robert Smithson, ‘A Tour of the Monuments of Passaic, New Jersey’, in *Robert Smithson: The Collected Writings*, ed. by Jack Flam (California: University of California Press, 1996), (p. 68).

and time must be allowed to pass. In *Black Square*, this duration is explicit. In *Inheritance*, future generations must ascertain this passing of time for themselves. The two artworks show the extreme ends of temporal projection of the message and their conduits – one, repetitive, encouraging change, mobility, and the development of a narrative as its story unfolds over time; the other, static and direct, mitigating change at the risk of meaning loss when it arrives in the future. Each artist employs temporality as a material quality of their radioactive artwork. To quote Robert Barry, in his discussion on his radioactive artworks ‘time is the essence of the piece.’¹⁸⁶ It is pertinent, then, to ask whether this temporal quality could be achieved through more visual art forms? I argue that the unexpected, contemporary use of radioactive materials and waste acts on a more conceptual plain. I further argue that a conceptual modality is more adaptable and changeable than a visual form. The runaway train of change is shaped – albeit not anchored – by the presence of the radioactive material.

¹⁸⁶ Mathieu Copeland, 'Ideas Come Out of Objects, Interview with Robert Barry', in *Voids: A Retrospective*, ed. by John Armleder, et al. (Switzerland: JRP Ringier, 2009), pp. 79-91 (p. 87).

2.

Spatiality: Non-sites

In the preceding chapter I discussed the temporal qualities of radiation; in this chapter I will discuss the spatial qualities.

Radiation is expansive, emitting from a central point and creating increasing proximal threat. The further away from it we are, the safer we are.¹⁸⁷ A GDF serves the same purpose of minimising danger by enclosing and concealing the threat. Concealment, however, risks us forgetting what has been removed from access over time – demonstrated by *Black Square XVII*. The concealment and minimisation of danger put people of the future at further risk – long after the nuclear industries have ceased. It is quite likely that future people’s inquisitiveness and desire to be able to obtain a sample of an ancient powerful material could be a driving force for intrusion.¹⁸⁸ No matter how much we explain it and provide warnings on the surface, it is probable that this will also serve as an encouragement to reach the mystical material. Exploring the option of displaying radioactive materials as part of the warning system may be a suitably provocative, yet mitigative approach.

Exposure

In a markedly reflective section of the WIPP Final Report titled ‘personal thoughts,’ Woodruff Sullivan, a physicist and astronomer working on the marker problem stated:

We have all become very marker-prone, but shouldn’t we nevertheless admit that, in the end, despite all we try to do, the most effective “marker” for any intruders will be a relatively limited amount of sickness or death caused by radioactive waste? In other words, it is largely a self-correcting process if anyone intrudes without appropriate precautions, and it seems unlikely that intrusion on such buried waste would lead to large-scale disaster. An analysis of the likely number of death[s] over 10,000 years due to inadvertent intrusion should be conducted. This cost should be weighted against that of the marker system.¹⁸⁹

¹⁸⁷ True for static radioactive objects and sources of radiation; though less true for toxic drift and fallout. We will explore the differences in this chapter.

¹⁸⁸ Assuming future humans will have moved away from nuclear power production.

¹⁸⁹ Hora, Winterfeldt, and Trauth, ‘Expert Judgement on Inadvertent Human Intrusion’, pp. F-143.

Rosemary Joyce reports the same conclusion is voiced by a concerned community group response to the problem of marking a site.¹⁹⁰ This shows that the potential for collateral damage as a warning is not exclusive to governmental solutions; it is observed by the public also. Whilst controversial, Sullivan's admission that exposure of the public to radiation by artists is perhaps a more favourable mechanism than one might think, a stance that would go on to be echoed by Wolfgang Ernst in 2012.

When I discuss my research with others, the response to the fact that artists are using radioactive materials is always surprise. Perhaps in a Western world of health and safety concern the wider population have become accustomed to these types of danger being removed from their day-to-day experience, and that it should be of no concern to them that they might encounter significantly elevated levels of radiation in their daily activities – we assume those dangers are dealt with or removed by appropriate authorities. I further speculate that the feeling of surprise produced by a source of radiation being installed by artists in very public places is an interest-generation device that RK&M can look towards for inspiration. By examining how encounter occurs in public spaces and how/when/if documentation plays a role in diminishing or increasing exposure and/or interest, recommendations for art documents and the radioactive art itself can be shored up.

A glaring problem posed by radioactive materials in art is one of safety.¹⁹¹ It is yet another balance that must be struck between proximal threat and spatially distal understanding. The mechanisms recommended in the RK&M Toolkit provide information to facilitate understanding from different degrees of proximity. The closer one gets to the danger, the deeper and more detailed the explanation and information becomes. What these do not provide is an *experience* of the point of interest. They are explanatory, but explanation does not exhaust the qualities of the object.¹⁹² Nevertheless, they are necessary and ethically right to put in place.

Radioactive art poses a similar problem. It must have explanations and warnings in place *because* the danger is now physically accessible but visually withdrawn. Without such warnings, the threat may not be perceivable. What is needed then, is a warning about the

¹⁹⁰ Joyce, *The Future of Nuclear Waste*, p. 215.

¹⁹¹ In my interview with Mari Keto about *Inheritance* in November 2022, she jokingly told me that some of the radioactive stones she had been using for her work were still sat on her desk and that she 'should probably do something about that.' Mari Keto, Interview with the author, 16 Nov 2022.

¹⁹² A condition Graham Harman would describe as 'duomining;' simultaneously reducing the GDF to its constituent parts as a series of safety barriers whilst also providing exhaustive information about the GDF, yet still failing to grant an experiential encounter with the withdrawn repository. Graham Harman, 'Undermining, Overmining, and Duomining: A Critique', in *ADD Metaphysics*, ed. by Jenna Sutela (Finland: Aalto University Design Research Laboratory, 2013).

warning if the purpose of radioactive art is to serve as an experience of what is concealed within a GDF. This warning about a warning may seem nonsensical and superfluous but directly mirrors the proximally increasing level of detail that the RK&M report advocates for – simply with the addition of an accessible radioactive material. Providing access to a (relatively) small sample of it on the surface may help prevent human interference with the massive stockpiles deep in the ground. In other words, a small amount of exposure and risk may provide the experience that is lacking with purely informative markers that the RK&M report prescribes. For this to be an effective and informative deterrent, supporting documents and mediators must draw attention to the presence of a radioactive art marker, or in other words, warnings about the warning.

Robert Smithson provides us with a suitable terminology for the function of a thing that stands in for another difficult to access thing. In his short, one-page theoretical musing from 1968 titled *A Provisional Theory of Non-Sites*, Smithson outlines how the ‘non-site’ is the contracted, abbreviated, perhaps even metaphorical representation of the site.¹⁹³ The site is inaccessible (or hard to access), while the non-site is the opposite. For Smithson, the non-site provides a contraction of time and space to such a degree that one can be transported to the site by means of what one might call a ‘non-trip.’¹⁹⁴ The non-site need not be representative, nor literal, but is free to be evocative. As such, I find this term has simultaneously broader applications to identify things that point to other things, whilst being more specific about how those things do the job of pointing. Whether or not the non-site has the power to contract time is questionable, but I am quite convinced of its ability to contract space and provide access in many different formats save for the physical and tangible (although there may be scope for these to be included as well).¹⁹⁵ The non-site goes beyond ‘documentation’ of a site. It can aid in defining the mechanisms of alerting percipients and viewers to the presence – either here or elsewhere – of radioactive dangers found in radioactive art. The non-site can provide an alert to immediate and present dangers, observable in *Inheritance*, and its provision of autoradiographs to visualise the imperceptible danger. Or the non-site can provide information about dangers that are in decay safely elsewhere so that they can be accessed in the future, as with *Black Square*. The wall text at the Garage museum, and – as noted by Simon herself – her engagement with others to discuss the piece and create written transcripts of interviews that can be accessed by wider communities contributes to the knowledge of the withdrawn radioactive cube. In

¹⁹³ Flam, ‘Collected Writings’, p. 364.

¹⁹⁴ Flam, ‘Collected Writings’, p. 364.

¹⁹⁵ It is important to differentiate the historicity of the non-site from, say, history writing. History writing, by definition, contracts time. The non-site is not a historical referent. It co-exists with its referent in the same time. It therefore does not contract time in the same way as history writing.

the case of *Black Square XVII*, the non-site may also evoke the withdrawn characteristics of GDFs and radioactive art. In absentia, we are left to visualise the physical and temporal qualities of the cube that exists elsewhere.

The implied contraction of space is perhaps the most useful aspect of Smithson's theory. In relation to his works of land art, notably *Spiral Jetty* (1970), approaching the work was intentionally difficult, but not impossible. This is evocative of the nuclear waste industries: difficult to access, but not impossible, hence the requirement to alert people to the dangers of what they may discover, intentionally or otherwise. His theory stemmed from this need to point to something (a site) that *could* be accessed if one really tried but ultimately could be understood or evoked through other means (a non-site or non-sites). Non-sites provide us with a way of understanding the function and contents of a GDF that is concealed and withdrawn; they also help in understanding that a radioactive artwork is present but dangerous.

The role of documents and non-sites is therefore very important. It is a complex role that must both warn and inform anyone of their potential encounter with radioactive material. This is further complicated by proximity. A non-site that exists nearby to a radiation source is likely to be more effective at warning but also puts the visitor at greater risk of proximal danger. A non-site that exists far away from a radiation source is more available to broader modes of access (it can be situated in a library, public square etc.) but does little to minimise danger where it matters. This problem is addressed in the RK&M report by the recommendation for increasingly more detailed information the closer one gets to the source.¹⁹⁶ No single marker is reliable; multiple markers address redundancy, damage, loss, and the potential for more distal markers to be missed. So, unsurprisingly, we begin to find the same problems faced by nuclear semiotics and RWM in the applications for a radioactive art marker. Multiple modes of communication and knowledge transfer are not only necessary on a practical level but on an ethical level also.

Following the 2011 meltdown event at the Fukushima Daiichi nuclear power plant an exclusion zone was put in place.¹⁹⁷ The exclusion zone is lesser known as the 'difficult to return to zone,' implying that it will one day be inhabitable.¹⁹⁸ The Japanese artist

¹⁹⁶ The RK&M report states, 'taking into account the different timescales and different potential audiences, it is recommended to develop information ranging from basic to details, from generic to expert and front contextual information to exact data.' Nuclear Energy Agency, 'Preservation of RK&M', p. 53.

¹⁹⁷ The Fukushima meltdown was rated by the International Nuclear and Radiological Event Scale (INES) as a level 7 event, the most severe level of the scale.

¹⁹⁸ There is a disdain towards this nomenclature that views it more as a public relations strategy than any promise of effective remedial work to allow return. It minimises the damaging effects of the nuclear power plant disaster.

collective Chim↑Pom devised and installed a long-term art exhibition within the exclusion zone titled *Don't Follow the Wind* (fig. 3.1).¹⁹⁹ The exhibition makes use of internal and external spaces in both domestic and commercial buildings and land. Despite being open 24 hours a day, the exhibition is closed to the public until the exclusion is lifted and it is deemed safe to return to by officials. As the 'cleanup' continues and radiation levels remain high, the timeline for how long the exclusion zone will be in place is unclear.²⁰⁰ However, the predominant contaminant in the zone is caesium-137 (the same material used in one of Robert Barry's pieces) which has a half-life of around 30 years. This half-life suggests that the reopening of the zone may be on a generational timescale as opposed to centuries or millennia.²⁰¹ Until access restrictions to the exhibition site are lifted, public access to the art is by satellite gallery exhibitions dubbed 'Non-Visitor Centres' (NVC) where many of the artists produced works that reference the main work in the exclusion zone. These NVCs were travelling exhibitions that referenced the inaccessible exhibition without directly reproducing the objects and interventions that exist within the exclusion zone. They allowed people to 'visit' the exhibition without having to enter the restricted, contaminated space. Fittingly, the NVC was deliberately obtuse in its presentation and representation of the artworks in the exclusion zone, mirroring their inaccessibility. In this way, the satellite exhibitions acted as non-sites, providing non-trips.

The main exhibition is also accessible online through images and texts, a mode of access which became the standard for pandemic-era art. However, there is a significant disparity between viewing an exhibition online and experiencing it in person in the presence of radioactive contamination. An experience that evoked not only the withdrawn, concealed contaminated exhibition space, but the alleged obscuring and manipulation of information by TEPCO was manifested in the non-site NVC. The artists sealed off the main gallery entrance with concrete blocks and erected a reportedly flimsy platform to a viewing window. The view of the gallery through the window was partially obscured and the only information about the works on display was via rumour and oral history 'in the form of a spoken audio guide blended with recordings of each site in the zone.'²⁰²

The axis of concealment of danger and human intrigue provides a fulcrum on which radioactive art mechanisms may function. The balance of this dichotomy presents the opportunity for leveraging human behaviours which will be explored further in the next

¹⁹⁹ The artist collective was able to install this exhibition through a combination of collaborations: working with evacuees who were permitted limited access to their homes and by using residents' permits.

²⁰⁰ The group frequently refer to the remedial works by TEPCO and the Japanese government with sceptical scare quotes.

²⁰¹ Nikolaus Hirsch and Jason Waite, 'Don't Follow the Wind', (Berlin: Sternberg Press, 2021), (p. 37).

²⁰² Hirsch and Waite, 'Don't Follow the Wind', p. 136.

chapter (pilgrimage, myth-making, and folklore, for example). That said, we must first examine how this dichotomy functions in more detail, and the spatial effects that it creates. Whilst this chapter is primarily spatial in focus, it is predicated by a number of assumed human responses and reactions to such spatial phenomena. To do this, I would like to reframe the language of concealment and withdrawal with a new term that I feel will guide the rest of this thesis much more clearly. We will come to this in just a moment.



FIG 3.1. Trevor Paglen, *Trinity Cube*, 2015-, irradiated glass from Fukushima Exclusion Zone, Trinitite, 7 7/8 x 7 7/8 x 7 7/8 in. Installation view at the *Don't Follow the Wind* exhibition.

Non-sites provide an ersatz, safe way to ‘experience’ otherwise dangerous locations. They are also important for the protection of delicate and fragile ecologies and environments of special interest to the public. An example of this is the Chauvet cave in France – a cave discovered in 1994 containing important prehistoric art, thought to be the oldest example of cave paintings by far. To protect the paintings, the cave was closed to all but a handful of researchers per year to limit foreign contaminants that may lead to a change in the delicate atmosphere of the cave and help prevent the possibility of mould growth that could damage the paintings. A facsimile cave was built less than a mile away and opened in 2015 that provided a near perfect reproduction of the original.²⁰³ The original was mapped using laser scanning technology capable of producing an extremely accurate replica. The tourist non-site, known as Chauvet 2, is so accurate that one may feel as if they have experienced the

²⁰³ As was also the case for the earlier discovery of the nearby Lascaux cave.

original. This level of simulation is useful for these kinds of research purposes but is uncommon in art non-sites. One cannot say they have experienced the original site no matter how accurate the simulation, but it can offer the proximal contact one may desire. Most severely lacking is indexicality. There is an enormous disparity between a cave where ancestors from tens of thousands of years stood and painted on the walls, and one that was 3D printed just 10 years ago. Simulations are good for maintaining safety but are lacking in authentic experience. This is a clear problem for the radioactive experience which is withheld by non-sites. Crucially, non-sites lack the proximal threat of radioactive materials that evoke the nuclear sublime (whether real or simply perceived). The withdrawal of radiological experience is both a function of the non-site, keeping viewers safe, but also a draw to the true radiological experience at the site.

Exposure is the point of ethical contention for a radioactive art marker and goes against the purpose of a GDF. The goal of a GDF is to minimise or prevent exposure. A separation of radioactive art marker and its non-site therefore becomes necessary on these ethical grounds. It seems then that we have ended in an endless loop of concealed radiological threat and its signifiers. There is, however, an important difference between the sealed GDF and the concealed radioactive art marker. The GDF is wholly inaccessible, whereas, just as with Robert Smithson's *Spiral Jetty*, a radiological art marker is withdrawn and hard to access but not impossible. Contamination of broadly inhabited spaces is mitigated against by the placement of toxic industries in far away or suitably removed places (just as with a GDF). These places can, however, remain accessible to the public and available to be experienced.²⁰⁴ To ethically justify a radioactive art marker, it must be away from populated areas. A likely siting would be with, or in close proximity to a GDF – also located distally from inhabited spaces. A non-site to the artwork could, and should, exist in an easily accessible location. It should alert the viewer in advance of coming into contact with any radioactive materials, so it should also be suitably close to the radioactive art marker. That said, we should not rely on a single non-site and instead should turn to either multiple non-sites or one that benefits from encouraging labour to produce more. This is a heavy burden on the non-site. It should provide all the necessary information for encouraging both experience and radiophobia – balancing distance with proximity, and concealment with intrigue.²⁰⁵ This is where art modes rooted in conceptualism and post-conceptualism may have benefits over more conventionally visual modes, by addressing the mind rather than the eyes. The mind of the perceiver affords us more resources than visual methods are capable of

²⁰⁴ Disused quarries, for example, are rarely wholly inaccessible and pose significant risk to health through water contaminated with heavy metals, toxic algae, and bacteria.

²⁰⁵ Radiophobia: the fear of radiation exposure, typically of ionising radiation.

realising at any given moment in time.²⁰⁶ The mind of the perceiver remains current to their culture and their era. Visual and language-based modes of communication are forever anchored to their moment of inception. As such, a conceptual non-site, just as with a post-conceptual radioactive art marker offers a more adaptable communication method than visual approaches can. Whilst this frees the non-site to be more formless, its ethical function is clear: it must mitigate and also translate the risk of radiological exposure that is to be found at its corresponding site.

The Away

As the remit, parameters, and limitations of a radiological art marker are beginning to take shape – particularly in the context of where that art marker should be located – we encounter another tired problem in the nuclear industry for which there is no knowable solution: how to distance people from radiation exposure.²⁰⁷ Non-sites are a suitable stepping stone in the realm of encounter of radioactive spaces. They provide *some* experience, without revealing all. For some, this withdrawn experience may not be enough. Non-sites may encourage interested parties to seek out the *full* experience – in other words, the radioactive component of the artwork – through acts of intentional discovery and pilgrimage. Whilst ‘site’ defines the radioactive component, it is not a robust enough term to describe the location, the spatial context and qualities, and the reasoning for withdrawal and concealment. To further my reasoning for the use of Robert Smithson’s terminologies, a new term is needed that in many respects expands on his corresponding term, the ‘non-trip.’ For me, ‘away’ is a term that offers a framework for developing arguments around spatial placement and separation of object and document, both for ethical reasons and to aid in discovery and interest propagation.

Rob Nixon briefly uses the term ‘away’ to differentiate between the positive leisurely connotation of the word, as in a holiday, to seek respite, to relax; and the negative connotation of the word, as in to flee, or to escape, ‘depending on whether leisure or terror is the propulsive force.’²⁰⁸ Timothy Morton uses ‘away’ to suggest there is no such thing as

²⁰⁶ It is acknowledged that conceptual art also typically employs visual elements. The distinction between (post-) conceptualism and conventionally visual modes is the shift of occularcentrism towards non-occularecentric methodologies.

²⁰⁷ For clarity, whilst there are significant overlaps, how to warn and inform people of a radiological hazard in the future is a different problem from how to distance and deter people from intrusion. The former often leaning towards semiotic and language solutions, the latter more to physical deterrent features such as berms and prohibitive structures.

²⁰⁸ Nixon, *Slow Violence*, p. 195.

‘away’ where *hyperobjects* are concerned, particularly with radioactive dust. Once the dust has been created by humankind, it will remain present for far longer than our present civilisations and will even outlast our species. Clean-up operations after nuclear disasters do not get rid of the radiation, they simply redistribute it to other locations, often in the vicinity of those of lower social standing.²⁰⁹ For Morton, there is no ‘away,’ just redistribution. Robert Jacobs echoes this: ‘we pretend there are places on this planet that can be separated from everywhere else.’²¹⁰ Many kinds of radioactive waste have such a damaging effect on our planet that they cannot be hidden away, just gathered to make a super-toxic region which should then be considered as ‘away’ even if we are simply kidding ourselves that the problem has been removed. The RK&M Final Report speculates possible futures and raises the concern: ‘places once considered to be “far away” may become exploited when communities and industries evolve and grow.’²¹¹ However, the report fails to address the politics of ‘far away’. The reminder that ‘away’ is simply redistribution exposes the ethical and geopolitical injustice that Nixon describes. ‘Away’ simply displaces environmental risk, burdening marginalised peoples or low-income populations whose lands and territories are deemed politically and economically expendable whilst privileging the elite. The ‘away’ in nuclear industries cannot, and must not, be seen as a product of RWM. It is not a neutral space but a product of socio-environmental inequality.²¹²

As the RK&M Final Report states, ‘away’ may not be a permanent feature of a place that is identified as being distant from other places. A place that is considered ‘away’ now, has potential to become local again, particularly if hazardous materials are not clearly marked so as to keep people in their own pre-existing ‘away’ – in other words, the zone of safety that is outside of, or ‘away’ from a zone of threat. For RK&M and RWM, ‘away’ is to separate and to make safe (safety is a problematic word, particularly over millennia, but that is not a primary focus of this thesis.) Between Morton and the RK&M report, there is a sense of *the away* not being that far away, and that in the future, *the away* could very well be *here* for communities yet to be formed. Nixon’s use similarly focuses on people and communities entangled with politics of forced relocation, dehumanisation, and colonial fallout.

My concept of *the away* is more tied with place than it is people. *The away* is a place; it is a noun, not an adverb. It is a place where things can be forgotten or all-but-forgotten, most

²⁰⁹ Morton, *Hyperobjects*, pp. 20, 115, 120.

²¹⁰ Jacobs, *Nuclear Bodies*, p. 16.

²¹¹ Nuclear Energy Agency, ‘Preservation of RK&M’, p. 36.

²¹² There is limited scope in this thesis to address both nuclear semiotics to the desired extent, and the sociopolitical considerations and ethical implications of GDF siting. GDF siting is a separate discipline, and this thesis presumes that nuclear semiotic strategies follow GDF siting choices. As such, nuclear semiotic strategies are constrained by the natural flow of decision making – that is not to say that this flow should not be challenged by other researchers and policy makers.

likely due to its distance from presently inhabited places, or its location in a place seldom visited. *The away* may be a hard-to-reach mesa in the middle of a desert, or in domestic settings, it may be an attic used for storage. It may be that it is in a place physically close to us, but out of reach or out of view; sewers and electricity substations for example. *The away* is not always synonymous with remoteness, although this is often a characteristic. Instead, it may be that the place is somewhere we would rarely encounter, even in an urban environment, underground being an obvious example where something may be in relatively close proximity, but invisible and most likely hard to find. *The away* may be a place of concealment and seclusion, of limited or restricted access: bunkers, airport runways, military installations, bank vaults. It may be that *the away* is a guarded place, relatively close-by but inaccessible because political, or governmental powers prevent our approach. *The away* may reveal societal powers (or our lack thereof) to access something.

The away may also be characterised by its ability to provide a sense of the sublime, its incomprehensible vastness in size, human endeavour or ingenuity, and expansion into deep-time creating a sense of awe. Situating something in *the away* may be because it is so large, or its field of influence expands beyond its boundaries. It may relate to a hazardous industry that must distance itself from communities to reduce risk in the event of accident or incident. *The away* may well be a place of interest through its novelty, as much as this is an undesirable quality in RWM.

It is important to differentiate *the away* from 'elsewhere'. Elsewhere does not have the same implications of removal from access as *the away*. Elsewhere has connotations of 'anywhere but here,' whereas *the away* is very specific in its choice of location. It is considered, measured, and a place of permanence. It may be a place that has turned a banal location into a novel location. In RWM, *the away* is very much in the negative sense of the word, if considering Nixon's binary example. It may be an inhospitable or a poorly resourced place. The conditions may be hostile to human inhabitation but this is an attractive quality for storing objects that we wish to remove from human access as much as possible.

The objects of removal need not be hostile though. The Svalbard Global Seed Vault is a cold storage facility on the remote island of Svalbard in the Arctic Circle. The contents of the vault anticipate the devastation of global crop diseases, ravaged lands and the extinction of flora. Whilst the vault is brutal and forbidding in its external appearance (fig. 3.2), the contents are for the good and future use of humanity to rectify our present-day and near-future hubristic activities. The Seed Vault is a place of safety for objects we currently value and anticipate our descendants will do the same. Conversely, *the away* is a very suitable place to put

undesirable things and things of no use. It is highly likely that *the away* is a specific place for a specific thing: sewage, seeds, radioactive waste; its location chosen for its ability to adequately support, separate and/or keep safe the objects of note. In RWM, that place is a suitable place to await the transmutation of radioactive waste; in a domestic context, it is a suitable place to store rarely used items or objects, like the attic. In RWM, it is an allegorical place, where our dishonourable acts serve as warnings to the future, but this allegory may be what induces mostly unwanted interest in a dangerous site. This is not to say that *the away* is a negative place in every context as Nixon identifies. *The away* can be a place of safe keeping as we see in the Seed Vault, and in Berger and Keto's *Inheritance*. *The away* may be a place we attempt to visit, perhaps on a regular basis – like retrieving the Christmas tree from the attic every winter.



FIG 3.2. External view of the Svalbard Global Seed Vault.

The away offers a new term for discussing how the hostility and threat of an object (or concept) that has been mostly removed from access can instead serve as a draw. Paradoxically, it is the difficulty associated with its withdrawal that contributes to its desirability; scarcity and access challenges making it more enticing. Withdrawal contributes to the minimisation of potential exposure to a harmful object or substance, but for our purposes, it must not be *totally* withdrawn. It must allow for a limited degree of experience of what the radiological contamination beneath the surface is, and what it feels like to be in its presence (if only experienced conceptually). In the same way *Spiral Jetty* is withdrawn

but still accessible to those that are most determined, a radioactive art marker must also be withdrawn but provide the experience needed to convey the message of danger in the most meaningful and blunt way that Sullivan described in the previous chapter.

So, let us imagine some of the qualities and functions of our hypothetical GDF art marker so far. We shall assume it has a withdrawn radioactive component, likely in close proximity to the GDF. It exists in *the away* as an object that provides an experience of the radioactivity stored below ground. As part of this experience of *the away*, one may encounter the nuclear sublime. There are a number of definitions of the sublime, which warrant a brief overview here. In the Burkean sense, it is the pleasurable experience found in displeasure, pain, and terror. However, Kantian reasoning is more appropriate for the discussion of nuclear aesthetics. Kant distinguishes between the *mathematical* sublime and the *dynamical* sublime. The former describes the incomprehensible vastness of radioactivity, similar to the hyperobject. The latter describes the overwhelming power or threat of something. The imperceptibility of radiation by human senses lends itself to both of Kant's concepts. The *mathematical* definition defines the hyperobjectivity of radiation, dealing specifically with the broad spatial reach of radioactivity. We can define toxic drift within the *mathematical* sublime – where the influence of radioactivity on the environment penetrates deeply into organisms but spreads broadly and indiscriminately. We are unlikely to be able to grasp the full effect of radioactive contamination from subatomic particles to cancers. In the context of a GDF, we may find the industrial scale of waste storage or the vast quantities of radioactive waste to be hard to fathom. Similarly, the *dynamical* sublime describes the uncomprehensible power of the radioactivity stored inside a GDF, and how lethal it may be to fully encounter it. The invisible threat formed by spatial reach and violent power, in Kantian reasoning, necessitates we must distance ourselves from the threat in order to safely reflect on it.

Graham Harman offers this critique: 'we cannot experience [absolute power] if [it] is one that currently threatens us; in that case our attention is swallowed up by our terrified interest in personal safety, leaving no room for sublimity at all.' He continues, 'from the moment we take something to be a serious threat, we have left the realm of the sublime. Just as beauty must exclude all personal interest, the sublime must exclude all personal fear.'²¹³

Here we run into the issues of Wolfgang Ernst's proposal for radiation to aestheticise itself. If warnings are to be put in place, surely, they would overcome any sublime experience and reduce the likelihood of repeated visits. Nuclear tourism is the obvious spanner in the works

²¹³ Graham Harman, *Art and objects*, (Cambridge; Medford: Polity, 2020), p. 42.

of this theory. People will flock to disasters, including nuclear disasters, for the experience. Admittedly, the *immediate* danger of a meltdown provokes flight *away* from the disaster, but even with elevated levels of radiation post-disaster (such that an exclusion zone remains in place to prevent habitation or lingering visitation), people will still overcome a sense of danger to experience the sublime of disaster. In Frances Ferguson's 1984 essay titled, 'The Nuclear Sublime,' she reminds us that 'the trick with the sublime, of course, is that we live to tell the tale of our encounters with it.'²¹⁴ With the relatively low exposure to radiation from the selected artworks, we do not fear death, but we can have a subjective experience of what it means, or what it feels like (if anything) to be in the presence of radiation.²¹⁵ What it feels like may simply be fear, hence the sublime, but we can anticipate the relative safety of short-term exposure allowing us to experience the nuclear sublime.

For Ferguson in the 1980s, nuclearity is experienced more bureaucratically making it difficult to imagine the conditions of post-nuclear attack. Cold War tensions are the framing device for her concept of the Nuclear Sublime. However, whilst post-Cold War nuclear tensions have since eased and risen again, our focus is less on nuclear warfare, and more on radioactive waste storage.²¹⁶ The concept of living in the shadow of a nuclear blast is much more unfathomable than imagining nuclear waste buried far away. And yet, our experience is still muddled by bureaucracy. Policy and barriers keep any experience we may have entrenched in technopolitics, not the imaginings of the embodied invasion by radioactive particles.

Jacques Derrida, writing at the same time as Ferguson described our experience of nuclearity as 'fabulously textual.' He writes:

Nuclear weaponry depends, more than any weaponry in the past, it seems, upon structures of information and communication, structures of language, including non-vocalisable language, structures of codes and graphic decoding. But the phenomenon is fabulously textual also to the extent that, for the moment, a nuclear war has not taken place: one can only talk and write about it.²¹⁷

The same can be said for nuclear waste. It is a policy-led industry, heavily regulated, and difficult to understand its many working parts and parameters. But this is peculiar only to us, in our timeline, and for the next couple of hundred years or so whilst we continue to

²¹⁴ Frances Ferguson, 'The Nuclear Sublime', *Diacritics*, 14 (1984), p. 6.

²¹⁵ Radiophobia being as much a 'feeling' when one is told that they are in the presence of radioactive materials.

²¹⁶ Although the conditions of post-nuclear attack are likely to come back to the forefront of our minds in the coming years as a result of recent nuclear sabre rattling.

²¹⁷ Jacques Derrida, Catherine Porter, and Philip Lewis, 'No Apocalypse, Not Now (Full Speed Ahead, Seven Missiles, Seven Missives)', *Diacritics*, 14 (1984), p. 23.

operate nuclear power stations and then into their decommissioning phase.²¹⁸ This technobureaucracy will be long gone for our descendants who are faced with a buried radioactive legacy. Their nuclear experience cannot be political. It *must* be experiential. It must be present and viscous. The nuclear sublime must become more visceral and hinge more on the *dynamical* sublime if it is to be an effective agent in repulsion. The type of encounter afforded by our imagined radioactive art marker must therefore also be visceral. Yet it must remain balanced in order to remain informative and not entirely repulsive – after all, we still need to maintain a degree of interest in a GDF to prevent a total loss of knowledge. The immediate encounter must not get bogged down in the technobureaucratic language of microcuries, dosages and half-lives. Many of these measurements are likely to be lost to the annals of the past. Yet it must also work harmoniously with its non-site to fully divulge the imperceptible experience. Radiophobia cannot be experienced without mediation, whether they be documents, non-sites or cancers. Evoking the nuclear sublime via a radioactive art marker encounter therefore relies on a combination of ‘just enough’ information and the visceral presence of what is being described.

In his article on art in exclusion zones, Sven Lütticken identifies Taryn Simon’s *Black Square XVII* and Trevor Paglen’s *Trinity Cube* – two visually similar pieces that both utilise the same technology of vitrification to produce the work – as both exuding the techno-sublime.²¹⁹ In the future, a GDF will represent a high degree of human ingenuity and a level of embracement of technology to the detriment of nature, ecology, and the environment; also of future inhabitants of the Earth. A GDF exemplifies the hubris of the Global North, extractivism in the Global South, and capitalist gain through technological advancement. If a warning or marker to the future should also warn against the folly of present-day humankind, the techno-sublime would be a suitable device to incorporate.²²⁰ The techno-sublime may also aid in alluding to a GDF not being a site of extractive industries but of waste deposition through the presentation of ‘spent’ nuclear fuel in its vitrified form, as opposed to raw forms of fuel ore. In other words, *this is a dump, not a mine*.

There is certainly a crossover between the nuclear sublime and the techno-sublime where opportunities for the function of an art marker may be observed. A GDF exemplifies both the monumental scale of human ingenuity but also the end of the usefulness of the power we created such that it must be buried and contained. It represents both the apotheosis and the

²¹⁸ The decommissioning phase of a nuclear power plant can last up to 100 years when including the final cleanup phase after allowing for radioactive decay.

²¹⁹ Hirsch and Waite, ‘Don’t Follow the Wind’, pp. 110–111.

²²⁰ The RK&M report does not specifically task the Art mechanism with conveying any specific messages but it is within the remit of the mode of communication.

humility of the atomic age. This great power is what makes it dangerous. Whilst a GDF alone exudes the techno-sublime, it cannot fully convey the nuclear sublime whilst simultaneously concealing and withdrawing its harmful contents from access. It is for this reason that the nuclear sublime must be released from the confines of the GDF in order to more fully provide a sublime experience for anyone who should encounter it.

Anna Volkmar, a researcher in the field of nuclear aesthetics, states that the wider ‘nuclear condition’ (or ‘nuclearity’ as I have been referring to it) oscillates between the uncanny and sublime, the shockingly close and the mightily distant.²²¹ Our experience of nuclearity is the fear of radioactive particles and waves entering and altering our bodies, perhaps shortening our lives by being in their presence, but also the concept that for many of us, nuclearity occurs elsewhere (as in, anywhere but here). We do not knowingly encounter it, and when we do, it is likely that we are unaware of it. This oscillation of the nuclear sublime is a reminder that a balance must be struck between closeness and distance when marking a GDF. *The away* provides the safety we need in order to experience the sublime and so that we can contemplate the GDF and its contents effectively. However, *the away* can only be so unreachable until it falls into unknowingness, yet it can only be so close until the fear produced by its danger expunges the sublime experience. A harmonious balance must be struck between the disinterested observance of the techno-sublime and the visceral presence and repulsive power of the nuclear sublime which arguably must collapse into fear if it is to be an effective deterrent. *Inheritance* is emblematic of this closeness due to its domestic setting. It acts as an omnipotent reminder to care for it, and by not doing so, it equally acts as a memento mori. *Black Square XVII* on the other hand, challenges our memory by engaging only with institutions, making it ‘mightily distant.’

To finally return to the *Don't Follow the Wind* exhibition inside the Fukushima exclusion zone, we see elements of the techno-sublime and the nuclear sublime, wrapped in an environment that oscillates between push and pull, closeness and distance, intrigue and fear. The artworks themselves are being irradiated by their contaminated siting. Many of the artworks are situated outdoors or otherwise exposed to the elements. In a conversation amongst the exhibition’s curatorial collective, Eva and Franco Mattes stated:

Many of [the artworks] had been absorbed into the context through their experience of the elements over time, and there seems to be more of a material symbiosis now between the artworks and the surroundings. Maybe this is even more striking if we consider these are art objects that are usually deemed to be preserved while here they

²²¹ Volkmar, ‘Why We Need Nuclear Art’.

have the same fate as the sites that host them, being it abandonment, demolition, reconstruction.²²²

Jason Waite adds, ‘as the works became absorbed into the sites through their gathering of dust, contamination, and traces of time, some of the works hit a tipping point and were decomposing faster than the general rate of entropy on the sites.’²²³ A sense of urgency is created that contrasts the long waiting period required to see the exhibition on account of the restrictions on entering the zone. The oscillation between push and pull maintains interest and anticipation of something that cannot be approached or witnessed firsthand.

Eva and Franco Mattes draw our attention to what I would call *the away* by purporting that the exclusion zone is not a safe place for the artworks and that they are at risk from contamination factors, and remedial actions. The placement of art in a dangerous place seems at odds with our current notions of value, both financial and cultural.²²⁴ This is a provocative action in itself, something that could be deemed controversial. Exposure is therefore very much an actant in the exhibition. It is a pervasive threat to not only humans but to the artworks themselves, accumulating contamination as they do.

As representations of cultural and societal affect, *Don't Follow the Wind* instils a sense of responsibility and desire in the viewer/percipient to care for the artworks.²²⁵ The placement of the exhibition has warranted the use of the evocative Non-Visitor Centre satellite exhibitions. This accessible, touring exhibition was representative of the exhibition within the exclusion zone whilst remaining deliberately obfuscating. The NVCs provided contracted, frustrating and perilous glimpses of referential non-sites which work more as talking points than they do art objects. They are the locus of oral transfer and are the primary mediator for *Don't Follow the Wind*. A sense of authenticity is produced by using displaced Fukushima residents as gallery invigilators who would provide accounts of their direct experience and share rumours with gallery visitors. These accounts would relate not only to the obscured objects in the NVC but the artworks inside the exclusion zone, also. Where ongoing maintenance of the artworks in the exclusion zone is hindered and limited to periodic visits by a select number of people due to the zone's restrictions, oral transfer of information becomes more important than material care. If artworks fall into disrepair, as Waite has

²²² Hirsch and Waite, ‘Don't Follow the Wind’, p. 43.

²²³ Hirsch and Waite, ‘Don't Follow the Wind’, p. 44.

²²⁴ Both of which are often driven by the currency of institutional validation – passing through museums and galleries ascribes cultural relevance and financial accrual for an artwork. Placement of art where it does not receive the protection of the institution and instead becomes more contaminated and more decomposed as Waite stated, is at odds with our present day understanding of how art accrues value.

²²⁵ Of course, the exclusion zone prevents anyone but the artist collective from doing so, emphasising the withdrawal of the artworks and exhibition.

reported, they can at least be transferred to communal memory. The authenticity of this information is magnified by the direct experience of the former residents that convey it. This relaying of direct experience contracts *the away* with a ‘non-trip.’

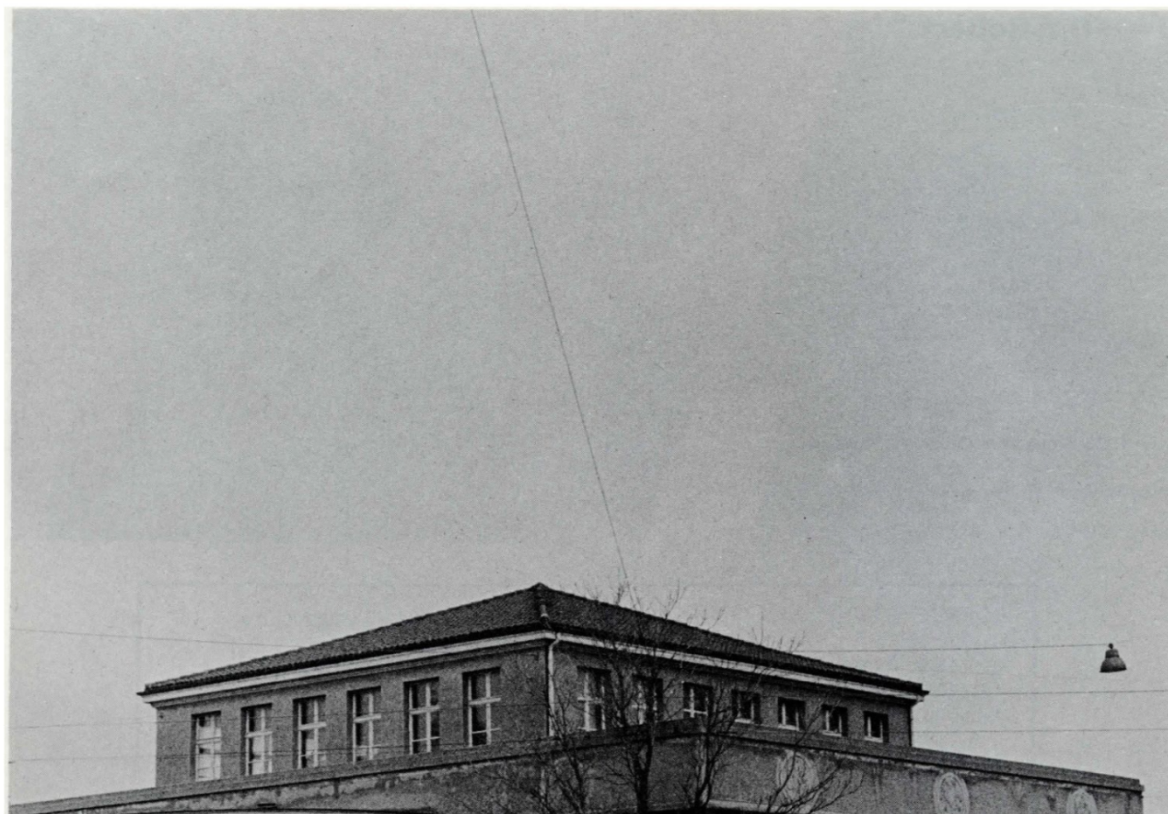
Imbued Spaces

If a ‘non-trip’ is produced by a non-site, then this has the effect of distancing the vast majority of people from the hazard – they no longer need to visit it, because they already have all the information. This leaves room for those that desire first-hand rather than second-hand experience, and those that wish to authenticate what they have been told. It is the toxicity of the Fukushima exclusion zone (and the legislative restrictions placed upon it) that limit visitation and prevent prolonged stays. This toxicity is an invisible blanket, an aura of toxicity, that not only covers the environment but emerges from within it. It is these qualities of fluidity, drift and emergence that make radiation seem confusing and unpredictable. We have already looked at radioactive objects in *Inheritance* and *Black Square XVII*, but now we turn to radioactive spaces. Toxically contaminated spaces differ significantly from contaminated objects in how they affect anyone in their presence. Where radiation comes from a single point of origin in *Black Square XVII*, *Inheritance*, and *Trinity Cube*, proximal threat is calculable, observable, and can be mitigated against. Contaminated spaces on the other hand present a broader, less definable zone of threat. They are less techno-sublime and more nuclear-sublime. They exude hyperobjectivity because one cannot define the limits of the contamination. Spaces cannot (or are very difficult to) be moved or removed. We can only separate ourselves from the contamination, not separating the contamination from us by moving it to *the away*. It is the difference between erecting shielding around a radioactive object (concrete, lead etc.) because the source is identifiable and wearing a radiation suit because the radioactive source is everywhere. In the former, the radioactive object is ‘the other,’ in the latter, we are. Radioactive spaces therefore offer a different mode of hostility to radioactive objects.

So we must consider this an alternative spatial use of radiation to that of radioactive objects. Radiophobia operates differently if we fear that we are already within the realm on contamination – inside the radioactive hyperobject. These spaces need not be contained either and can therefore function to create a zone of indiscriminate contamination rather than specific proximal threat. To explore this further, we will now look at Robert Barry’s *Uranyl Nitrate* ($UO_2(NO_3)_2$) (1969). To understand its balance of spatial withdrawal with

broad threat, I will discuss Barry's piece using Wesley Cray's concept of the *imbued artefact*.²²⁶

Robert Barry, *Uranyl Nitrate* ($\text{UO}_2(\text{NO}_3)_2$) (1969)



Robert Barry, Photograph of the roof of Kunsthalle Berne, being occupied by the radiation from «Uranyl Nitrate ($\text{UO}_2(\text{NO}_3)_2$)»

FIG 3.3. Robert Barry, *Uranyl Nitrate* ($\text{UO}_2(\text{NO}_3)_2$), 1969, uranyl nitrate powder, dimensions variable, Kunsthalle Bern, Switzerland.

Uranyl Nitrate consists of a radioactive powder disbursed into the roof space for the 1969 exhibition *Live In Your Head: When Attitudes Become Form* curated by Harald Szeemann at the Kunsthalle Bern.²²⁷ More broadly, according to a transportation insurance document, a 'chemical substance' was used, but the title of the artwork alludes to a radioactive salt that was commonly used in uranium glazes for pottery, such as Fiestaware between the 1930s and 1970s.²²⁸ Uranyl nitrate's primary use is in spent nuclear fuel reprocessing which leads to

²²⁶ Cray, 'Conceptual Art, Ideas, and Ontology'.

²²⁷ The area in which the deposit was made is sometimes referred to as the attic space, the roof space, or a space/room on the top floor, depending on who is writing about it. Reports are conflicting but it is assumed all spaces are one and the same.

²²⁸ Harald Szeemann, 'Transportart: Flugzeug New York (1)', (Kunsthalle Bern, 1969). ORAU Museum of Radiation and Radioactivity, 'Fiestaware (ca. 1930s)', (n.d.).

enriched uranium.²²⁹ It is a highly toxic solution that may be fatal if ingested or inhaled but relatively harmless with enough distance.²³⁰ Barry's deposited powder is neither observable nor detectable without the aid of instrumentation, and exists in a space that is out of bounds to the public.²³¹ In the exhibition catalogue, a photograph of the roof of the Kunsthalle taken from the street is captioned: 'Photograph of the roof of the Kunsthalle Berne, being occupied by the radiation from *Uranyl Nitrate* ($UO_2(NO_3)_2$).'²³² The word 'occupied' has connotations of filling the space, perhaps suggesting the piece has an imperceptible form beyond the powder itself. This speaks to the characteristic of radiation expanding out from its deposited point(s) of origin, being inescapable when sharing the same space.²³³

Wesley Cray's concept of the imbued artefact provides a framework for not only understanding where and how to locate this invisible (but energetically active) artwork, but also to understand and speculate upon its dynamic future. Following Cray, it would be reductive to state that the roof space is merely a container for the artwork but instead can be described as a space *imbued* with the imperceptible active threat of radiation. This radiation has (or may have) permeated the fabric of the building, irradiating and contaminating it as the narrative of toxic drift slowly unfolds as the building changes, is remodelled, re-used etc. This results in an uncertainty of the boundaries of threat for the percipient. It becomes atmospheric, an occupied zone with untraditional boundaries that we are unaccustomed to experiencing in traditional gallery installations. The radioactively *imbued* space is not static; it suffuses the gallery in unknown and unknowable ways without mediation. All of this occurs outside the register of perceptibility. There is no observable object that emits radiological threat – without signification we cannot know that the space has been contaminated with an imperceptible toxic powder. As such, the imbuelement is not directly correlated with perception. Without mediation or being told about the presence of the radiological intervention, the gallery visitor is unaware of the presence and danger posed by

²²⁹ American Chemical Society, 'Uranyl Nitrate', (2024).

²³⁰ U.S. Department of Energy, 'Safety Data Sheet Uranyl Nitrate Hexahydrate', (n.d.).

²³¹ The transportation document suggests that the 'chemical substance' was mailed from New York to Switzerland, such was the relative disregard for the hazards the material posed. It is likely that Barry had ordered the radioactive material from a mail-order scientific warehouse. According to Barry, this is how he obtained barium-133 for *0.5 Microcurie Radiation Installation* (1969). 'You got a little brown box through the mail with one of those yellow stickers and a red star on it, you know? But it was shipped by mail... And the only way you could tell it was anything was to put it up against a Geiger counter.' Judith Richards, 'Oral history interview with Robert Barry, 2010 May 14-15', *Smithsonian - Archives of American Art*, (2010). No concerns over special handling or protective measures appear to have been raised or documented. It is assumed that whomever was responsible for distributing the powder at the Kunsthalle on behalf of the artist, did so with little to no safety concerns.

²³² Harald Szeemann, 'Live in your head: When Attitudes Become Form. Works - Concepts - Processes - Situations - Information', ed. by Kunsthalle Bern (Bern: Kunsthalle Bern, 1969).

²³³ *Uranyl Nitrate* was shown in the *When Attitudes Become Form* exhibition tour in London and Krefeld, both in 1969. However, the deposition of the radioactive powder was seemingly not carried out at either of the touring shows. In 2019, *Uranyl Nitrate* was recommissioned by Swiss Institute, New York and supposedly included the deposition of a radioactive powder.

the contaminated and imbued space. A radiophobia is produced in the percipient only when they are told or read about the artwork in the catalogue. Without this additional literal work, some may argue that the work does not exist if it is imperceptible. The heavy lifting of the piece is done in the literal documentation – the title, the description, the photograph. Without these and save for the unlikely scenario someone were to spend a significant amount of time in the alleged presence of the radioactive powder, radiation's veil of imperceptibility yields no effect on the gallery visitor. It is withdrawn from register, which risks a withdrawal from knowledge and memory. We seem to be stuck in a cyclical loop. How can radiation be self-signifying in this instance? Mediation is key to alerting the gallery visitor to the presence and danger of the radiation. This leads us now to speak to the benefits of radioactive materials in conceptual art pieces, over purely dematerialised works.²³⁴

Ontologically speaking, Cray gives a great deal of autonomy to artworks – they are dynamic and can be located 'wherever anyone is having the relevant idea.'²³⁵ He further states that once an object has been imbued, so it shall remain, irrespective of whether it is remembered as such.²³⁶ This is important to the long-term, deep-time narrative of radioactive artworks. For Cray, once an artist has done additional work to establish radioactive materials as artworks, then irrespective of RK&M loss, they will remain imbued with meaning.

The ambiguity over whether Barry's radioactive powder was ever actually deposited still results in an imbued space. Spreading a rumour and creating mystique within the given space is enough to imbue it with imperceptible energy, even if only perceived. Whether the radioactive powder is present, was present, or was never present is somewhat irrelevant – the conceptual nature of the work has implied that the roof space is hazardous due to an unseeable harmful energy. The powder has a slow violence that is persistent whether it is truly there or if it was simply a rumour. Whether real or perceived, the violence occurs conceptually in the mind of the percipient. Its real, material violence is in the radiation emitted by the powder and the contamination of the space it occupies, or occupied.²³⁷ In other words, whether real or entirely conceptual, a slow violence is produced.²³⁸ Its positioning in *the away*, a difficult-to-access space, off-limits to gallery-goers promotes intrigue from a safe distance – the interplay of danger and distance creating a sublime effect.

²³⁴ Albeit no conceptual piece can be truly dematerialised without a literal mediator.

²³⁵ Cray, 'Conceptual Art, Ideas, and Ontology', p. 237.

²³⁶ Cray, 'Conceptual Art, Ideas, and Ontology', p. 240.

²³⁷ The distinction here between past and present is due to the renovation works at the Kunsthalle in 1988. Since those works, it has not been determined if the powder is still present.

²³⁸ A similar example of imperceptible slow violence that does not use radioactive material can be found in Tom Friedman's *Untitled (A Curse)*, (1992). A seemingly empty pedestal above which the viewer learns of the presence of a floating spherical space which Friedman had had cursed by a witch. It forces the viewer into an awareness of an invisible threat in a space, whether real or not.

No immediate threat to life is likely to be perceived, and so this withdrawal maintains intrigue rather than flight. The documentation of the work, copies of which are held on-site, promotes further intrigue, responses, and updates from other artists as we shall see in the next chapter. In this sense, Cray would argue that Barry did not add an *object* to the Kunsthalle, but instead he *imbued* the space with a new conceptual characteristic.²³⁹ The space was altered beyond any contamination caused by radioactive material. It is the perceived zone of imperceptible threat that further constitutes the artwork. Furthermore, it was Barry's choice of the roof space – a liminal, off-limits area – that hovered above the gallery itself that casts an air of contamination over the whole building.

So, what does *Uranyl Nitrate* tell us about the role of radioactive materials as self-signifiers of danger? In Cray's terms, the radioactive materials are the material presence that is crucial to the ontology of imbuelement. Even when *Uranyl Nitrate* is imperceptible, the supposed deposition of the powder is the locus of the piece. Here, in the roof space of the Kunsthalle, the imbuelement is the radiation that occupies the space. This is not a visual, aesthetic intervention. It is an imbuelement of the space with a material-ideational energy. The roof space, and by extension, the Kunsthalle become jointly the artefact; a space charged with the radiophobia-inducing energy to threaten and repel. Crucially, the *experience* is much broader than with the other art objects we have discussed thus far. Hyperobjectivity is much more at play with *Uranyl Nitrate*. However, to maintain the balance of attraction and repulsion, mediation is critical with imbued spaces. The lack of an object places greater responsibility on literal communication, simply to let the percipient know they have encountered the artwork. *Uranyl Nitrate* provides us with a unique example of radiological environmental intervention that also reveals the problems in conveying the imbuelement of the space without mediation that is shared with RK&M.

Encounter

Slow violence problematises encounter. With the unspectacular comes the imperceptible. How can we be aware that we have encountered something invisible if there are no immediate changes, responses or perceptions? As has now been established, radioactive art needs mediators: documents, signs (literal and figurative), wall texts, labels, warnings, photographs, maps, at least at the point of their inception or installation. All these modes of mediation – though not necessarily all together – draw our attention to something that we

²³⁹ Although Harman would argue that an idea or imbuelement are also objects. Here, with Cray's view, I simply draw the distinction between physical and conceptual.

cannot perceive. These non-sites are crucial to our experience and to our encounter with imperceptible works, let alone imperceptible hazards. In exactly the same way that GDFs need mediators and non-sites, so do radioactive art markers.

Conceptual art is uniquely placed in addressing the mode of encounter outside of aesthetics and the remit of the visual. Encounter for conceptual art is almost always through the non-site but then perceived and conceived in the mind of the viewer. The role and status of the document as either an art object in itself or simply a way to access the withdrawn object has been fiercely debated over the years. In 2019, Nathalie Zonnenberg published a case study analysis of conceptual art exhibitions from the late 1960s to the present day using the theoretical frameworks towards ‘the document’ by Lucy Lippard, Seth Siegelaub, and Boris Groys.²⁴⁰ Zonnenberg’s analysis provides a substantial basis for defining the limitations of the role of the document in scholarly debate which shall form the basis of the next section.

Lippard observed a move towards nothingness as an artform and a shift towards a focus on content and away from formalism. Lippard termed this ‘dematerialization.’²⁴¹ For Lippard, dematerialisation gave primacy to the concept or idea over the visibility or commodifiability of the art object. For Groys, the document referred to the art without being art itself, but as Zonnenberg observes, the documents ‘can be considered the only “originals” of conceptual artworks that museums or private collectors own.’²⁴² Groys’s views are important for considering any conceptual work that may serve as an analogue for informing the Art Mechanism. For Groys, it is the document that is *considered* the art, without being the art itself. Despite a somewhat anti-market agenda by the artists during the peak of the conceptual art era, documentation has still attracted financial value. This may work to its advantage in the desire to keep the document safe, but owners and/or custodians of the document are unlikely to update or make changes to the document *because* of its financial value, let alone wishing to make changes to the artist’s intent. The anti-market agenda adopted by many artists of the era, as Lippard regards, is a principle of the dematerialisation of the object. Siegelaub shared similar views about the document, stating that it was a record of the work, and not the work itself.²⁴³ In an interview with Ursula Meyer Siegelaub states:

²⁴⁰ Zonnenberg, *Conceptual Art in a Curatorial Perspective*.

²⁴¹ Lucy R. Lippard, *Six years: The dematerialization of the art object from 1966-1972: A cross-reference book of information on some esthetic boundaries : consisting of a bibliography into which are inserted a fragmented text, art works, documents, interviews, and symposia, arranged chronologically and focused on so-called conceptual or information or idea art with mentions of such vaguely designated areas as minimal, anti-form, systems, earth, of process art, occurring now in the Americas, Europe, England, Australia, and Asia (with occasional political overtones)*, (Berkeley: University of California Press, 2001), p. vii.

²⁴² Zonnenberg, *Conceptual Art in a Curatorial Perspective*, p. 21.

²⁴³ Martinetti, *Seth Siegelaub*, pp. 130, 467.

When art does not any longer depend on its physical presence, when it has become an abstraction, it is not distorted and not altered by its representation in books and catalogues. It becomes *primary* information while the reproduction of conventional art in books or catalogues is necessarily *secondary* information.²⁴⁴

By conveying concepts through a few sentences, the work is not distorted according to Siegelaub because the catalogue is the primary information that conveys the work.²⁴⁵ Art historian Jo Melvin writes of this shift towards conceptualism:

This departure from viewers' customary mode of encountering art got them to think about art's duration, portability, and circulation.²⁴⁶

The non-sites, mediators and documents of conceptual art facilitate new approaches to perception that had previously been absent from visual forms. Immaterial things suddenly became art. Where material and immaterial meet is the remit of Siegelaub's influence in the presentation of conceptual art through documentation, notably through the decommodification of art.

Together, the three theorists and critics present an argument for where the art does and does not exist, and what the document does and does not do, combined with an overt interrogation of the art market.²⁴⁷ Whilst the three viewpoints have their differences, there is a consensus towards the document being not-art, and instead that the document evidences the lack of the presence of the art, and in some respects, is a stand-in for the absent art. It is a point of access and the mode of encounter via which viewers experience the real art. The dichotomy of presence and absence is perhaps quite a useful way to frame the document in conceptual art. In conceptual art the viewer is often presented with a document, text, or otherwise language, to illustrate or conjure the absent artwork. The artwork may be present but is likely to be absent from view. It could be absent from perception until the document transforms the viewer into a percipient. The presence of the document shrinks the distance and scale of the absent work into a cognition that renders the hyperobject into perceptibility.

²⁴⁴ Ursula Meyer, 'Interview between Seth Siegelaub and Ursula Meyer: "When you become aware of something, it immediately becomes part of you"', in *Seth Siegelaub: Beyond Conceptual Art*, ed. by Coelewijn Martinetti (Amsterdam: Stedelijk Museum Amsterdam, 1969), pp. 190-193.

²⁴⁵ Lippard, *Six Years*, p. 125.

²⁴⁶ Jo Melvin, 'Seth Siegelaub and Studio International: Conceptual Art and Production', in *Seth Siegelaub: Beyond Conceptual Art*, ed. by Coelewijn Martinetti (Amsterdam: Stedelijk Museum Amsterdam, 2016), pp. 466-477 (p. 475).

²⁴⁷ There is certainly an element of Walter Benjamin-esque 'aura' to the document, and even a sense of a lack of authenticity where it is regarded as being not the real work. For Benjamin, the photograph or document withered the aura of the 'original' work. But conceptual art creates a paradox for the aura. Conceptual artists (e.g. Lawrence Weiner and Sol LeWitt) of the 1960s and 1970s presented instructions as the art. 'Finishing' the art by executing the instructions was not the art itself. Therefore, for Benjamin, the aura exists in the instructions. However, these instructions are reproducible and lack 'authenticity' as originals. Conceptual art therefore exists in a strange liminal zone of simultaneously having aura and lacking aura at the same time. Walter Benjamin, *The Work of Art in the Age of Mechanical Reproduction*, (London: Penguin Books, 2008).

The document may therefore be viewed as talismanic or a medium (in the spiritual sense), conjuring the invisible that exists around us. This may ascribe deeper reverence of the document by the viewer because of its ability to render perceptible the imperceptible. The document, however, is not a reification of the art concept. It does not objectify the concept, nor should it be perceived as the art as per Zonnenberg's findings.

The document, therefore, plays an exceptional role in encounter. It reveals work that has been done either outside of perception, or elsewhere in *the away*. Yet, whilst the document is evidence of withdrawal, I stray from this consensus that the document is simply a stand-in for what is absent. The talismanic abilities of the document reveal what was already present but existed on a different plane of sensory experience. Ontologically, the art, particularly imbued spaces, is persistent whether observed or not. Mediators provide the access to encounter the invisible artwork. Radioactivity and radioactive materials assert an active persistence that decentres anthropos. Their perpetually energetic ontological condition continues working and contaminating the space imperceptibly until documents, non-sites or other mediators direct our attention to it. Even if radioactive art is forgotten about, the ontology of radioactive art does not dissipate with the loss of knowledge. It continues to be art irrespective of our awareness of it.

However, Cray argues that contextual placement is integral to the act of imbuelement. It cements the idea as an object within its contextual surroundings. Context is constituted, for Cray, of material, history, provenance, placement etc. Extending this into the remit of encounter, we see that *where* we encounter an art object or imbued space is vital to our interpretation of it. Whilst *Uranyl Nitrate* existed within the (albeit untraditional) institutional expectations of the gallery, the same is not true for Barry's *0.5 Microcurie Radiation Installation* (1969). *Uranyl Nitrate* benefitted (and still benefits) from contextual placement. Gallery visitors arrive preconditioned to be receptive to the unexpected and to have challenged their ideas of what art is and can be. The benefits of context are why wall texts exist on entry, and not as epilogues on exit. The catalogue for *Live in Your Head: When Attitudes Become Form* was accessible to gallery visitors during the exhibition and provided the literal work required to direct their perception to the imperceptible. For *0.5 Microcurie Radiation Installation*, there is no such benefit.

Robert Barry, *0.5 Microcurie Radiation Installation* (1969)

Robert Barry's first 1969 piece was actioned as part of Seth Siegelau's experimental 'January Show' (*January 5-31, 1969*) in New York. Barry 'showed' eight works as part of the group exhibition with Douglas Huebler, Joseph Kosuth and Lawrence Weiner in which all artworks were difficult or impossible to perceive. The announcement card for the exhibition states that there were '0 objects' to be shown. Instead, the only tangible element was to be a catalogue listing the 32 works in the show, printed in an edition of 2000. Barry's other seven pieces consisted of monofilament and radio waves. *0.5 Microcurie* was the only radioactive piece. It is listed in the catalogue as follows:

*0.5 Microcurie Radiation Installation, January 5, 1969, Barium-133, Central Park, N. Y., 10 year duration (approximate). Collection: Private, N. Y.*²⁴⁸

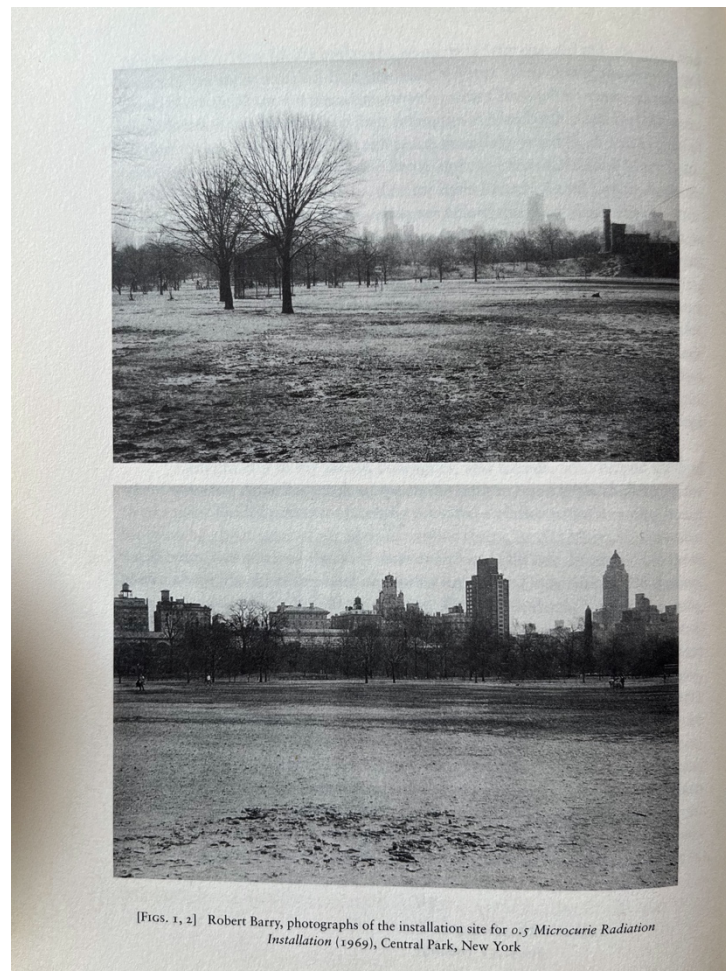


FIG 3.4. Robert Barry, *0.5 Microcurie Radiation Installation*, 1969, barium-133. 10 year duration (approximate), Private Collection, NY.

²⁴⁸ Seth Siegelau, 'January 5-31, 1969', (New York: Seth Siegelau, 1969).

For this piece Barry buried four capsules of barium-133 in two places on the lawn of Central Park, New York. He allegedly chose this particular radioisotope because of the similarity to his name. Carried in his pocket to the chosen locations, he ‘inconspicuously buried the capsules’.²⁴⁹ He then documented the approximate locations with a photograph of each, the only accompanying documents. ‘As far as I know, they’re still there’ stated Barry in a 2009 interview with Mathieu Copeland.²⁵⁰ A belief allegedly corroborated by Peter Eleey in his own search for the piece:

More than three decades later, I went to the park on a spring afternoon with Barry’s images in hand like a pirate with a treasure map, trying to guess where he might have buried these things.²⁵¹

He continues, ‘Barry’s radioactive capsules are, as it happens, still there.’²⁵² This claim is made without any further basis, but one would assume he is correct. This internalised knowledge of the exact location is pertinent to the argument of whether a nuclear waste repository should even be marked or not, a significant debate in the 1980s when nuclear semiotics was in its relative infancy.²⁵³ If the knowledge and memory of the location remains only with Barry then the potential for harm to other persons is increased through lack of shared knowledge. Being the only person to document such a search for the work (and possibly the only person to conduct a search) Eleey introduces the mechanism of *rumour* to the knowledge of the existence of the piece. As we recall from the *Don’t Follow the Wind* non-site exhibitions, rumour is a powerful tool in maintaining and re-establishing interest.

The contextual placement of *0.5 Microcurie Radiation Installation* is unexpected. It is *away* having been buried underground but reads more as a violation of a public space rather than an intervention in an institutional space. It lacks contextual mediation; it has no signs or documents close by. Encounter is only through the photographs and information provided in the exhibition catalogue which were exhibited at Siegelau’s gallery nearly two miles away on East 52nd Street. Encounter – knowingly – could only occur at the non-site. Thus, encounter at the site is unmediated with gamma rays acting silently on those in its vicinity. It could be argued that without the presence of mediators, as an artwork, it does not exist, it is simply a violent object. Not so, Cray would counter. It has been imbued, ergo it is an artwork. Artistic meaning has been ascribed to the capsules of barium-133 beyond their energetic characteristics. And documents *do* exist, but their contextual removal to the gallery re-

²⁴⁹ Eleey, ‘The Quick’, p. 31.

²⁵⁰ Copeland, ‘Ideas’, p. 85.

²⁵¹ Eleey, ‘The Quick’, p. 31.

²⁵² Eleey, ‘The Quick’, p. 50.

²⁵³ Human Interference Task Force, *Reducing the Likelihood of Future Human Activities That Could Affect Geological High-Level Waste Repositories* (Columbus, OH: United States Department of Energy, 1984).

excites the phenomenological status of the buried capsules as artworks. But this disconnect between site and non-site is problematic where toxicity and hazards are present. Ethically, RK&M tells us that the two should co-exist, and *0.5 Microcurie Radiation Installation* shows us the problem of separating the two. A situation should never be permitted whereby someone encounters the toxic element without first or simultaneously encountering the mediator of its imperceptibility. It would seem that the ability for radiation to signify itself is bogged down in mediation again. *0.5 Microcurie Radiation Installation* is, at base, what Ernst proposed – a self-signifying radiation source. And yet it fails to do this. It needs mediators, non-sites and documents. I argue that this is a problem that declines with time, if mediated properly to begin with. In the next chapter, we will address this further, not by means of documentation, but via the power of oral transfer.

Institutional Support

So far, Cray has caused us to question the potential for self-signification outside of the contextual arena of the museum or gallery. We now turn to Boris Groys to further explore the ramifications of the gallery context. Critically, I argue that a radioactive art marker must be free of institutional support within a short period of time relative to its prospective deep-time projection. This is important to the production of narrative and the embracement of toxic drift that permits self-signification. However, Groys argues that conceptual art cannot exist independently of art institutions and curatorial discourse. Whilst I do not expect to resolve this with counterargument, it offers an opportunity to explore the boundaries of curatorship in the context of expansive spatiality, energies, stretched temporalities, and imbuement. Ideally, for radioactive materials to be able to self-signify in an art context, they must evolve beyond the interpretation of the curator. Their narrative must be self-forming and self-sustaining. According to Groys, the failure of conceptual art follows the shift from artwork as object to artwork as statement or idea.²⁵⁴ Accordingly, ideas only become ‘art’ when contextualised as such by art institutions. It is the semantic support provided to conceptual art by art institutions that gives them power. Without which, they are powerless, argues Groys. He states:

The new artwork looks really new and alive only if it resembles, in a certain sense, every other ordinary, profane thing, or every other ordinary product of popular culture. Only in this case can new artwork function as a signifier for the world outside the museum walls. The new can be experienced only as such only if it produces an

²⁵⁴ Groys, *Art Power*, pp. 53-54.

effect of the out-of-bounds infinity – if it opens an infinite view on the reality outside of the museum.²⁵⁵

He continues:

The small, controllable space of the museum allows the spectator to imagine the world outside the museum's walls as splendid, infinite, ecstatic. This is, in fact, the primary function of the museum: to let us imagine what is outside the museum as infinite.²⁵⁶

What Groy's is describing here is the non-site. The contracted, metaphorical – though not always – stand-in for an experience elsewhere in *the away*. Groy's goes on to further denigrate documents as not being art themselves.²⁵⁷

If we return to *0.5 Microcurie Radiation Installation*, we can observe Groy's argument. If Siegelau had not exhibited the documentation of Barry's piece – the photographs, the isotope, the half-life – would anyone other than Barry have known it had been enacted? Considering the small sample and barium-133's relatively short half-life of 30 years, the chances are that Groy's is correct. The documentation was crucial in drawing percipients' attention to the work. However, following Cray, it would not have nullified the art of Barry's intervention. Barry imbued the capsules with artistic intent and therefore they carry a meaning in addition to their original objecthood.

Groy's views challenge the autonomy of the conceptual art idea. A radioactive art marker must be created with autonomy, or able to become autonomous if it is to function as intended. It must supersede critique, judgement, and social criticism many times over if it is to remain perpetually current. In Groy's opinion, the art institution gives life to the idea as art and without such critical support, the concept cannot be considered as the art itself. Even when recategorising the concept as an installation, Groy returns to the spatiality of the exhibition space as a material characteristic of the conceptual piece (generally in line with Cray's argument of contextual placement).²⁵⁸ This is in stark contrast to Lucy Lippard's view that conceptual art bypasses entirely the necessity for institutional support. Peter Osborne and Benjamin Buchloh also present arguments on this topic, both concluding that the role of the institution is minimised in conceptual art, and whilst still necessary in their views,

²⁵⁵ Groy's, *Art Power*, p. 30.

²⁵⁶ Groy's, *Art Power*, p. 30.

²⁵⁷ Groy's, *Art Power*, p. 49.

²⁵⁸ Groy's, *Art Power*, pp. 94-95.

institutions are secondary.²⁵⁹ Groys's view is at the extreme end but does present some areas for consideration.

Of particular interest are imbued spaces. To what extent do we consider imbueement to be a fixed space? In *Uranyl Nitrate*, the roof space is 'occupied' by radiation, so we can clearly state the physical parameters of the imbued space.²⁶⁰ However, we must not only consider the spatial but the temporal, particularly in relation to toxic drift. The pervasiveness of radiation interventions endures beyond the existence of its institutional container. If Groys is correct, then once the radioactive material exits the building for whatever reason (renovations, picked up on shoes, stuck to alveoli etc.), that imbued material ceases to carry artistic intent. Let us assume this is correct for now. Which brings us to the question of energy. To what extent, then, does energy that is emitted from Barry's uranyl nitrate deposit constitute art. The radioactive energy is expansive and goes beyond the spatial confines of the Kunsthalle roof. If particles of energy permeate and traverse the fabric of the building, is there a limit to when that energy is and is not considered art?

Groys places a huge amount of stress on the institution-art relationship, and whilst I can see the grounds for his reasoning in some respects, I feel it is not a comprehensive argument, and radioactive art materials are an outlier to his theory. Energetic art relies on non-site knowledge transmission, but the effects do not need to be restricted to containers, spatial or temporal, in order to be perceived. I argue that slow violence plays a significant role in the unfolding of perception. Once the artist sets the materials in motion, whether it be freely distributed, buried under grass, hidden in a repository in Moscow or simply wrapped in lead, the energy is the carrier of artistic intent that alters environs and bodies. Slowness removes the immediacy of the artist-institution relationship and instead sets forth a long unfolding of malleable narrative that can be perceived differently and relationally as time progresses.

For the purposes of nuclear semiotics, whether or not art is perceived as art in the long-term is irrelevant. What we seek for RWM and RK&M is a carrier of a message. An art marker's form is also mostly irrelevant so long as it is a reliable, stable carrier. What art and artists can add is the intention of the message and how it interjects into society and the environment. Stretching temporality out into envisaged futures of a radioactive art marker, institutional care and dissemination of knowledge is undoubtedly beneficial to the success of RK&M, if not critical. As time moves on, however, institutional care will give way to other types of care

²⁵⁹ Benjamin Buchloh, 'Conceptual Art 1962-1969: From the Aesthetic of Administration to the Critique of Institutions', *October*, 55 (1990). Peter Osborne, *Conceptual Art*, (London: Phaidon, 2002).

²⁶⁰ Although the zone of contamination may blur the edges of these parameters somewhat.

which will unfold with the narrative of radiation and toxic drift. On the scale of institutional escape, from the extremes of Groys to Lippard, Osborne presents the argument that is most applicable to the deep-timescales of RWM and RK&M. Osborne formulates a temporally distributed ontology of conceptual art, identifying the formation of a new ontology that is aligned with the idea, not with the institution. He acknowledges the role of the institution but that it is secondary and plays a supporting but potentially escapable role. Osborne argues that conceptual art transforms what art actually *is* – its ontology.²⁶¹ As such, care and interpretation should evolve and adapt over time and should not be confined physically or temporally by their epistemology.

Having tested the boundaries of the role of the institution, we can now address the art market and value. Any devised art marker must be inherently worthless lest it be plundered for materials or moved to a museum where its threatening meaning may be mitigated or made safe.²⁶² We see a significant variance between the objective values afforded to the different artworks. From *Black Square XVII* and *Trinity Cube*, both made from radioactive waste, something we deem repugnant, vile and unhandleable; to the heirloomic value of the radioactive jewellery in *Inheritance*. We must question in what way the involvement of institutions and the art market in these artworks affects the value we ascribe to them. Furthermore, we must ask whether value, or lack thereof, affects our involvement with the piece. Does value equal reverence and increased care? Do we respond to waste with disgust?

Robert Smithson identifies our relationship with waste as being devoid of excitement. He argues that waste is a product of enjoyment, and the immediacy of producing it. But by enjoying ourselves, buying new things and discarding the old ones – clothes, cars etc. – we lose interest in the old ones.²⁶³ ‘Found objects’ are a common encounter in galleries. We are accustomed to waste objects that have been imbued with artistic meaning; their contexts changed by their new setting. ‘Waste’ in the gallery context can therefore accrue value and is not the panacea to the question of what form a radioactive art marker should take.²⁶⁴ Art

²⁶¹ Osborne, *Conceptual Art*, p. 52.

²⁶² There are accounts of radioactive artworks being given very specific viewing conditions. When *Inheritance* was exhibited at the Bildmuseet, the legalities of display were considered at length involving ‘several radiological assessments to arrive at the conditions under which the work can be exhibited. In our case under a vitrine and at a viewing distance of at least 60 cm.’ We Make Money Not Art, ‘Inheritance, a Precious Heirloom Made of Gold and Radioactive Stones’, (2016).

²⁶³ Flam, ‘Collected Writings’, p. 303.

²⁶⁴ In February 2023, during my research on *Trinity Cube*, I learned there was another almost identical version of the cube produced in 2017 by Paglen. The cube’s material description read, ‘irradiated glass from Fukushima Exclusion Zone, Trinitite.’ My concerns were raised when I observed the cube being displayed on a pedestal in PACE gallery, New York, seemingly with no shielding. Upon further enquiry, the gallery revealed to me that there was in fact no radioactive material included in the composition of the 2017 cube and it was in fact fabricated using standard glass fused at high temperatures. In 2023, the 2017 cube’s asking price was USD 125,000. The cube’s alternative composition cannot be declared as waste materials and so calls into question how that affects

objects, even found art, are not ‘replaceable’ as Smithson observes – quite the opposite. Dematerialisation (save for documentation and non-sites) bypasses the accrual of perceived object value. *Trinity Cube*, despite being toxic waste, is objectively beautiful. By contrast, *Uranyl Nitrate* evades such aesthetic judgement. *Black Square XVII* (although we have never seen the cube itself) is likely to be comparably pleasing aesthetically as *Trinity Cube*, having been produced by the same process of vitrification. Yet its aesthetic is concealed. We never see the *Black Square*. It is a gift to people in the 31st century; it is not for our own enjoyment in the present. In these examples we can observe different tangible versus intangible approaches and how these might circumvent the accrual of value.

Framing a toxic object as a gift to people of the future raises some interesting questions. How can waste and toxicity be a gift?²⁶⁵ Robert Jacobs asks us to reframe our message to future generations from a warning to an apology.²⁶⁶ But, how might we go about this? Offerings are a symbol of humility amongst many cultures. A gift by way of apology may partially fulfil this alternative approach. The heirloom jewellery produced by Berger and Keto in *Inheritance* can be construed as a gift in many ways, although this is problematised by the ability of future generations to receive the gift. Instead, the gift becomes a burden for the great many potential recipients. The jewellery exudes value, using it as a primary mechanism and driving force for knowledge transfer. Its perceived value is intended as a motivation to perform rituals and measure its radioactivity to determine an appropriate time to wear the jewellery. Whether value and gift will be codependent properties throughout its lifetime, we cannot be certain. Nevertheless, the value of *Inheritance* as an art object is (or will be) usurped by its perceived financial value. The minimisation of art value is arguably important for its longevity – Stephen Kaltenbach’s unopened time capsules being a prime example of the problem. If *Black Square XVII* is ever to be opened and the message retrieved, it cannot hold any meaningful artistic value. If any acts of ‘completion’ of these artworks are to be achieved, they must be freely dismantlable and/or breakable by people or beings in the distant future. Likewise, documents must be freely adaptable to maintain knowledge and comprehensibility. Ergo, documents must *not* be perceived as artworks. But they undoubtedly will be. They will have value. Here we encounter the problem that art history poses to the art object projected into deep-time.

perceived value. PACE Gallery, ‘Trevor Paglen, Trinity Cube, 2017’, (New York, n.d.). Margherita Ciocci, Email to the author, 9 Feb 2023.

²⁶⁵ *Das Gift* in German means ‘poison’ having been derived from the expression, ‘giving someone a gift’ as a euphemism for poisoning someone.

²⁶⁶ Jacobs, *Nuclear Bodies*, p. 238.

Art, in and of itself, encourages an art-historical perspective which is entangled with economic value and limited access.²⁶⁷ Jon Lomberg, an artist who sat on the WIPP markers panel asserted that a marker must not look like a work of art lest the message be interpreted as an artistic statement rather than a warning.²⁶⁸ Such was the concern over this unresolvable art problem, the DOE rejected art as a potential mechanism for repository marking.²⁶⁹ Even a potential 'non-traditional,' 'non-aesthetic' art marker would be complicated by a Groysian art-historical context. And so, we must concede to Lomberg and the DOE's concerns and stray away from aesthetic practices. Instead, we must adopt an Osbornian approach that gives primacy to the idea as ontologically self-manifesting without institutional support – at least not in the long-term. Considering that the RK&M proposal calls for the *support* of art as a non-site to draw attention to a marker at a site, art must not work in isolation but part of the systemic message. Su Ballard and Elizabeth Linden observe the obfuscation of art by art history, claiming that it 'seals' the work away from other disciplines and prevents a future for critical cooperative transdisciplinary viewpoints of that object.²⁷⁰ As such, an art marker must leverage artistic ideas to convey a message but not *be* art. Well, does a shoemaker not make shoes? Does a writer not write books? This seems like a nonsensical statement; of course, an art marker is art if produced by an artist. This is what imbuelement hinges on. Nevertheless, for the longevity of the message conveyed by the art marker, it is crucial that it must not be construed as art. It must not be art-historical. It must be the type of art that people often regard as not being art at all – the type of art that repeatedly produces the 'my four-year-old could have done that' statement. Again, the remit of conceptual art. Simplicity, even over-simplicity, should be foregrounded as the basis for form.

Removing an art marker from the interpretive arena of the art institution seems all the more important now. Art writer Sue Spaid discusses at length an approach to art that may offer some suitability for an art marker. Writing in 2002, Spaid examines the newly coined *Ecoventionist Art* (a portmanteau of ecological and invention) that describes 'an artist-initiated project that employs an inventive strategy to physically transform a local ecology.'²⁷¹ Spaid quotes artist Patricia Johanson: 'unlike ordinary art that depends on a body of art history or critical interpretation, an ecovention can be grasped directly.'²⁷² For

²⁶⁷ Su Ballard and L. Linden, 'Spiral Jetty, geoaesthetics, and art: Writing the Anthropocene', *The Anthropocene Review*, 6 (2019), pp. 13-14.

²⁶⁸ Trauth, Hora, and Guzowski, 'Expert Judgment on Markers', p. G84.

²⁶⁹ U.S. Department of Energy, Permanent Markers Implementation Plan (DOE/WIPP-04-3302) (Carlsbad, NM: Carlsbad Field Office Waste Isolation Pilot Plant, 2004).

²⁷⁰ Ballard and Linden, 'Geoesthetics', p. 14.

²⁷¹ Sue Spaid, *Ecovention: Current Art to Transform Ecologies*, (Cincinnati, OH: Contemporary Arts Center, 2002), p. 1.

²⁷² Although Spaid does state this is an oversimplification. Spaid, *Ecovention*, p. 14.

environmental, ecological, and earthwork artists, according to Spaid, there is an emphasis on nature as the medium. This is an important consideration for the life of a radioactive art marker. Accounting for toxic drift over deep-time, what may originate as a contained radiological object or intervention, is likely to enter new phases of contact with environments it was never intended for – Joyce has already made us aware of this. Its temporality will simply outlive any preconceived notion of storage or placement. If we are to envisage the life of a radiological art object as being predominantly ecoventionist – which I believe it will be – long after it has left the hands of institutional custodianship, we can adopt a new view of how it will operate as an RK&M mechanism, adopting Osborne’s continually evolving ontology view. Spaid emphasises locality and the impact ecoventions have on local communities. She views their ‘role as stakeholders as being of paramount importance to an ecovention’s survivability, since citizens are the stewards who will protect and maintain the ecovention once it’s built.’²⁷³ It is as a result of this impact that ecovention projects remain local.²⁷⁴

We will return to the role of local communities in the next chapter, but this anachronistic view of how and where a radiological material may be situated in its distant life is an important consideration for art marker design before it has even been produced. Not only does this temporal shift in thinking permit speculative imagination for what is yet to come, it also sets out a route for an art marker that starts out as art but is able to escape the viscosity of the institution and of art-historical context. It lends itself to the message, and not to the art. The art is superfluous; it is a mere conduit for the message. If the ‘art’ gets lost along the way, so be it; it may even be beneficial.

Envisaging this environmental ecoventionist stage of a radiological art marker’s life, we can go so far as to call it a ruinous state. This seems to be at odds with a conceptual or post-conceptual approach – how could it possibly be ruinous? We must remember that conceptual art (and post-conceptual art in particular) is rarely, if ever, fully dematerialised. Containers are ubiquitous in the examples used in this thesis, whether lead jackets, or rooms and spaces in *the away*. When those containers cease to exist, or fail, they can absolutely be called ruinous. The contents are free to drift, the spread of energy no longer curtailed. Though once these artworks break free of their preconceived loci of mediation, how might future people access them? I argue that the lack of presence is of no hindrance to the enjoyment of conceptual and post-conceptual art. Their spatial withdrawal and inaccessibility are what make them enticing. Their non-sites do the literal translation and the art is completed in one’s mind. Even the thrill of what *used* to be there can be a draw. Walter

²⁷³ Spaid, *Ecovention*, p. 2.

²⁷⁴ Spaid, *Ecovention*, pp. 12-13.

De Maria's *Las Vegas Piece* (1969) – four connected lines 35 miles off a main road, scribed into the earth a few inches deep, eight feet wide, and up to a mile long – provides a good example of artwork loss, experience, and the function of the non-site (fig. 3.5). Having been eroded through exposure, by all accounts, *Las Vegas Piece* has long since disappeared and yet it still appears to draw visitors despite the absence of the lines. A journal article by *The Center for Land Use Interpretation*, states:

Some would argue that [Las Vegas Piece] isn't there at all, that the piece is gone. Certainly, as originally intended by De Maria, the piece no longer exists, just as "none" of [Michael] Heizer's dry lake pieces exist, even if traces can be found. Of course these are ruins of land art, not land art. But for a group of art historians, the interest in going there was not to experience the piece, but to experience the place where the piece was.²⁷⁵

The article reveals the drive in some to see something that once was, even if it is only barely perceptible (if at all). What causes that drive, I interpret to be the equivalent of the imbued landscape. De Maria's intervention into the landscape is enough to entice the art historians to experience its former presence. It was the role of the photographic documents of the work that allowed them to ascertain evidence and authenticity of the location. The article concludes:

In a paralaxed overlay, when the alignment lines up, the viewer descends into the photo at the same time the piece in the photo emerges into the viewer's live view. You are there, even if it is not.²⁷⁶

This shows the importance of non-sites to sites, particularly if a ruinous period is to be anticipated. It also shows that ruins are not 'the end' of an art marker, and that the space they occupy, or occupied has been imbued, even if the work is gone, and the non-site is there to remind us of this. This account reveals many potential outcomes and stages for a radiological art marker. It just so happens that this account was a result of an exploration by art historians. However, an approach that minimises art-historical context, even going so far as to remove the author, will still yield this heuristic mode of discovery. The drive to *experience* an imbued space, even if there is nothing to witness starts with an ecovention. The non-site must therefore be authentic. It must facilitate this discovery.

²⁷⁵ The Center for Land Use Interpretation, 'A Journey to the Ends of Land Art - A Positive Spin Around a Double Negative', (2013).

²⁷⁶ The Center for Land Use Interpretation, 'A Positive Spin'.

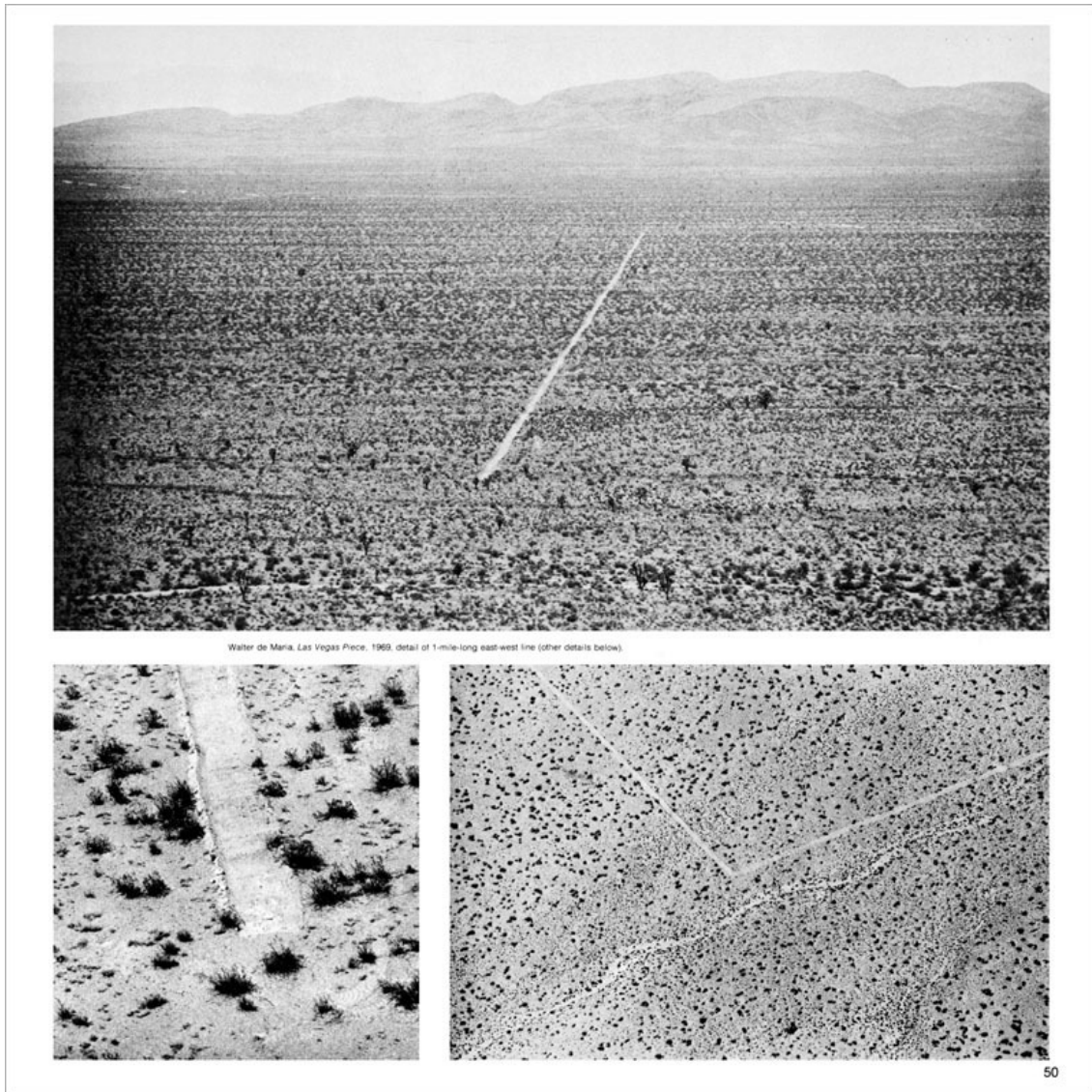


FIG 3.5. Walter de Maria, *Las Vegas Piece*, 1969, cuts in earth, two one-mile lines, two half-mile lines, 8 feet wide. Las Vegas, Nevada. Photographs: Gianfranco Gorgoni, *Walter de Maria's Las Vegas Piece, Desert Valley, 95 miles northeast of Las Vegas, Nevada, 1969, 1970*, chromogenic print, multiple dimensions.

Authenticity

The non-site bears a great deal of responsibility – it must not only point to the site, but it must do so in a way that balances discouragement with encouragement to visit it. In its role as mediator it must also be perceived as truthful and authentic. Pointing to an invisible threat, it is possible that in the distant future it may be perceived as nothing more than a ghost story. Documentation and to a greater extent, instrumentation, are necessary for determining the authenticity of the site and to allow future generations to corroborate our

message and seek truthfulness in the warning. *Inheritance* provides the instrumentation to do so, as we have already seen. Measurement is a way to apprehend the claim of danger that the non-site purports the site to have. In 1999, a report (see Appendix 1.1) produced by a (most likely) university radiological department shows that Robert Barry's *Cesium 137* piece had been 'found [...] attached to a building support pillar at a height of approximately 2.5m' in a 'Karlsruhe museum.'²⁷⁷ It was identified as a 'possible danger to visitors,' thus necessitating investigation.²⁷⁸ The report details the external appearance and dimensions of the 'object,' noting its pine box, (which interestingly, the Panza Collection, the owners of the piece, now no longer have nor can they account for its loss.) The report provides gamma doses from outside the box and determines there was indeed a source of radiation inside. 'As a result, the museum management dismantled the box and opened it with extreme caution, as it was of enormous value. Nowhere was a radiation sign visible or was there a reference to radioactivity!'²⁷⁹ The radiation source was deemed to be within permitted limits and was subsequently closed back up and reinstalled.

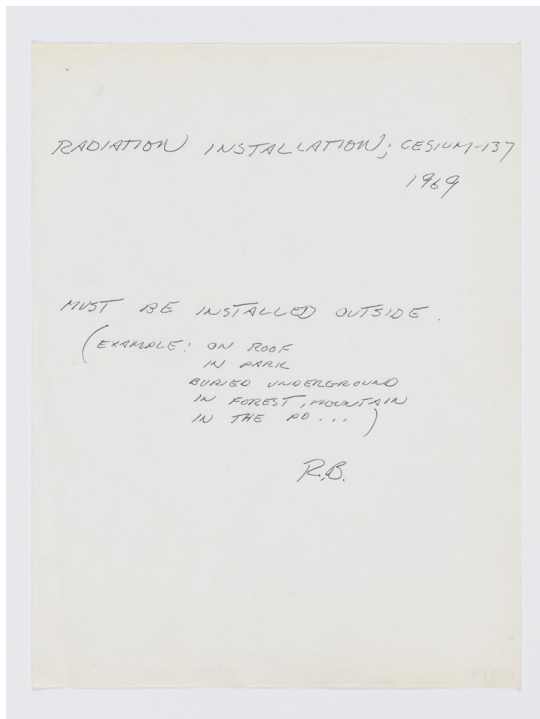
The report raises some interesting questions and considerations regarding radioactive artworks and their handling. Clearly, the safety of the work had been called into question. What the impetus was that prompted the investigation is not clear. The report notes the absence of any radiation warning sign, so that clearly was not the prompt. It is more probable that documentation and knowledge may have played the leading role in the inquiry. The fact the artwork was 'found' is interesting. The alleged placement indicates that it had been installed in a similar fashion to when it was exhibited at The Museum of Contemporary Art, Los Angeles in 1995-1996 as part of *1965-1975: Reconsidering the Object of Art* (fig. 3.7). The piece can be observed in the exhibition photos (albeit poor quality) attached to a pillar, but details and documents regarding the piece are scant. The piece had been on long-term loan to the Solomon R. Guggenheim Foundation between 1995 and 2003 and as far as discernible, no special considerations were paid to the safe storage or management of the piece whilst it was in the Guggenheim's care.²⁸⁰ Along with *Inheritance*, *Cesium 137* is the only other work that is provided with explicit safety guidelines by the artist. These guidelines were supplied on a slip of paper and are as follows:

²⁷⁷ Although unconfirmed, the museum in question was very likely to be The ZKM Centre for Art and Media in Karlsruhe, though they were not able to corroborate the anecdote with a corresponding exhibition and were confused by the wording that the piece was 'found.' Records show that Barry's work has been exhibited at The ZKM on four separate occasions between 2002-2008. No such interest has been ascertained in Barry's work by other surrounding museums in the Karlsruhe area. When I contacted other possible museums, they either did not respond or had no knowledge of the piece.

²⁷⁸ This report has been found via No Show Museum and with no source, it has not been corroborated as true. However, this only builds uncertainty and rumour as a result.

²⁷⁹ No Show Museum, 'Robert Barry'.

²⁸⁰ The Panza Collection has no records of the exhibitions *Cesium 137* travelled to except to the MOCA, during this loan period to the Guggenheim.



Radiation Installation; Cesium-137

1969

Must be installed outside.

(Example: *On roof*
 In Park
 Buried Underground
 In Forest, Mountain
 In the Po...)

R.B.

FIG 3.6. Robert Barry, *Cesium 137*, 1969, installation note handwritten by Robert Barry, Panza Collection, Italy.

The guidelines are separate to the piece and there are no records to indicate that they have ever been exhibited together as a whole. As a non-site, what the note contributes is a degree of authenticity to the site's hazardous nature. The combination of the insistent '*must be installed outside*' with the title of the piece connotes its incompatibility with domesticity. It must always be *away*. Furthermore, it appears that none of these guidelines were followed throughout the artwork's life to date.²⁸¹ At no point in the correspondence between Barry and the curator of the MOCA exhibition Ann Goldstein was there any mention of any safety considerations for the piece.²⁸² Neither Barry nor Goldstein acknowledge the guidelines that Barry proposed in the note in the Panza collection.²⁸³

²⁸¹ Although I cannot confirm this for definite in light of the poor record keeping associated with the piece.

²⁸² From information gleaned from my own correspondence with the gallery.

²⁸³ This is in stark contrast to the safety reviews and consultations that went into displaying *Inheritance* at the *Perpetual Uncertainty* exhibition.



FIG 3.7. 1965-1975: *Reconsidering the Object of Art*, installation view showing what is believed to be *Cesium 137* mounted to a pillar, Museum of Contemporary Art, Los Angeles, USA.

The *Cesium 137* report indicates that documentation may have played a role in the need to authenticate the danger. Yet a lack of clear documentation also made it necessary to do the same. Herein lies the conundrum of whether to say too much or too little, and wherein is the right amount of danger or threat to present as a warning about a GDF? Just as troubling is that to test the danger presented by *Cesium 137* there were multiple actors involved, especially in obtaining all the necessary skills and equipment for measurement and testing. This is in stark contrast to *Inheritance* which provides all the equipment required. It calls into question whether a radioactive art marker should encourage testing and measurement, or if the vagueness of its radioactivity should be enough to elicit only occasional enquiry.

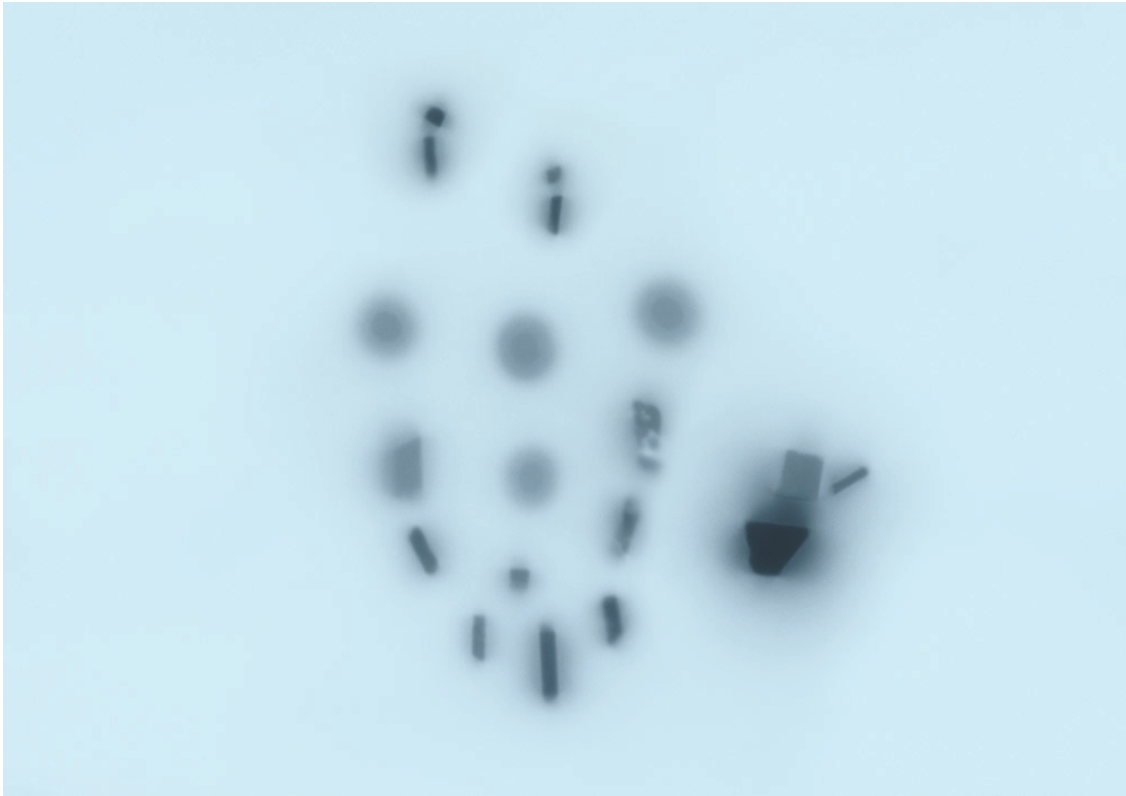


FIG 3.8. Erich Berger & Mari Keto, *Inheritance*, 2016, auto-radiograph, unknown dimensions, Private Collection.

There is certainly a sense that there is a desire to ascertain the knowledge of whether the space around the radioactive art object is dangerous. To what extent does its sphere of threat encroach on our space? How threatening is it? Instrumentation helps reveal this but so do photographs – more specifically, *radiographs*. With *Inheritance*, Berger and Keto provide a radiograph demonstrating the exposure of photosensitive paper to radioactive particles and waves (fig. 3.8). Photosensitive material has the ability to record with permanence (i.e., not just temporarily render sonorous as with a Geiger counter) trajectories and quantities of radiation that pass through its sensorial plane. Shimpei Takeda's Trace series of 'photographs' (or radiographs) provide evidence and records of radioactivity in soil samples taken from the Tohoku and Kanto regions of Japan (fig. 3.9). The radiographs visualise intensity and activity of radioactive particles and waves, not just representationally, but through indexical exposure to the contaminated land. Its authenticity as a document is therefore extremely high. However, the radiograph is most appropriate to testing samples, or objects and does not reflect the wider context of contamination.

Whilst not requiring a great deal of specialist equipment – certainly none that need any mechanical maintenance, or replacement parts – it does require controlled conditions. Total

darkness is required for a radiograph to be produced due to the electromagnetic sensitivity of the photographic paper. The Trace series both reveals with intimate detail but also obscures by being frustratingly delayed in its revelatory performance. Radiographs lack the immediacy of the Geiger counter. They also lack the interconnectedness of one place to another. They are isolated squares of representation, not representative of the space in its totality – they are merely samples. Toxic drift shows us that the landscape is contaminated and imbued with toxicity and toxic narratives that a sample, or selection of samples, cannot reveal in any meaningful manner. Whilst photosensitive approaches to revelation are rich in authenticity, they lack the nuanced, interconnected narrative of radioactivity that the landscape can reveal in much broader contexts. There is certainly a place for radiographs as authentic actors in documenting radioactive objects, but the arena for these is much smaller than the vast unfolding narrative of radiation and toxic drift that can be written into the landscape for future people to read. We will return to the role of the landscape in the final chapters.



FIG 3.9. Shimpei Takeda, *Trace #7, Nihonmatsu Castle*, 2012, gelatin-silver photograph, image: 40 x 50.5 cm, International Center of Photography, New York, USA.

To ‘authenticate’ claims of radioactivity is to translate radiation into a sensory mode. Its inaccessibility and withdrawal from perception is what creates the radiophobia of which we may come to rely on in art marker design. To translate and mediate invisible threat, sensorial planes are a necessary boundary through which radiation must pass – photographic paper, or an inert gas in a Geiger counter. We value technological mediation as it allows us to

materialise the invisible with relative speed. It prevents our ignorance and the development of cancers that would otherwise be the delayed revelatory manifestation of ionising radiation. We view these mediators as authentic because of their sensorial plane – they must be passed through by radioactive particles and waves. As such, it is the indexical registration that produces authenticity. Yet each sensorial mode renders radioactivity differently, and we are therefore observing the subjectivity of the technological mediator, not the radiation itself. Whilst these mediators are high in indexicality, the radiation is still always withdrawn. This raises the question of whether the non-site can ever be truly authentic? Common sense would tell us, no. However, for the purposes of a radioactive art marker, there is a sense of non-sites being authentic *enough*. In this vastly speculative endeavour, there is room for manoeuvre where something that is inherently temporary in the life of a radioactive art marker is capable of fulfilling a role in a manner that is *good enough* for a short period of time before its authenticity must be renewed. It may even be the impetus we so desire for the art marker. Just a small degree of speculation as to authenticity leads to an underlying level of sustained inquisitiveness, prolonging the production of (K)knowledge and (M)memory where (R)records are deemed ever so slightly questionable. Whatever prompted the testing of *Cesium 137* was greater than mere record loss. There seem to be knowledge and memory inconsistencies as well, suggested by the statement that the artwork was ‘found.’ Nevertheless, this Sebeokian relay of inconsistency prompting reestablishment of RK&M is productive to RK&M sustainability.²⁸⁴ For this, we ask a great deal of our descendants. We are playing a dangerous game of balancing inconsistency and loss with demanding that they work to reestablish those losses.

Conclusion

Radiation, radioactivity, and its sources are always spatially withdrawn. Mediators are crucial to the revelatory experience but are not solely responsible for shaping our experience of radioactive art. Context is pertinent to encounter. Unexpectedness is a limiting factor as we saw in *0.5 Microcurie Radiation Installation*. This reveals the dependence, even if only in part, on institutional support for contextual expectedness as part of the revelatory experience. This institutional reliance complicates radioactive art marker design. Ethically, only smaller quantities of shorter-lived radionuclides should be permitted for such close-

²⁸⁴ As a reminder, the Sebeokian relay encourages knowledge transfer once every generation, and may at times be prompted by knowledge loss.

contact experiences in institutions.²⁸⁵ The likelihood, as per Sullivan's statement, is that a significantly potent enough source of radiation is the most effective deterrent. This would not be possible in an institutional setting. The obduracy and potency of any radioactive material used in an art marker must have the temporal stamina to maintain its message for the required duration. The requirements for institutional support and the robustness of material violence appear to be at odds with each other.

The siting of a radioactive art marker as a non-site to a GDF in relative proximity seems to be the most sensible and equally provocative location. It must serve as an experiential warning about the site. Mediation must therefore also be in close proximity and should also be literal. Documents and supporting non-sites must be freely accessible but must also evade the perception that they themselves are the locus of the art. They also must not accrue value. Artistic radioactive intervention must not be readable as art at all beyond the short-term. It is merely the artistic intent and conceptual art approaches to knowledge transfer that are desirable for GDF marking purposes. The option to be hesitant about *how much* information to convey through mediation should also be explored in conceptual art marker design. Speculation, rumour and uncertainty are powerful facilitators of knowledge transfer as was observed in both the NVC exhibitions and in *Uranyl Nitrate*. We will explore this further in the next chapter. Spatial withdrawal can be further highlighted as a looming menace by the withdrawal of information. In this sense, radiation enters the spectral realm of invisible threat.²⁸⁶ Withdrawal influences human engagement, and as will be argued in the next chapter, may contribute to the development of a socially sustained mythological narrative that is further determined by toxic drift throughout deep-time. Adopting some 'closed-gallery' exhibition tropes may offer further considerations for balancing institutional support in the short-term whilst sufficiently remaining withdrawn. This will be explored in the final chapter.

²⁸⁵ Nuclear safety guidelines focus on 'dose' and 'dose rate,' – how much and how quickly. These can be controlled by the radioisotope choice, type of particle decay, distance, and shielding. These would need to be considered in more detail within institutional settings where exposure is more of an issue.

²⁸⁶ Erich Berger, co-artist of *Inheritance* also uses the term 'spectral' in his ongoing research project since 2019, *Spectral Landscapes*. Berger states: 'Spectral Landscapes is investigating radioactivity and the landscape. I collect data which allow me to portray the gamma radiation fields as bodies which protrude from the radioactive base-rock as intricate but intrinsic features of the landscape.[...] I refer to these bodies as spectral because their presence is ghostly and can only be detected via extra-sensorial means, but then they are also spectral because they are fields of light, of photons, although located in a part of the spectrum not visible to human eye.' Erich Berger, 'Spectral Landscapes', (n.d.).

3.

People: Laborious Stewardship

Counter-intuitively, concealment and withdrawal may influence desire to learn more. This is why the consensus for marking a GDF with an exceptional amount of information is believed to mitigate this innate inquisitiveness and prevent intrusion. The desire for knowledge by future generations must not be underestimated. As already stated, we must account for the fact that even with all the information laid out before our descendants, the information cannot exhaust the qualitative *experience* of the GDF, of the radioactive waste containers, and of the radiation itself. The nuclear sublime is both attractive and repulsive. Long after nuclear industries cease to operate and exist, the novelty of discovering a tomb of toxic endeavours from the past would undoubtedly be so intriguing that any warning to not enter would not necessarily be headed. In this chapter we turn to the maintenance of RK&M by people, the impetus for doing so, and the draw of laborious stewardship.

Ines Marita, *The Radiation Piece - Chronik Einer Suche* (2016)

Documentation and non-sites provide the impetus for discovering more, particularly if the site is concealed, i.e. cannot be observed. Even with documentation that purports to be truthful, we may still desire to seek and obtain our own evidence of the existence of unseen things. In 2009, Robert Barry himself could not state with any certainty that *Uranyl Nitrate* was still present in the Kunsthalle Bern since its installation in 1969: 'As far as I know, it's still there!'²⁸⁷ In his interview with Mathieu Copeland, Copeland states '[The *Uranyl Nitrate* piece] is apparently still emitting.'²⁸⁸ Uncertainty and doubt are powerful mechanisms for reestablishing truth in rumour. Whether Copeland actually sought out to detect traces of the powder is something I have not been able to ascertain, leaving me simply with the uncorroborated *rumour* that Copeland has started.²⁸⁹ But Copeland is not the only person whose intrigue has been sparked by *Uranyl Nitrate*. In 2016, artist Ines Marita produced a multi-part artwork in response to Barry's *Uranyl Nitrate*. Marita's *The Radiation Piece - Chronik einer Suche* (2016) comprises of (the intention to conduct) a guided tour of the

²⁸⁷ Copeland, 'Ideas', p. 87.

²⁸⁸ Copeland, 'Ideas', p. 85.

²⁸⁹ Despite a number of attempts, I was never able to interview Mathieu Copeland about Barry's radioactive works.

Kunsthalle Bern roof space along with corresponding photographs, an audio installation, and a photograph of the roof of the Kunsthalle Bern (figs. 4.1 and 4.2). In my interview with Marita, she informed me that she was working at the Kunsthalle in 2016, during which time she had seen the 1969 *When Attitudes Become Form* exhibition catalogue and had also read Mathieu Copeland's interview with Robert Barry from which she noted Barry's statement 'As far as I know, it's still there!' This in turn sparked Marita's intrigue as to whether or not the piece was extant in the roof of the gallery and formed the impetus for her own response.²⁹⁰



FIG 4.1. Ines Marita, *Chronik einer Suche*, 2016, guided tour/audio installation, 2-channel, 9m 40s, Kunsthalle Bern, Switzerland. Photograph of guided tour.

²⁹⁰ Ines Marita, Interview with the author, 21 Jul 2020.



FIG 4.2. Ines Marita, *Chronik einer Suche*, 2016, guided tour/audio installation, 2-channel, 9m 40s, Kunsthalle Bern, Switzerland. Photograph of Kunsthalle Bern rooftop.

In her inquisitive approach, Marita discovered that by 2011 the Kunsthalle staff were unaware of the existence of Barry's piece, quoting a technician at the time: 'It must have been lost during the renovation work in 1988.'²⁹¹ According to Marita, the technician had worked there 'for 20-30 years' and they had no knowledge of whether the piece was extant. Marita's conclusion was that even the people who worked most closely to the piece had no memory, awareness, or knew where to access direct information as to the piece's existence. It seemed to Marita that there had been no concerted effort to conserve the radioactive component of Barry's work during these renovations – assuming it was there in the first place. The lack of conservation might be attributed to the artwork's 'dematerialised' and/or 'conceptual' modality. No attempts to relocate the work to another space (if that would have been at all possible), no additional documents were created (e.g., more detailed images of the installation site before renovations), and no attempts were made to locate it by means of instrumentation by curators, stakeholders, or otherwise.²⁹² The beneficial observation of this is that the physical intervention in the roof space appears to have not accrued any significant financial value, indicated by its lack of care. It further seems that the lack of consideration for the radioactively contaminated space for any workers involved in the renovations may have also been a serious oversight. Marita contacted the *Labor für Radio und Umweltchemie* (Laboratory for Radio and Environmental Chemistry) at Bern University regarding the use of a Geiger counter in the hope of detecting traces of Barry's piece. This proposal was met with

²⁹¹ Marita, 'Interview with Ines Marita'.

²⁹² Relocation is likely to have been impossible given my earlier argument regarding the autonomy of an imbued space. That is not to say that the radioactive powder could not have been relocated.

scepticism by workers at the laboratory when considering the small amount of material that was used, which therefore may be difficult to detect.

Marita's intention for her piece was to lead attendees on a guided tour to the top floor of the building where they would search for evidence of Barry's piece. When I questioned her on this, Marita revealed that this portion of the work was altered at the last minute. Instead, the attendees – who are believed to have had a limited amount of knowledge of Barry's piece – were led to the roof space but no attempt to search the area was made, the reason being Marita's last-minute decision to honour Barry's artistic ambiguity.²⁹³ The attendees were then led back down to the vestibule where the audio piece was played.²⁹⁴ The audio piece is composed of fragments of texts, quotes from Barry himself, and texts that trace the research of his work.²⁹⁵ Finally, Marita's photograph of the Kunsthalle roof is a facsimile of the original photo for Barry's piece (fig. 4.2). It is taken at the same angle from the street and shows the subtle changes of telegraph wires, tram cables and vegetation that have occurred over time. Marita's photograph is a literal update of Barry's photograph. However, neither Marita's nor Barry's photographs confirm nor deny the existence of the uranyl nitrate allegedly installed in the roof space. Instead, Marita's photograph serves to bring the ambiguity surrounding the presence of the uranyl nitrate deposit back into the consciousness and consideration of the audience. This has the effect of reviving knowledge and memory of the imbued space, something which she had discovered had already escaped the consciousness of the gallery staff.

Uncertainty

A number of instances of forgetting are identifiable in *Chronik*, most pointing to the uncertainty or poor recollection that the artwork was ever installed in the Kunsthalle. These instances point to forgetting that is directly linked with the locality and fabric of the building and the installation. Renovations were conducted seemingly without regard for the radioactive powder's presence or potential risks it may pose to health. In a 2025 Robert Barry piece that arrived into his radioactive oeuvre far too late to be included at length in this thesis, safety considerations are much more prevalent than in his 1969 artworks. For

²⁹³ Marita was unable to tell me very much about the backgrounds of the attendees, and who they were, but she did inform me that at least one scientist came who pointed out that the floor was granite which could interfere with readings, being naturally slightly radioactive. Marita, 'Interview with Ines Marita'.

²⁹⁴ The guided tour piece was enacted only twice, and I am led to believe that both instances were conducted in the same manner.

²⁹⁵ Ines Marita, 'The Radiation Piece - Chronik einer Suche', (2016).

Radiation Piece: Copper Uraninite ($\text{Cu}[\text{UO}_2(\text{PO}_4)]_2(\text{H}_2\text{O}_{12})$, (2025), Mathieu Copeland installed a piece of torbernite in a Paris park on Barry's behalf as part of Barry's Art Basel show. In a press release, a reference to the 1969 *0.5 Microcurie Radiation Installation* in New York's Central Park is made, attesting to the uncertainty as to whether or not it is still there. With safety in mind, *Copper Uraninite* was buried in the park for only a few minutes during which time the space the radiation 'occupied' was photographed, and then the torbernite was then removed by Copeland.²⁹⁶

Part of the mystique surrounding *Uranyl Nitrate* and *0.5 Microcurie Radiation Installation* are the uncertainties as to whether or not they were ever installed or if they were, if they are still there. Their imperceptibility only contributes to this mystique and is fodder for the rumour mill. Withdrawal and inaccessibility feed into doubt which lead to the search (*Suche*) for the truth. Peter Eleey allegedly went in search of and found *0.5 Microcurie Radiation Installation*; Marita went in search of *Uranyl Nitrate*.²⁹⁷ Certainly, no one will be in search of *Copper Uraninite* given the explicit information that it was removed after a few short minutes. Perhaps someone may be interested to see if the ground is contaminated at some point from its brief exposure, but this seems unlikely. The withholding of information, its scarcity, its difficulty in proving it, these do not prevent the forgetting of an installation or of radioactive intervention. They do however contribute to the mitigation of certainty. It seems odd that we might attempt to circumvent certainty as it follows that certainty leads to fact – something we can all agree as truth. That said, these examples show that uncertainty leads to truth-seeking and work. In the same way that one person's claim that they have seen a ghost does not prove that these elusive, invisible spectres are real; one person's claim that a small deposit of radioactive material is extant does not make it so. Despite Eleey's claim and the likelihood that it is probably still there in the lawn of Central Park, we cannot accept this proclamation as true at face value. What Eleey's claim *can* do though, is motivate others to corroborate and seek their own truth. Motivated individuals who search for these radioactive interventions are powerful actors in the Sebeokian relay. They show that it is not the role of the great majority of people to transfer information. It can in fact be just a single person once per generation who does the work of seeking and reporting their findings to reestablish, truthfulness, doubt, uncertainty, inconclusivity, and reinterest. The outcome of the search is perhaps of little consequence, but the very act of their reporting is the product of the work that contributes to the relay.

²⁹⁶ Sawa, 'Experimentalists'.

²⁹⁷ Eleey, 'The Quick'.

Reframing the Sebeokian Relay

Concerned with RK&M transmission, Thomas Sebeok understood the unlikelihood of a message being comprehensible when projected 10,000+ years into the future and instead proposed an approach that broke those 10,000 years into 300 intergenerational transfer events. Whilst his (somewhat) tongue-in-cheek ‘Atomic Priesthood’ concept was and continues to be widely criticised, the potential of its focus on a folkloric approach to knowledge transmission continues to be incorporated into nuclear semiotic discourse and artistic exploration today.²⁹⁸ Conceived as a hierarchical structure of governance of a message that incorporates ritualism, cultural assembly, and a mythopoetic approach to maintenance, its problems far outweighed its potential to be deemed a viable mechanism in nuclear semiotics. However, the potential for semiotic adaptation through intergenerational relay (*histoire événementielle*) highlighted the benefits of frequent repetition and maintenance, allowing space for renewal through stewardship. This knowledge management through stewardship has been adopted into the RK&M Final Report, particularly where the management of societal narratives is encouraged as interpretative mechanisms. Just as we observed in the uncertainty surrounding the presence of Robert Barry’s radioactive artworks, Sebeok exposed the benefits of instability, both symbolic and conceptual, and that flux is not to be feared.

The ebb and flow of factual information and memory is countered by the fluctuation of knowledge retention and loss. A primary criticism of Sebeok’s relay system is the prerequisite obedience of future decedents to perform the labour of renewal. Whilst we must be cautious of talking down to our future decedents as if we are the learned teacher and the future others are obedient students – as Robert Jacobs rightly points out – we must instead foster a sense of *responsibility* to care, act, and propagate anew.²⁹⁹ Jacobs’s criticism of the Sebeokian relay continues:

[Knowledge transfer] would apparently work because [it] would have some utility to us in the twenty-first century, not because [it has] any understandable relevance or value to the people who would need to faithfully maintain [it] and pass [it] on.³⁰⁰

²⁹⁸ Bryan McGovern Wilson, 'Atomic Priesthood: Black Rose Sun', (2017). Robert Williams and Bryan McGovern Wilson, *Cumbrian Alchemy*, (Cumbria: UniPress Cumbria, 2013). Sebeok’s ‘Atomic Priesthood’ was a proposed pseudo-religious council of overseers of GDF knowledge. It was criticised primarily for its potential to become political and its hierarchical structure which may privilege information to upper classes and those in power. Umberto Eco, *The Search for the Perfect Language*, (Oxford: Blackwell, 1995), pp. 176-177.

²⁹⁹ Jacobs, *Nuclear Bodies*, pp. 233-238.

³⁰⁰ Jacobs, *Nuclear Bodies*, pp. 233-234.

To address Jacobs's criticism, a value must be ascribed to the labour of maintenance that future generations are tasked with. Impetus and reward must be carefully considered to encourage a relay system; more so, labourers of the future must feel their labour is continually justified. A number of conditions may feed into this mode of care: ethical responsibility, tradition and ritual, or the symbolic value of connecting past to future. The RK&M Final Report and Toolkit systematises what Sebeok left abstract by advocating for the integration of similar systems into existing societal functions, eliminating any singular effort of transfer but entering into a bureaucratic form of care. However, as we can see in Marita's *Chronik*, individual, heuristic discoveries, learning and reinterpretive acts are full of potential benefit for radioactive artworks and GDFs that require a degree of oversight.

A shift towards *responsibility* is indeed necessary. Still, we are stuck with the ongoing reasoning as to why responsibility is necessary and should be performed by any given generation of stewards. Anna Volkmar offers a subtly different approach to Jacobs; not of *responsibility* but of *care*.

The Care Approach

As approaches to RWM and nuclear semiotics have evolved over recent decades, the question of 'how to *warn* future generations against waste' has been reformulated to 'how to *inform* them about nuclear technologies and risks they pose.'³⁰¹ Despite this shift, there is still a fundamental distrust of future generations to act in their own best interests.³⁰² The warn and inform approach is further maligned by the instability of signs and symbols that may be employed. Anna Volkmar proposes a third term that is, in her view, necessary for fully realising this shift in approach: *care*.³⁰³ The *care* approach, according to Volkmar, encourages community engagement and continued meaning-making practice. It is about addressing the intended future recipient with their responsibilities. She continues:

RK&M is about finding ways to communicate with future generations. Every message is created (consciously or not) with a certain recipient in mind. As such, the kind of message that is sent determines, at least to some extent, the kind of response it provokes. While a warning addresses an *intruder* and an instruction a *user*, what is

³⁰¹ The Human Interference Task Force that established nuclear semiotics in the 1980s was tasked with how to warn future people. A growing trend towards layered communication that also informs was adopted by SNL in the 1990s, and RK&M has developed this into a systemic warn and inform approach in the 2010s.

³⁰² Historian Nick Yablon writes about the problem of establishing a 'theory of obedience rather than obligation.' And that our descendants should not be imagined as 'passive subjects rather than active agents.' Nick Yablon, *Remembrance of Things Present: The Invention of the Time Capsule*, (Chicago: The University of Chicago Press, 2019), p. 54.

³⁰³ Volkmar, 'Wicked Complexity', p. 150.

needed to attach relevance to a piece of information handed down, is a *carer* – someone who takes responsibility rather than following (or ignoring) a warning or instruction, be it in the present or in the future.³⁰⁴

Volkmar's approach emphasises *responsibility* and the need to act in ways beneficial to RK&M, as opposed to the more passive receiving of information that is favoured by the *warn* and *inform* approaches. For me, the choice of the word 'care' goes beyond responsibility which may be a maligned action, or one performed out of imposition rather than desire. 'Care' assumes a nurturing role where the outcome is more considered. The persistence of message and responsibility that is inscribed on radioactive artworks may be viewed as catalysts for fostering a care approach. Responsibility is evident in *Inheritance* and *Black Square XVII*, where recipients are tasked with measurement or completion duties. They are less evident in Robert Barry's pieces, and the reopening of the *Don't Follow the Wind* exhibition is more focused on the bureaucratic completion of remedial works following the Fukushima reactor meltdown. *Responsibility* for these works may be reduced simply to keeping them safely away from people. *Care* of these works, on the other hand, implies a more involved role. Care connotes active engagement with the objects; not just custodianship but stewardship. The care approach may usher in the 'shared authorship' that Zonnenberg opined about and that is observed in action with Marita's *Chronik*. In Volkmar's revised approach, people of the future are not distrusted but quite the opposite; they are invited to receive and add to the message, co-authoring and renewing the interest.

To develop Volkmar's proposal even further, radioactive art can contribute to the marking and retention of knowledge of a GDF through constant acts of renewal. To achieve this, a relay system of caring stewards must be formed. This is no simple task, and it is unlikely that the role can reliably be bestowed from generation to generation. Instead, it is more probable that the role of a caring steward emerges periodically, if not perpetually from the demands of the radioactive art object itself. An art object that requires nurturement and care that cannot be ignored – however that may be manifested through form – is preferable to a more passive art object that does not impose the same conditions on its custodian. Regardless, the object must demand the custodian instead becomes the steward in order to maintain RK&M.

With the active role of carer, all stewards must therefore perform labour which in itself is problematic. But as withdrawal and uncertainty have shown, labour can be in the form of seeking truthfulness. As such, the radioactive art object's placement is an important factor in the flux and entropy of its meaning and associated RK&M. Radioactive art does not project from point A to point B in time, it is an energetic mechanism that collapses the problem of

³⁰⁴ Volkmar, 'Wicked Complexity', p. 155.

signifier and signified. It is a clock, but it does not simply count down. As Cray has pointed out, the contextual placement is imperative to the function of this clock.³⁰⁵ A critical distinction must be drawn between *conservation* in a museological context that aims to arrest decay, and *maintenance* that allows for systems of labour that permit a degree of change – the replacement of parts or updating of texts. A form of maintenance that exists outside of museological constraints may be more desirable to allow for entropy. Placing the object outside of systems where knowledge is more ‘assured,’ but open to interpretation and free to be subjective allows for a greater degree of entropy – more uncertainty. Being outside of ‘expert’ care may actually be beneficial to an accrual of cultural meaning. However, tasking individuals or communities with care responsibilities is not the panacea we are looking for. It is an approach that demands the labour of maintenance, whether physical, social, conceptual or otherwise. The impetus to do this is still lacking.

Artist Mierle Laderman Ukeles’s *Manifesto for Maintenance Art, 1969!* (1969) is an illuminative take on the maintenance responsibilities of stewards and custodians.³⁰⁶ The manifesto is first and foremost a feminist comment on domestic labour. However, it also provides a philosophical view on the maintenance of not just art, but waste in art. In her three-part manifesto, Ukeles begins by identifying the mundanity of maintenance, elucidating her experience as a mother in her proposal for doing menial household maintenance tasks as a live performance piece. This, she correlated with the ‘life instinct’ for ‘maintenance of the species’.³⁰⁷ She continues in her second part by highlighting maintenance jobs which she states are ‘confer[ed] lousy status’ by culture. In her third and most relevant part to this thesis, her proposal would highlight ‘service’ systems: purifying, recycling, depolluting, rehabilitating. For Ukeles, maintenance ‘takes all the fucking time.’³⁰⁸ It is not an enjoyable task, nor is it bestowed social reverence. As Sebeok rightly pointed out 15 years later with the need for an ‘enforcement mechanism,’ Ukeles says there is a need for maintenance to ‘renew the excitement’ to overcome boredom and to effect its repetition.³⁰⁹

³⁰⁵ Cray, ‘Conceptual Art, Ideas, and Ontology’, p. 243.

³⁰⁶ Throughout her career, Ukeles’s (1939–) work has primarily revolved around feminist notions of labour and maintenance. Her work often involves the principles of waste, sanitation, care, and pollution in the realms of domesticity, waste management, and as art institutional critique.

³⁰⁷ Mierle Laderman Ukeles, ‘Manifesto for Maintenance Art, 1969!’, in *Six years: The dematerialization of the art object from 1966-1972: A cross-reference book of information on some esthetic boundaries : consisting of a bibliography into which are inserted a fragmented text, art works, documents, interviews, and symposia, arranged chronologically and focused on so-called conceptual or information or idea art with mentions of such vaguely designated areas as minimal, anti-form, systems, earth, of process art, occurring now in the Americas, Europe, England, Australia, and Asia (with occasional political overtones)*, ed. by Lucy R. Lippard (Berkeley: The University of California Press, 1969), pp. 220-221.

³⁰⁸ Ukeles, ‘Manifesto for Maintenance Art’, p. 220.

³⁰⁹ Sebeok, ‘Communication Measures’, p. 26.

Ukeles's manifesto refocuses any 'care' approach with the reality that radioactive art objects are, in essence, repugnant. In most cases, they are constituted of waste and of byproducts of the nuclear industry. Responsibility for waste is not problematic, but caring for waste is a different story. If maintenance is expected to elicit ongoing interest by fostering a care approach, the question arises: how does this influence the form of a potential radioactive art marker? Should the mechanism for inciting care confer more physicality than conceptual and post-conceptual modes and forms typically offer? Care and nurturement are surely easier to encourage when there is a physical object that requires those activities. Conceptual maintenance becomes more problematic in lieu of a physical object due to the lack of an aide-mémoire. *Inheritance* is a good example of a physical object acting as an aide-mémoire for conceptual maintenance through ritual. Its perceived value and the implied familial entitlement of future generations encourage revisitation, it is the excitement through tradition and ceremony that provides the enforcement. *Inheritance* shows how a physical object encourages conceptual maintenance through the repetition of ceremony. However, in GDFs, prevention of intrusion, of access, and of extraction is the goal. With our current understanding of material use, spent radioactive material provides no incentive to perform maintenance.³¹⁰ In the previous chapter, Smithson spoke of the coupling of waste and enjoyment, but the enjoyment comes from the immediacy of producing waste.³¹¹ To expand on Smithson, the waste is now devoid of enjoyment, there can be no 'excitement' about the waste. But does attributing value to waste via the medium of art propagate excitement? Does a countdown to safety inspire safeguarding and custodianship? These are not questions that can be answered now, but they may progenerate further discussion and considerations in RWM and art marker design.

In an approach similar to Ukeles, Gustav Metzger's *Auto-destructive Art Manifesto* (1959-1961) provides a valuable alternative perspective in which art is left to decay, where entropy is not arrested, and maintenance is not encouraged. Metzger grew up having escaped Nazi Germany after losing his family. His art was inspired by his experiences and memories but became more politically driven towards anti-nuclear armament and opposed the Cold War arms race. His art came from a 'necessity to alert the public, to alert vast numbers of people to the dangers [of nuclear weaponry and global entropy] and the risk to natural existence.'³¹² His manifesto advocated destruction as a process of creation, and that the art should return to nothing within 20 years. The manifesto further specifies the autonomy of the work, and

³¹⁰ There is a speculative future in which waste radioactive materials become valuable for the manufacture of something not yet conceived. In which case, locating and excavating from a GDF is likely to be a valuable endeavour.

³¹¹ Flam, 'Collected Writings', p. 303.

³¹² Gustav Metzger - *Auto-destructive Art*, dir. by Tate (2015).

that the entropy must be self-sustaining, without the need for ownership, custodianship, or intervention. It must be public and never private and encourage public participation.

Metzger provides us with a framework for an alternative view. The celebration of loss is a paradoxical thing but is wholly applicable to the selected artworks. In each of the selected works there is a durational quality that requires patience and the measurement of time. In many respects, radioactivity is auto-destructive, working towards zero (or near zero) in a self-sustaining decay that requires no intervention. Framed through Metzger's manifesto, we are challenged to simply observe this decay as a countdown. Through this framing we find a mechanism that increases excitement the closer the radioactive material gets to becoming safe through decay – a concept that seems quite alien to nuclear semiotic studies where interest is only predicted to decline as time stretches on. Herein, we find some of the excitement Ukeles prescribed.

Both Ukeles's and Metzger's manifestos propose ideas that challenge the distinction between the celebrated labour of development and against the denigrated work of maintenance. For Ukeles, maintenance leaves little room for developmental alteration, just as Metzger contrasted auto-destructive art with its antithesis, *auto-creative art*. They both emphasise entropy, albeit encouraged by Metzger, and held in state by Ukeles. This hierarchy of maintenance is also observed by Shannon Mattern. Mattern argues that innovation and creation is fetishised, especially when it disrupts the mundanity of the status quo.³¹³ She further argues that society devalues the crucial work of maintenance that we are all so reliant upon, aligning with Ukeles. For Mattern, the adoption of a care and repair framework provides a newly bestowed value towards responsibility and maintenance over novelty.³¹⁴ A new value associated with maintenance can be ushered in with the perceived *competence* of caring for a radioactive object. However, I have already advocated for a form of care that exists outside of museological conditions to allow for a greater degree of entropy. We can again turn to *Inheritance* to observe an alternative to structured maintenance; structured ritualism. Ritualism is less associated with museological care than it is with the domestic space. Domesticity, as Ukeles points out is abundant with deeply personal maintenance tasks. Novelty is replaced with responsibility as Mattern prescribes, and competence is derived from heritage and tradition and less from specialist museological practices. Of course, irrespective of the setting, competence necessitates the robust transmission of specialised practical knowledge in radiological safety, material science, and conservation techniques that facilitate a durable form of intergenerational transfer of knowledge. The

³¹³ Shannon Mattern, 'Maintenance and Care', *Places Journal*.

³¹⁴ Mattern, 'Maintenance and Care'.

custodian must be responsive to the needs of the art object lest they become exposed to the increase in risk of its neglect. This cyclical entropy–response loop encourages the care that Volkmar prescribes. It is Berger and Keto’s specification for stewardship as a mode of maintenance that nurtures the social and cultural meaning of the artwork beyond its materiality. In so doing, the shared authorship becomes a factory of cultural production – though this runs the risk of being perceived as positive where a sense of threat and nuclear sublime should not be minimised. Again, a balance must be struck.

A shift towards responsibility of care and the elevation of status bestowed upon it is clearly of value to RWM purposes. Devolving responsibility to a host community rather than a museum (at least in the medium-term onwards) is likely to be beneficial to this shift. Entropy is to be acknowledged and observed as a condition of the existence of radioactive artworks. It should not be arrested but instead form a shared authorship between the decay of the artwork and its materials, and the labour of human care that creates a dynamic narrative for the artwork. In this way, the artwork and its message are not rigidly aimed through time towards an end point in 10,000 or 100,000 years but are perpetually defined anew by its own physical processes and the human labour that attends to it. Stated differently, Georges Didi-Huberman writes:

Before an image [...] we have to humbly recognize this fact: that it will probably outlive us, that before us it is the element of the future, the element of permanence. The image often has more memory and more future than the being who contemplates it.³¹⁵

Didi-Huberman observes the dynamic memory of an image that is a product of shared authorship over time. Clearly, Didi-Huberman was writing about images, but this can be extrapolated to conceptual works. His anachronistic view ascribes a memory to art that extends far before and far after the viewer who observes it. In this sense, the viewer is a temporary contributor to the artwork’s shared authorship of little significance, but nevertheless still important to the artwork’s accrual of memory.

It is important to acknowledge the dynamic life of a radioactive artwork and the relative insignificance of any one custodian or steward. And yet at the same time, each must ascribe care and continue to evolve the narrative of the art object. It is the accrual of stewards that forms the communal shared authorship that allows for a devolution of responsibility into community care and away from the rigid stewardship of institutional care. Everyone must

³¹⁵ Georges Didi-Huberman, 'Before the Image, Before Time: The Sovereignty of Anachronism', in *Compelling Visuality: The Work of Art in and out of History*, ed. by Claire Farago and Robert Zwijnenberg (Minnesota: University of Minnesota Press, 2003), pp. 31-44 (p. 33).

perform on and with the radioactive art object, reshaping and realigning its meaning every time, but forever informed by its past and the unshakeable rigidity of half-lives. This fulfils the RK&M definition of success as being not that the message arrives in the future as fully interpretable, but that at every stage of the message's life that each actor understands the dangers and their responsibilities towards it. The artist is responsible for setting in motion everything that happens around the radioactive artwork, but its material core and message is set in motion from its creation. Herein lies the observable ontology of the artwork, the autonomy of the message is always present, but the reshaping of the message benefits from Volkmar's care approach.

The key to understanding and contextualising entropy here is in the duration of the work/art/performance. For Ukeles, the opportunity for development was minimal in the context of daily maintenance tasks: cooking, cleaning, recycling etc. That said, over greater periods of time, those developments, however small, compound to noticeable changes. For Metzger, the time limit of 20 years supposes minimal day to day changes, but from something to nothing over twenty years is an entire change of state. The need to *zoom out* of the minutia of change to observe entropy at work is seen in a number of other artists from the 1960s and 70s. Dan Graham's *March 31, 1966* (1966) provides a list of distances measured in miles ranging from the edge of the known universe (10^{23} miles), to the distance from the cornea to the retinal wall (0.00000098 miles). Siah Armajani's *A FAIRLY LARGE NUMBER OR A 350,000 (Computer, 1969) DIGIT NUMBER* (1969) similarly uses mathematical notation to convey the invisible, from atoms in the universe, to the number of sand grains to fill up the (visible) universe (10^{100} grains). By zooming out we can see time in greater context. Graham and Armajani each use a single frame or unit of reference to aid in shifting our perspectives. Through this change in perspective, we can begin to comprehend the invisibly large expressed in values relative to fathomably perceptible scales.

Despite their valuable perspectives on the subject, we must now break away from Metzger and Ukeles. By zooming out of time and of space we gain a different perception of scale, seeing how smaller chunks fit into bigger chunks. By breaking the bigger chunks down into perceptible, experiential chunks, we can convey information through maintenance, and by destruction and rebuilding in Sebeok's manageable intergenerational divisions. The slow violence that language and knowledge experience can arguably be mitigated, if not overcome, by entropy – that is to say, transformed. Over time, maintenance becomes development; destruction becomes creation. For those changes to occur, greater expanses of time are necessary and are no longer the problem. This change in perspective finds the opportunities offered by intergenerational processes in deep-time. Nevertheless, as Sebeok rightly states,

the change must be encouraged, and we must find the excitement to encourage continuity. Intergenerational approaches can help achieve this.

From here, we will explore the different intergenerational practices that can be utilised for deep-time communication, and seek examples of them in action in our examples or radioactive art.

Rumour, Myth-Making, and Radiophobia

With *Chronik einer Suche*, Ines Marita performed a maintenance task by renewing knowledge and creating new documents about Robert Barry's *Uranyl Nitrate*. But curiously, the mystique of Barry's piece is left intact. Whilst Marita's initial intention was to search for and reveal the presence of Barry's work, her response quickly turned to protecting ambiguity, aware of the important role it played/plays in maintaining interest and knowledge. In *Chronik* we observe an artwork, or an act, that brings rumour back into parlance of the Kunsthalle. Whilst knowledge and records of Barry's piece were still relatively robust, memory – particularly local memory – seemed to be in decline. Suddenly, through Marita, the invisible threat was revealed not through the act of finding, but through the act of remembering about the threat. Importantly, the 'truthfulness' (or otherwise) of Barry's artistic intervention was never revealed. This is an important distinction for nuclear semiotics and shows that rumour can be powerful in recycling 'knowledge' even if it is unproven. Even if the radioactive powder *was* disbursed in 1969 but has subsequently been lost or redistributed in the intervening years, Marita did not seek to reveal this. *Chronik* revives the knowledge of invisible threat. It has also revived the knowledge and renewed the memory that the roof space is an imbued space – that the concept of the work also exists in that location.³¹⁶ That threat may be there to be detected, it may not, but perceived radiological threat has the potential to revive knowledge and lead to a radiophobia in the majority of people, keeping people aware but at bay.

Radiation is an engine for myth-making (or mythopoesis) due to its resistance to both sensorial and temporal human perception. Its otherness creates a vacuum of understanding that myth, rumour and conceptualisation are uniquely positioned to fill. In respect of RK&M, this vacuum is not to be seen as a failing but rather an opportunity for alternative modes of producing and renewing knowledge and memory. Like conceptual art, the presence and

³¹⁶ This would be especially true if the radioactive component turned out to have never been installed.

existence of radiation are often confirmed by documents and interlocutors. Marita only learned of the presence of *Uranyl Nitrate* because of its documentation. The documentation associated with Barry's piece neither confirms nor denies the presence of the radioactive material and as such, Marita observed the power of this ambiguity and chose to maintain it rather than seek it out with instruments.³¹⁷

RK&M is sceptical of a mythological approach to marking a GDF in the long-term. The report differentiates between mediated and non-mediated approaches to transmission – a societal approach, and a marker approach.³¹⁸ As a mediated mode of transmission, the report expressly states that the long-term, as defined by the RK&M initiative 'implies that mediated transmission is no longer taking place.'³¹⁹ The report adds, 'mediated transmission relying on a "rolling future" involves the vulnerable requirement of a chain of responsibilities.'³²⁰ Societal and cultural approaches are more appropriate to short-term transmission, not the long-term, according to the report. However, there is strong support for myth-making in the artworks that function as 'rumour engines,' seeding self-perpetuating narratives that can contribute to the RK&M systemic approach. We can briefly turn to Roland Barthes's concept of mythology to explore how a radioactive artwork may function as a self-mythologising machine. For Barthes the mythological process begins when the sign produced by the signifier of radiation (the Geiger counter, the warning sign, the cancer, the document) and the signified radioactive object is reappropriated and becomes a 'second-order system.' The signified object is then 'emptied' of its literal (scientific) meaning and is replaced by an ideological meaning that can include concepts of invisible threat, technological hubris, the unnatural and the deadly. This, combination of signifier and the newly signified according to Barthes, creates the myth of radiation.³²¹ In this way, radioactive artworks and interventions are no longer a combination of signifier and signified, but they become a new signifier to broader cultural concepts. A radioactive artwork is no longer about its own radioactivity, but points to the broader context of contamination and toxic drift.

In this way, the politics of how nuclear waste came into being is erased. Instead, they are replaced simply by the danger that exists outside of human history. The withdrawal of radiation from perception makes it an ideal vessel for myth-making. It cannot be reasserted,

³¹⁷ This does also highlight whether documentation can be trusted and believed in the future. Will future generations take a sceptical view of the 'truthfulness' of documentation. Indexicality, as we have seen, would contribute to mitigating this, but it is possible, if not probable, that documents will not constitute the full truth. Though this is not to be deemed deeply problematic if it encourages the seeking of truthfulness of the radioactive component of the art marker.

³¹⁸ Nuclear Energy Agency, 'Preservation of RK&M', p. 54.

³¹⁹ Nuclear Energy Agency, 'Preservation of RK&M', p. 55.

³²⁰ Nuclear Energy Agency, 'Preservation of RK&M', p. 56.

³²¹ Roland Barthes, *Mythologies*, (New York: Noonday Press, 1972), p. 113.

its reality is very different to ours and cannot be sensed directly. Artists that utilise radioactive materials transform them into signifiers of threat and the production of radiophobia – ideal for our needs for conveying the dangers of a GDF. Artists that leverage rumour, speculation and fear – some of the most logical modes of knowledge production when dealing with an invisible threat – are of particular interest. The public’s ‘knowledge’ of radiation is richly dictated by popular culture, scaremongering headlines and media narratives; in other words, it is primarily a concept of social production, not direct experience. Ferguson made this clear in her concept of the Nuclear Sublime. In popular culture, average workaday characters are transformed into superhumans and superheroes by radiation exposure. Computer games like *Fallout* (and its television series adaptation) allow us to explore radioactive wastelands that are rich with novelty and excitement. All the while, Homer Simpson’s role as Nuclear Safety Inspector satirises any seriousness of the civil nuclear industry. The shaping of the ‘truth’ about radiation by bureaucracy and popular culture is ambiguous and contestable. Our knowledge is skewed by frequent misinformation and ignorance. This shows the long-standing history and power of popular culture in shaping our understanding of nuclearity. Where knowledge emerges from, then, is rather important. Again, we return to the power of direct experience, rather than ‘information’ fed through popular culture, clickbait headlines and social media algorithms that learn and feed into our biases. Knowledge that emerges directly from those closest to invisible radiological threat is likely to carry greater gravitas and ‘truthfulness’ by virtue of its direct indexicality with the affected percipient. Rumour can therefore play a significant role in shaping our knowledge and understanding of the nuclear.

To return to the Non-Visitor Centre for the *Don’t Follow the Wind* exhibition, we see how rumour is a multi-layered mechanism in knowledge transfer. The exhibition site inside the exclusion zone was conceived of as a means to ‘bring long-term attention’ to the spectacle of (the) disaster ‘through the forms of art and rumour.’³²² The artist collective identified the role of rumour in residents and ex-residents of the zone in garnering information about their homes, the ‘safety’ of the zone, and the alleged remedial work being carried out by the government. The exhibition itself is partly conveyed through rumour in lieu of being able to visit it. The NVC satellite exhibitions were modelled on Smithson’s non-sites as an extension of the site to not only provide a visual of what is inaccessible, but also to create a sense of further inaccessibility. The NVC followed the conceptual art trope of the ‘closed gallery,’ bricking up the entrance to the museum with concrete blocks (we will return to the closed gallery trope in the final chapter). By scaling a ‘precarious scaffold and peering into a window for a partial view,’ visitors were provided an experience of what is hidden and

³²² Hirsch and Waite, ‘Don’t Follow the Wind’, p. 17.

concealed. 'The structure [...] was attended to by former Fukushima residents forcibly displaced from the zone. Providing firsthand accounts of the ongoing impact of the crisis, their presence and testimonies collapsed the distance between Tokyo and Fukushima.' ³²³

If the ambiguity of radioactivity is the fuel for the machine, social transfer is the oil that keeps it moving. Social psychologists Gordon Allport and Leo Postman's 'basic law of rumour' explains the workings of the machine.³²⁴ Their study proposed a formula stating the ideal conditions for propagating rumour: $R \sim i \times a$. Where R is the Rumour, i is the importance of the subject to the people involved and a , the ambiguity of the evidence concerning that subject. When both i and a are high, rumour surfaces as the dominant mode of making sense of a situation and relieving tension. Radiation is of high importance, particularly if made present and signified. Ambiguity is on the scale of the hyperobject; unknowable, with the web of its effects impossible to fully know. Rumour is a very suitable method in this case for transfer of information and knowledge. It was already in effect as a result of the so-called TEPCO 'cover up' at Fukushima, and the hesitations of the Japanese government to provide much needed information and clarity. *Don't Follow the Wind* harnessed this social approach to knowledge transfer in both the concealment and closure of their exhibition site, and obscurity and ambiguity at their non-site Non-Visitor Centre.

Rumour was deemed a more reliable source of information than the piecemeal information supplied by official sources by virtue of its emergence from direct experience. This reliability was perpetuated in the NVC exhibitions. For Chim↑Pom, the Fukushima artist collective, concealment was leveraged as visitor experience. Fractured experience by multiple people encourages the sharing of information to realise the whole. In the hyperobject of radiation, this is a potentially infinite source of fractured experience. The zooming in to the atomic level of ionising contamination to the zooming out of broader changes in the landscape confer endless experiences of myriad actors, all with their own tale to tell. However, rumour by its very nature is unconfirmed, potentially false, or uncorroborated evidence. It cannot be relied upon as fact. Robert Jacobs already cast his doubts over social transfer as a game of 'telephone' in the opening chapter. Yet the artist collective evoke a sense of authenticity by providing 'firsthand' rumour straight from the experiences of those affected. Stories emerge directly from the source of the experience, and that experience is also perpetual, fuelled by radiation. With 'telephone,' there is one source of information that is manipulated as it is passed. However, that source is singular and very different to radiation with its ever-unfolding narrative. I argue that 'firsthand' experience is effective at the initial stages of

³²³ Hirsch and Waite, 'Don't Follow the Wind', pp. 135-136.

³²⁴ Gordon W. Allport and Leo Postman, 'An Analysis of Rumor', *Public Opinion Quarterly*, 10 (1946), p. 502.

knowledge transfer but concede that it very quickly has the potential to become spurious, and more likely to become ‘fake news,’ whether actual or perceived. Rumour, though, like its bedfellow gossip, is incredibly powerful. It creates a sense of insider information and a sense of power of the holder of the information, true or not. Rumour, whilst likely to be short-lived as a mode of transfer relative to our deep-timescales, is not to be dismissed. I further argue that rumour’s communal production has the potential to develop into the more enduring forms of socio-cultural transfer, mythology and folklore. We will explore this in more depth shortly.

Rumour and mythopoesis allow for the fluidity of meaning that Smithson’s entropy calls for. It leverages semiotic drift that can work in partnership with toxic drift, evolving and changing as necessary. These social approaches encourage active participation, maintaining ‘knowledge,’ transferring it, and remaking it anew. The radioactive art object is the catalyst of this labour, using its own threat, and its own signification to motivate its stewards. It demands care, especially in domestic settings such that *Inheritance* finds itself in. Concealment is extremely influential in withholding ‘truth.’ I argue that there is no ‘truth’ to be found in ‘fully’ knowing a radioactively contaminated place, as all its hyperobjective qualities can never be fully exhausted. Its permanent withdrawal encourages rumour and withholds truth. Mythopoesis relies on uncertainty to perpetuate it. Both *Uranyl Nitrate* and *0.5 Microcurie Radiation Installation* exude uncertainty. The existence (or otherwise) of the message contained within the radioactive component of *Black Square XVII* is also withdrawn and uncertain. Concealment creates inquisitiveness and mystique, which can be spread by rumour.

Area 51, the US military base now synonymous with alleged extra-terrestrial visits, is a prime example of a remote place with restricted access which has led to a significant amount of speculation. Access restrictions and the mythology/secretcy/rumour around the base’s alleged involvement with extra-terrestrial life has created significant interest by the wider population not just locally and nationally, but internationally. Existing in the away is complicated, but for the purposes of encouraging remembrance, its almost complete withdrawal from public access is its own catalyst for sparking discussion. Here, we can identify the relationship between the away and social relay, and knowledge transferred by spoken word, or rumour. Another example can be found, again, in the work of Stephen Kaltenbach who created ‘rumours’ about works he never performed but convinced people he had.³²⁵ These rumours have the effect of mythologising a work where the content of the

³²⁵ In 1969, Kaltenbach began placing adverts in Artforum magazine. These were short phrases and instructions, one of which was ‘Start a rumor,’ (March 1969).

absent work is created by social speculation in lieu of the truth. This mythologising effect is observed by O'Sullivan in his critique of Robert Smithson's *Spiral Jetty*. He likens *Spiral Jetty* to a 'complex myth-making machine' which is accentuated by the disappearance and reemergence of the artwork as the lake water levels rose and fell.³²⁶ I argue that concealment, and the oscillation between concealment and exposure, either through natural or imposed cycles, has the potential to create rumour which leads to social discourse on the content or the truth of a piece. Concealment and withdrawal also produce a motivating factor: truth-seeking.

Truth-seeking may take a number of different forms. For example, it may be the consultation of documents, it may be a physical trip to *the away* to observe an object or intervention in the flesh. We are slowly building a case that supports the potential of removal of art into *the away* and withdrawing it from access and increasing difficulty in experiencing it that contributes to the mythopoetic mechanism. These searches are then retold as stories. The mythology is furthered by missed encounters, difficulties, and further ambiguity. Observing Marita's search (*Suche*) for Robert Barry's *Uranyl Nitrate*, we can see that the finding of Barry's piece was not the artwork; instead, the act of searching became the artwork. Inconclusivity is incredibly potent and is significantly overlooked in nuclear semiotics. That said, to produce these findings and non-findings, a significant amount of labour is required – the labour of searches and pilgrimage.

Pilgrimage and The Away

The positioning of GDFs (and potentially) radioactive artworks in *the away* necessitates that interested parties must travel to them in order to see and experience them. Because the documents and non-sites cannot fully exhaust the qualities of the site, one must be in the presence of both to more fully experience the artwork and its message. Paradoxically, the more detailed a non-site becomes, the more powerfully it evokes the site that it fails to fully capture in its description. This can increase desire to visit the site and to experience it without mediation, not the inverse. In this site/non-site dialectic a new locus of meaning is produced, in the journey itself.

The draw of the nuclear sublime plays a significant role in this encouragement of journeying. The novelty of a toxic landscape like Pripyat for example (the now abandoned town closest to

³²⁶ S. O'Sullivan, 'Fictioning the Landscape: Robert Smithson and Ruins in Reverse', *Take On Art Magazine*, 3 (2017), p. 61. The *Spiral Jetty* was submerged under water in 1972 and did not reemerge until 2002.

Chernobyl) – safe enough for a short visit, dangerous enough to experience the thrill – escapes any sense of individual responsibility. A toxic landscape is not comparable to, say, a beach littered with plastic that one can help clean up by picking up bottles. The radiologically contaminated site is beyond any contribution to ‘clean up’ that one may be able to make. It is temporally and spatially expansive. And so, all one can do is simply experience what that inferiority is like in the face of such rampant toxicity. Whether a GDF goes so far as to ask us to ‘Stop Worrying and Love the Bomb’ is questionable, but it certainly demands our acceptance.³²⁷ A GDF demands that we accept that it exists, and will *always* exist, and so to live with it. It may be a stretch to say that it even asks us to *enjoy* the novel experience it provides for us, but it is nothing short of demanding of our reverence for it – as a feat of engineering, or of immense hubris, or environmental catastrophe. This type of experience may be the psychological driver for future pilgrimages and ritualistic return.

We need only look to sites of devastation and catastrophe to see examples of macabre ‘dark’ tourism: Pompeii and Auschwitz, for example.³²⁸ Dangerous tourism is equally a draw: Mount Everest, Chernobyl, and more recently, the Titanic.³²⁹ Mircea Eliade’s seminal writing on pilgrimage characterises the act as a movement toward sacred centres in the elsewhere that provide a privileged access to transcendent spaces.³³⁰ Whilst a GDF or radioactive art marker is unlikely to convey the sacred, it certainly conveys otherness. It is a central point that houses and/or emits transcendental energy in a realm very different to our everyday experience. Its otherness should be seen as both enticing and repulsive, a significant problem in itself. What must be avoided though is a sense of commemoration or allowing the markers to be perceived as a monument to a great achievement (even if Ernest Rutherford’s splitting of the atom was such a thing). Markers and the GDF must always be perceived as venerable, yet sinister and dreaded. Enticement and repulsion must be balanced in order to protect the vast majority of people but not be so repulsive that the draw of the nuclear sublime exuded by radioactive art markers and the GDF cannot be experienced.

But what of the draw of a radioactive art marker? So far, this thesis has advocated for a withdrawn conceptual artwork in lieu of an aesthetic experience. If there is no object to draw the pilgrims to the location, then what is doing the luring? Boris Groys writes of the gallery visitor’s utter disinterest in going off to find or experience art:

³²⁷ Dr. *Strangelove or: How I Learned to Stop Worrying and Love the Bomb*, dir. by Stanley Kubrick (USA, 1964).

³²⁸ Tony Johnston, ‘The Geographies of Thanatourism’, *Geography*, 100 (2015), p. 21.

³²⁹ The implosion of the OceanGate Titan submersible in 2023 evidencing the risks of this kind of tourism.

³³⁰ M. Eliade, *The Sacred and the Profane: The Nature of Religion*, (New York, NY: Harcourt, 1959).

Today's consumer of art prefers art to be brought - delivered. Such a consumer does not want to go off, travel to another place, be placed in another context, in order to experience the original as original. Rather, he or she wants the original to come to him or her - as in fact it does, but only as a copy.... The distinction between original and copy is a topological one... If we make our way to the artwork, then it is an original. If we force the artwork to come to us, then it is a copy.³³¹

For Groys, the gallery visitor is content with being presented an ersatz artwork in lieu of effort. This may be so, and certainly defines the safety offered by non-sites and their respective 'non-trips'. However, Groys stops short of saying there is a proportion of people who would be willing to make the effort to behold the original, for authenticity's sake. Groys, as has been established, firmly believed that documents and non-sites were not the art. The presence of a document merely established that the art was absent. Drawing from Benjamin, Groys goes on to say, 'nothing has more aura than the invisible,' alluding to the excitement and pull of that which is withdrawn.³³² Yet, as has been shown so far, whilst conceptual in nature, the artworks selected for this thesis are not entirely 'dematerialised.' There are physical components, and even if they are withdrawn from immediate access to the pilgrim, their presence provides a sensual quality that can only be experienced in proximity to it. Importantly, it is also the repulsive factor. Radioactive art does not encourage lingering due to its aesthetic limitations. In other words, the nuclear sublime is the draw, not its aesthetics. A radiological artistic intervention that confers presence (as opposed to being distantly removed), such as *Uranyl Nitrate* operates through embodied experience. It acknowledges its own inadequacy as a withdrawn material by addressing the promise of incomplete knowledge by the GDF's other explanatory markers. Stated differently, the presence of radioactive materials provides draw and experience that explanatory systemic RK&M solutions cannot and do not. In small quantities, the presence of radioactive materials deposited or dispersed with artistic intent may help address the balance needed between draw and repulsion, and the incompleteness/completeness of experience between non-site and site.

As Smithson previously alluded, to have a non-site is to assume the existence of the non-trip. For me, whilst there is some practicality in partly defining the experience through a non-trip, I find limitations in this idea. For Smithson, space between site and non-site is contracted – one need not travel to it, for the non-site provides all the information necessary. Critics of Smithson: Owens, O'Sullivan, and Ballard & Linden, all intimate that the documentation of *Spiral Jetty*, through the photographs, essay, and film, is just as good as, if not

³³¹ Groys, *Art Power*, p. 63.

³³² Groys, *Art Power*, p. 86.

interchangeable with the real site.³³³ Whilst some may agree (others certainly disagree as I do) the experience of a remote location in *the away*, and the journey to and from the site are part of the experience of the work that cannot be replicated by documentation and non-sites alone. Art historian Erin Hogan writes about her journey exploring the land art of the American West in her Volkswagen Jetta. The experience of the desert heat, the great distances of nothing, the tricks that the horizon played on her eyes, the rough terrain, the unsuitability of her vehicle; these all contribute to the experience of reaching the intentionally remote work of land art.³³⁴ Likewise, artist Tacita Dean's *Trying to Find the Spiral Jetty*, an audio artwork of discussions in the car (real and dramatised) trying to reach Smithson's remote artwork point to the importance of the journey as its own contingent part of the piece.³³⁵ Journeys of discovery into *the away* to seek truth and authenticity are rife with rumour and myth. The difficult journeys experienced by Dean and Hogan have been retold as stories, adding to the documentation, adding to oral history and social transfer, and refuelling rumour. The non-trip does not replicate these struggles and experiences. The non-site does not and cannot fully realise the qualitative experience of journeying, and we must always account for this lack of authenticity as a drive to experience truthfulness.

Journeying, especially walking, is an artistic practice in itself that can aid in defining ritualism in reaching *the away*. Contrasting approaches to walking as art practice can be found in the works of Richard Long and Hamish Fulton.³³⁶ Where Long's practice involved mark-making in the landscape, wearing a path into grass or arranging stones; Fulton's starkly different practice defined the act of walking as the artwork, not the mark that was made. For Fulton, the documentation of the act through text, dates and photographs were enough to evidence and document the walk, aligning with Smithson's non-trip. However, Long's approach to environmental pilgrimatic markmaking is potentially beneficial to the goal of marking a GDF. Tyre tracks and footprints in the vicinity and approach to a GDF or radioactive art marker contribute to the production of a landscape of markmaking. They evidence not only the successful pilgrimages, but the divergences, the circumventions of hazards, the mis-steps, and the unsuccessful attempts denoted by U-turns. These all play into the readability of the surrounding landscape of the withdrawn site. They further reference the human labour involved in attempting to reach it.

³³³ Craig Owens, 'Earthwords', *October*, 10 (1979), p. 128. Ballard and Linden, 'Gеоaesthetics', p. 33. O'Sullivan, 'Fictioning the Landscape', p. 61.

³³⁴ Hogan, *Spiral Jetta*.

³³⁵ Tacita Dean, 'Trying to Find the Spiral Jetty', (1998), p. Audio Cassette.

³³⁶ Both Long and Fulton studied at St Martin's School of Art in London in the 1960s. Along with the duo Gilbert and George, both Long and Fulton progressed sculptural praxis to include the body as the site of practice. Both Long and Fulton each contributed towards a shift away from the produced sculptural object, to the lived experience as sculpture.

None of the example radioactive artworks feature or manifest a pilgrimatic act (though ritualism is present). However, the only artwork that exists in the hard-to-access *away* (as opposed to the rarely accessed public, domestic and commercial spaces that others exist in) is *Black Square XVII*. Given the vitrified cube's extreme withdrawal, it seems unlikely that pilgrimage would occur for this work. Instead, the benefits of pilgrimage and pilgrimatic markmaking are to be for a radioactive art marker at or near a GDF site. Pilgrimage's dynamic performance of memory and stewardship is enacted through the human body in motion, not through encoded signifiers. As a physical practice its message proposes a durability that differs from symbolic texts. Participation builds community knowledge, it is ritualistic and perpetuates the significance of a GDF site even if the message is lost. Radioactive art markers may serve as a locus for pilgrimatic and ritualistic engagement through the desire or sublime drive to *experience* what they offer. Their existence in *the away* is what facilitates the pilgrimage.

To explore an example of pilgrimage as a product of the lure of the combination of labour and experiential reward, let us briefly turn towards *The Clock of the Long Now*. *The Clock of the Long Now* is a monumentally sized mechanical timepiece designed to keep accurate time for 10,000 years. Stewart Brand, co-founder of The Long Now Foundation advocates for mechanisms (physical and conceptual) that correct the 'short-sightedness' of contemporary thinking around 'responsibility.'³³⁷ The clock does not tick, nor does it move, nor chime in the way one might expect a clock to do so. The design of the clock conserves power and limits wear by not displaying time until asked to do so by (presumably) a human. The cranking of a set of gears, powered by human labour, provides the additional power to display the time amongst other outputs such as solar positioning. By doing so, a reward is provided to the labourer by the clock in the form of a chime that is unique to that day, never to be repeated. A mechanical computer determines one of the 3.5 million unique chime sequences, one for every day the clock is visited for the next 10,000 years.³³⁸

This is an excellent example of a mechanism that encourages revisitation, repetition, and that provides reward in order to maintain knowledge of a marker, repository or indeed any deep-time-projecting object. Quoting Brian Eno, the co-founder of The Long Now Foundation, Stewart Brand says the clock aims for the mythic depth to become

[...] one of those system-level ideas which sets in motion all sorts of behaviour without ever having to be referred to directly again. This is what dominant myths do:

³³⁷ Stewart Brand, *The Clock of the Long Now: Time and Responsibility*, (London: Phoenix, 2000), p. 2.

³³⁸ The Long Now Foundation, 'The Clock of the Long Now', (2023).

they make some sorts of behaviour ring with recognition and familiarity for social cohesion about what would otherwise be very hard-to-discuss topics.³³⁹

Echoing Sebeok's proposed relay system as discussed in the previous chapters, Eno furthers this concept with the mechanism of mythology to fuel the relay. An act of labour or maintenance is a viable mechanism in achieving or perpetuating the relay, with a variety of intervals proposed in the differing examples: daily in the case of *The Clock of the Long Now*, generationally in the case of *Inheritance*. Other examples include comparatively selfless, or unrewarded acts of maintenance, such as an account of a visit to Spiral Jetty in Su Ballard and Elizabeth Linden's essay on the sculpture whereby visitors would 'replace rocks here and there that had rolled out of place.'³⁴⁰

Pilgrimage and revisitation pre-empt the destination being visitable in the future and thus acts of selfless maintenance are to be anticipated, not just at the destination but along the path of pilgrimage, and particularly if the destination experiences accelerated entropy because of its status as a site of pilgrimage. The slow violence of entropy is seen here to combine with perceived responsibility to selflessly manage and maintain an object or artwork. The Clock will even be provided with spare parts if and when components and gears wear or seize. An art marker surely must benefit from the involvement of the human (or human descendent) and invite the transcendence of short-sightedness by encouraging selfless acts through imposed responsibility if it is to survive.³⁴¹ In this way, a marker should not only address the human but invite participation through maintenance. Wear is not necessarily a bad thing if it provides an incentive for people of the future to participate in maintenance and reinvigorate knowledge through shared authorship. Whether it follows that survival of the fabric and materiality of the work begets the survival of the message remains unclear. Regardless, *The Clock's* inference of responsibility is likely to manifest a care approach in its visitors to aid in its anticipated 10,000-year endurance.

The clock, which is currently under construction, will exist inside a mountain that will require a day's hike, or pilgrimage, to reach its interior gears.³⁴² Inside the mountain, a spiral staircase winds around the clock that is hundreds of feet tall. The symbolism of a clock designed to keep time for millennia inside a mountain is one of permanence and a foundational marriage of the principles of human ingenuity and perception, with the perpetuity of sublime nature. The scale of the human to the mountain and the clock is

³³⁹ Brand, *Time and Responsibility*, p. 49.

³⁴⁰ Ballard and Linden, 'Geoesthetics', p. 38.

³⁴¹ The ethics of this approach are still questionable, as future peoples are unable to consent to imposed responsibility.

³⁴² The Long Now Foundation, 'The Clock of the Long Now'.

evocative of the fleeting insignificance of a lifetime and of homo sapiens in relation to the destination of the pilgrimage. The away is a necessity for constructing such sublime experiences, for the sheer space requirements alone. To construct something of a similar nature that provides a similar experience (i.e. to serve the same purpose) in a more urban environment is arguably impractical if not impossible.

The promise of reward by *The Clock of the Long Now* to the pilgrim labourer is unique to them. It offers fresh potential and reward that is renewed daily in the form of music, a universally accepted reward, common across cultures past and present for millennia. This novelty for the labour of maintenance is what ‘renews the excitement’ as Ukeles observed. Novelty and unique reward provide recountable story. It cannot be experienced in its entirety and must be shared socially. Its difficulty in accessibility promotes further story-telling by those that attempt the pilgrimage. Even failed attempts promote social discourse, providing details of difficulties, wrong turnings, and challenging conditions.

Returning to the concept of inconclusivity as beneficial to the sharing of knowledge, there are a number of examples which add to the mythology of a place or destination. In her attempt to find James Turrell’s *Roden Crater*, a concealed transcendental space of monumental size, Erin Hogan stated it was ‘an unidentifiable peak in a crater field’ and impossible to find.³⁴³ Tacita Dean, similarly failed to find Spiral Jetty. These failed searches were not shameful attempts but instead led to the production of documentation. Photography and conceptual art, particularly that which is democratic and replicable have long co-existed as evidence of labour or performance. They serve as instructions for any further reproduction or reenactment, continually contributing to the cumulative culture and shared authorship of a piece. When instructions are for ephemeral events (a long walk for example – a pilgrimage), photographs evidence a time-limited action that constitutes the art.³⁴⁴ Pilgrimages and journeys do not accrue value solely through their completion but also through their accumulation of attempts, traces, and retellings. Pilgrimages persist as co-authorships to withdrawn artworks. Pilgrimages attribute meaning through repetition, experience, collective memory, and ensure the longevity of the withdrawn artworks through ongoing participation rather than finite resolution. This can only be facilitated by *the away*, by providing space for failure and the propagation of rumour.

³⁴³ Hogan, *Spiral Jetty*, p. 122.

³⁴⁴ As discussed by William L. Fox, ‘Going to Ground: Performing Land Art as a Photograph’, in *Gianfranco Gorgoni: Land Art Photographs*, ed. by Ann Wolfe, Germano Celant, and William L. Fox (New York: Monacelli Press, 2021), pp. 127-143.

Radiophobia

One way of ‘renewing the excitement’ is with the use of threat. Sublime experiences hinge on the same mechanism, drawing people in to experience the thrill of danger. Threat operates on responses that are believed to be innate, although there is an argument to be made that these are learned behaviours based on cultural understanding and relationships with the environment.³⁴⁵ Radiation is threatening which is heightened by its invisibility. The negative response to the threat of radiation is described as radiophobia which plays a pivotal role in the balance of attraction and repulsion for the purposes of GDF marking. Let us now turn to an example of radiophobia in action in one of the selected artworks.

In 2018, Robert Barry’s *Uranyl Nitrate* was recommissioned by Swiss Institute New York as part of the 2019 re-staging of Harald Szeemann’s *Grandfather: A Pioneer Like Us* exhibition. As part of the exhibition, three seminal conceptual works from *Live in Your Head: When Attitudes Become Form* and *documenta 5* – both curated by Szeemann, the latter in 1972 – were included, notably Robert Barry’s *Uranyl Nitrate* piece.³⁴⁶ Associate Curator of Swiss Institute Daniel Merritt informs me that Barry was approached a few months before the show to recommission the piece.³⁴⁷ Barry agreed and a small capsule of uranyl nitrate was released on his behalf on the roof terrace of the Swiss Institute, just outside of the lift vestibule. A wall text was written indoors in pencil directly onto the wall including details about the piece (fig. 4.3).

³⁴⁵ A good example is found in the people that live in the rural communities surrounding the nuclear test site at Semipalatinsk in Kazakhstan that operated between 1949 and 1989. Some residents believe they have not only physiologically adapted to living in and with the contaminated space, but that their bodies now ‘need’ the radiation. In some cases, individuals believe they have been made stronger as a result of their radiologically contaminated landscape. Magdalena E. Stawkowski, “I am a radioactive mutant”: Emergent biological subjectivities at Kazakhstan’s Semipalatinsk Nuclear Test Site’, *American Ethnologist*, 43 (2016), p. 145.

³⁴⁶ The other two works were Allen Ruppersberg’s *Travel Piece* (1969), and Giovanni Anselmo’s *Infinito* (1971).

³⁴⁷ Daniel Merritt, Interview with the author, 22 July 2020.

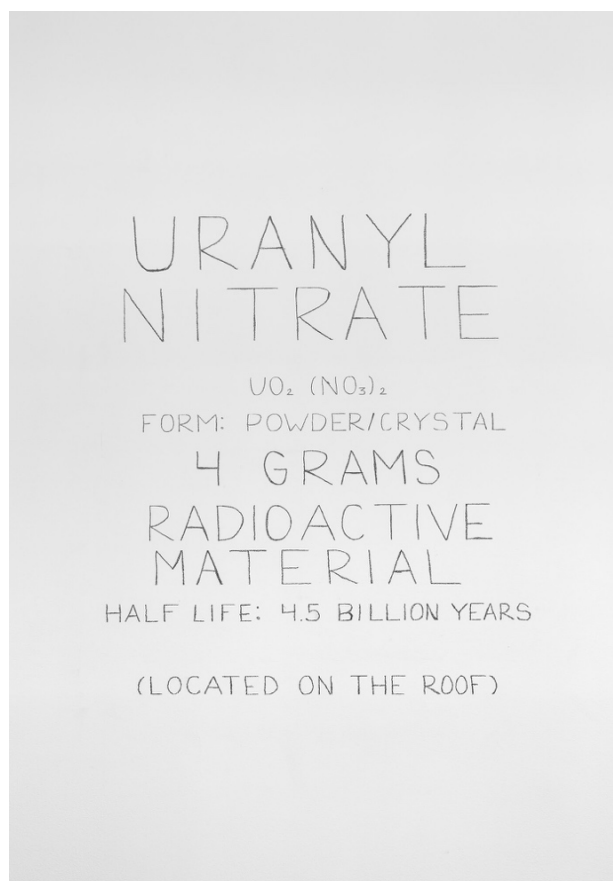


FIG 4.3. Robert Barry, *Uranyl Nitrate* ($UO_2(NO_3)_2$), 1969, wall text in pencil at Swiss Institute, New York.

The work has since been incorporated into Swiss Institute's SI ONSITE programme of semi-permanent artworks installed in response to Swiss Institute's architecture and infrastructure. A plastic label on the roof now draws attention to the work. As part of the documentation of the new work, a photographer was asked to create new images, one that emulated the original photograph of the Kunsthalle Bern rooftop taken from the street (fig. 4.4); the other, a photograph that was to be taken on the rooftop itself, depicting the space where the uranyl nitrate was distributed. This request required the photographer to be in close proximity to the radioactive powder, albeit presumably imperceivable (or very difficult to perceive). Merritt recalls the incident in his interview with me, stating the photographer had reportedly experienced a psychological 'reaction' to the piece (or perhaps, more accurately to the material), believing they could feel the effects of the radiation on their body and therefore refused to continue with photographing the site. Radiophobia was created through knowledge combined with a psychological response to the material, and thus the photographer removed themselves from the area they believed to be contaminated. This can be seen as detrimental to the generation of further archival information (the photograph was

not taken) but conversely may also be seen as a potential benefit by increasing ambiguity and mystery. Regardless, this radiophobic effect is ideal for the purposes of a radioactive art marker: imperceptible materials combined with knowledge, producing an urge to flee the area.³⁴⁸



FIG 4.4. Robert Barry, *Uranyl Nitrate* ($UO_2(NO_3)_2$), 1969, photograph of Swiss Institute rooftop, Swiss Institute, New York.

In the previous chapter, I raised the question of *0.5 Microcurie Radiation Installation's* failure to self-signify, as per Ernst's proposal. What the Swiss Institute recommission shows us is an alternative to documentation: oral communication. A *New Yorker* review of the *Grandfather* exhibition at Swiss Institute said of Barry's piece that it was 'now created inconspicuously (you have to be told of it)' suggesting that even the pencil wall text was easily missed and that word of mouth, presumably imparted by staff, was the prevalent form

³⁴⁸ It should be noted that the enemy of this approach is scepticism. Although now believed to be unsubstantiated, the legend of a curse inscribed on the tomb of Tutankhamun did not prevent the tomb from being opened. The RK&M Final Report also acknowledges this: '[Markers] should not intend to simply scare future generations. Depending on their material, structural design and intended time scope, the information markers are intended to carry can range from "this is man-made" to more elaborate messages. As the example of the pyramids shows, a sheer warning is not enough to keep people away. Warnings are only effective when the addressed share the same symbolic universe of the producers, and even then, men's curious or self-confident nature may supersede. The fear of radiation may become viewed as outdated superstition, just as the fear of the gods did in the case of the pyramids' Nuclear Energy Agency, 'Preservation of RK&M', p. 69. The provision for *evidence* that an unseen threat is present (i.e. radiation), may reduce or eliminate any scepticism at a GDF.

of knowledge transfer.³⁴⁹ Just as has been the case with the *Non-Visitor Centres* for the *Don't Follow the Wind* exhibition, oral histories and rumour are a viable tool in mediation.

Concern for radiological hazard was the reason for testing Barry's *Cesium 137*; its *perceived* threat being the catalyst. Notably, it is the withdrawal of information that produces this effect. A full accompanying explanation of the radiation emitted, its type of decay, and what bio shields are necessary and effective for maintaining safety would limit any psychological reaction to the invisible danger. Instead, radiophobia is a product of uncertainty. It is what is not included, what is hard to understand, and mistrust of the information that is provided by the institution responsible that produces a perceived threat. Barry's use of scientific language of isotopes, decay particles and half-lives in his wall text description may go slightly beyond common knowledge. Mediation is therefore untrustworthy as we cannot fully understand it – we cannot know for sure if 4 grams of unshielded uranyl nitrate is harmful to us at our given proximity to it. The contextual placement also forces us to question both how and what is being mediated. What does a gallery know about radiological risk? How am I to know I am safe? In the context of *Don't Follow the Wind*, the control of information by the Japanese government and TEPCO encourages us to question any political constructs of influence over our understanding. The exhibition's placement in an officially restricted zone signals danger. Likewise, *Black Square XVII* demands we question the role of ROSATOM as an institution that is entrusted with separating us from the danger for at least 1000 years. Who controls knowledge and access to it? An asymmetry of power creates tensions in trust, and if we feel that we cannot trust what we have been told, or suspect mis- or disinformation, radiophobia has the potential to follow. Radiophobia as an artistic strategy is a product of invisible threat and unresolved encounter. It takes the document as its mediator converting language or photography into perception but the experience is not entirely mental or conceptual, it is a real-world threat (this is the *experience* that I have been advocating for). There is potential to mitigate institutional mistrust by percipients by the transfer of knowledge management and production to communities.

Atomic Communities

At any given stage of the nuclear production industry, there are always people and communities that will disproportionately experience the effects of living in these highly charged areas. As is often typical for industrial areas, people of lower economic standing

³⁴⁹ Peter Schjeldahl, 'Wizard', in *The New Yorker*, (New York: Conde Nast, 2019).

represent a large part of these communities. Industrial areas and cheaper housing often coincide, which raises the question of the role of communities that live in the shadow of industrialism. Sometimes communities arise in surrounding areas as a result of job production. The Windscale (now Sellafield) nuclear reactor facility was built in the 1940s on sparsely inhabited land.³⁵⁰ Today, in its decommissioning phase, the site employs approximately 11,000 staff, mostly from the local West Cumbria region. This calls into question what happens to the communal legacy of Sellafield once its decommissioning phase ends and is no longer an employer for the region. (Are community cohesion and shared knowledge products of the primary employer in the region? Will the loss of Sellafield negatively impact local knowledge?) The RK&M report states that ‘industrial heritage sites are also often accompanied by living memory of local inhabitants, families of workers, etc.’ suggesting the importance of industrial sites as producers of cultural memory.³⁵¹ Similarly, the search for suitable GDF sites in the UK includes community consultation very early into the process to determine whether the community will accept the presence and operation of a repository within their locale. Since public and local authority consultation began in the 1980s, there has been overwhelming opposition to GDF planning. In 2008, the UK government shifted tactics to invite communities across the country to express their interest in hosting.³⁵² Only three councils applied. As of 2026, there are still no plans for a specific GDF site.

Willingness of a host community is hugely important. Their acceptance of buried toxic waste in their land is not only necessary for construction to begin but actively shapes narratives in the future – whether they be positive or negative. We have already seen the power of the displaced communities of Fukushima and their potential for the production of rumour – a mode of both authentic and uncorroborated knowledge at the same time. Communities are a locus of ‘shared authorship’ by virtue of their shared stewardship of both knowledge and objects. Whilst institutional care and custodianship undoubtedly have their places and merits, a transition towards community care and cultural adoption is likely to result in a democratic approach to perceiving and receiving encoded and signified radiological intervention.

³⁵⁰ Consisting of mostly farmland and a former ordnance factory.

³⁵¹ Nuclear Energy Agency, ‘Preservation of RK&M’, p. 134.

³⁵² Food and Rural Affairs Department for Environment, Managing Radioactive Waste Safely: A Framework for Implementing Geological Disposal (Cm 7386), (London: Crown Copyright, 2008).

Archive expert Christophe Jacobs argues for the necessity for communities to be involved with the institution dedicated to the preservation and transmission of its heritage.³⁵³ A curator, or an institution alone is not sufficient for the preservation and transfer of heritage. Heritage is a product of, and must belong to, its people and communities. To return to Zonnenberg's argument, the community must be engaged with in a manner appropriate to the type of 'receivers' that are prevalent in the present day.³⁵⁴ However, as Christophe Jacobs points out, the institution is far from durable. It faces threats of destruction from natural disaster, personnel changes, societal shifts, and illegal activities, mirroring the potential reasons for RK&M loss. In these instances, the decentralisation of curatorship back into the community affirms Christophe Jacobs's assertion that 'communities could have a greater role to play in this long-term conservation' and that the 'institutional age' is only a step in long-term heritage transfer.³⁵⁵

To enter the care of an atomic community and remain easily transferable – that is, requiring the least maintenance with little to no specialist skill – a radioactive art marker should, at its very core, be what art writer and curator Tony Godfrey describes as 'democratic art'.³⁵⁶ For Godfrey, a democratic artwork exists outside of the commercial gallery circuit and is overtly simple in instruction and in execution. This facilitates reproducibility by any viewer, visitor or percipient. The instructions can be widely distributed if necessary and need not be site specific. Furthermore, it need not be art-historical in its context. Its inherent democracy can further aid in escaping the art-historical context, and accelerate its adoption into local culture, such that it becomes a local tradition or ritual. An artwork that is unadopted by any custodial institution, arguably leads to its democracy. It is not assigned a financial value if it is culturally owned by its percipients and practitioners. It costs nothing to reproduce, and no institution will be exerting their powers of ownership to seek remuneration due to copyright infringement for example. In this sense, a democratic approach to art maintenance no longer requires artistic skill, only 'desire.'

Art historian Alistair Rider observes this unskilled, non-visual act of artistic production by broadly labelling it 'routine art.' To shift from the labour of maintenance to a vision of a community that engages with artistic maintenance activities by virtue of their innate sensibility, the perceived skill of the artist must be circumvented through a democratic approach. This shift allows all who perceive the art to become artists, labourers of both

³⁵³ Christophe Jacobs, 'Archival and Museum Curatorship Challenges for RK&M Preservation', in *International Conference and Debate on Radioactive Waste Management and Constructing Memory for Future Generations*, (Verdun, France: Nuclear Energy Agency, 2014), pp. 79-80 (p. 79).

³⁵⁴ Zonnenberg, *Conceptual Art in a Curatorial Perspective*, pp. 92-93.

³⁵⁵ Jacobs, 'Archival and Museum Curatorship Challenges', p. 80.

³⁵⁶ Tony Godfrey, *Conceptual Art*, (London: Phaidon, 1998), p. 130.

concept and material observance. Celebration of a radioactive art marker, according to Rider, would therefore emerge from the perceptiveness that the marker and its material observance provide, and not from its craft-based techniques.³⁵⁷ This allows for divergent modes of care to emerge and evolve, and dominant maintenance practices to be revealed. There is no ‘goal’ with routine art, it is open-ended with no defined output, strongly implying that the modality of the routine is shaped by its interpretant caregiver. Rider observes that individual experience is a constituent part of the social collective experience.³⁵⁸ As such, a shared authorship is fostered when maintenance is encouraged through a democratic, routine-led mode of artistic stewardship and care. Arguably, at the stage of an art marker’s life where community custodianship is the primary form of care, the democratic approach both shapes and is shaped by temporally appropriate community responses to living in an atomic landscape, whether individually or as a community. All maintenance-driven responses contribute to the knowledge maintenance and ritualism of an art marker and its concurrent GDF. A divergence from art history, towards an adoptable, process-led mode of artistic approach devoid of aesthetics is a point of further discussion in the final chapter.

The role of atomic communities as stewards is quite simple – transfer the knowledge and keep it local. To predict the community’s feelings towards their atomic heritage is impossible. Communities living in or near to toxic areas across the world respond very differently to one another. Some individuals from the Semipalatinsk people living in the former testing site for Soviet nuclear weapons report their ‘need’ for radiological contamination, such is their perceived dependence on it having lived with it for so long. Others report that it gives them super strength, perpetuating the comic book trope of radiological event equals superhero. On the other hand, as concern over carbon particulates, microplastics, and other hard-to-detect contaminants grows, some individuals and communities look towards migrating away from polluted areas and adopting a ‘cleaner’ lifestyle. This includes attitudes towards food additives, with trends towards wholefoods and limiting the consumption of ultraprocessed foods continue. Living in areas with low toxicity and pollutants is often within easier reach of the more upwardly socially mobile and financially affluent. Disadvantaged groups, as Rob Nixon eruditely points out, so often bear the brunt of over-production and over-consumption, overflow, and the throwaway economy.³⁵⁹ Irrespective of the social status of a GDF host community or its nearby communities, it would seem that a positive or – at least – a cautious veneration of a toxic

³⁵⁷ Alistair Rider, 'The Routine Art', in *Specialism*, ed. by David Blamey (London: Open Editions, 2016), pp. 100-110.

³⁵⁸ Just as *The Clock of the Long Now* plays a melody for the individual who turns its gears. The Clock (or an artwork) cannot be experienced in its totality. It provides individual experience which can then be shared.

³⁵⁹ Nixon, *Slow Violence*, p. 35.

land would be prudent. A reverential view towards a future landscape that has been changed by leaking and deteriorating containment systems could help shape a culture to be more attentive to danger, reinforcing awareness amongst distant generations that a toxic hazard lies beneath their feet. There is an acute lean into speculative methodologies here. It is imaginable that in the deep-future, after warnings and markers have long since eroded, been destroyed, repurposed, or lost, and after any physical components of a radioactive art marker have likewise disappeared, that a culture might have evolved over the intervening centuries. Radioactive art markers will have contributed to this, warning through the provision of what is to come – radiation leaks. This is the hope, anyway. To what end, then, do the selected artworks foster community culture, and the shared heritage of toxicity? How might we shape a radioactive art marker to facilitate this in the future?

The *Don't Follow the Wind* exhibition exemplifies this dynamic by deliberately leveraging rumour and the oral traditions through which it circulates as a key mode of knowledge transfer – mirroring the mistrust of ‘official’ information (or perceived misinformation) as was believed to have been supplied by TEPCO and the Japanese government. It would be reasonable to assume that in the deep-future, rumour (and folklore) would increase in communities attached to toxic lands as credible, legible sources of knowledge. The entropy of ‘official’ information sparks the community discourse. Similarly, Robert Barry was unable to corroborate the continued existence of *0.5 Microcurie Radiation Installation*, prompting investigations and rumours by individuals with no conclusive evidence to prove the affirmative. The perception of continued heritage continues through rumour, whether it really exists or not.

A picture begins to build around the importance of not just the communities and culture that are, or become, associated with toxic landscapes, but also the importance of locality. Non-sites bridge this gap of non-locality, allowing others to access knowledge from outside of the site. Contrary to this, when we look back at Marita’s *Chronik* we see the value in non-sites also being present *at* the site – their presence being the impetus for her response. This becomes especially important when the artwork (or radioactive threat) is imperceivable. The separation of documentation from the site begins to increase risk of exposure which was observed in *0.5 Microcurie Radiation Installation*. Without signs, one does not know what is being signified. *Local* information sparked immediate inquisitiveness for Marita. It has the power to create radiophobia which is not possible when separated from the source of threat: there is no signifier of the imperceptible. The inclusion of Navajo in the WIPP marker as one of the seven languages (the other six being the six official languages of the United Nations) upholds the belief that locality is important to the transfer and maintenance of knowledge. It

allows for the adoption of the responsibility of knowledge transfer when it is entrusted, even if only in part, to a local community. Atomic communities, then, must endure the same conditions as signifiers of imperceptible radioactive artworks. They must be present in the vicinity of the danger in order to effectively care for the knowledge of a GDF or radioactive art marker. Here we see that experience and lived experience are incredibly valuable in knowledge transfer – akin to Japan’s *Hibakusha*.³⁶⁰ It infers a greater sense of authenticity to others which is an asset in meeting the goal of deep-time communication.

An art marker that utilises the same product as a GDF – vitrified waste, as is seen in Taryn Simon’s *Black Square XVII* and Trevor Paglen’s *Trinity Cube* – enhances this sense of authenticity. It is local. Artist Michael Heizer encountered resistance and uncertainty about his vast land art project *City* (1970-2022) from the nearby community. Despite the artwork’s remote site, there were still people affected by the earthworks and concrete mixers rolling through their town. William Fox recounts the shift in community perspective when Heizer – a secretive and notable recluse – finally engaged with the community:

That’s what art is. It’s just communication, conversation, dialogue. And you either get it or don’t get it. Well, they started to get it [the people of Alamo]. They liked the fact that it was big, that it was made with materials they knew – they liked that it was dirt, because that was what was under their fingernails. They liked that he was working in land, and it was masculine and manipulative, because that’s what they do. They use the ground for a purpose. They eat from it. And this guy [Heizer] was just doing his thing. They liked the fact it was there, in that place, because it showed them how important it was to the rest of the world.³⁶¹

Seemingly, from this example, community engagement and the use of local materials – materials that local communities also use and understand – can build a foundation of acceptance as opposed to resistance.³⁶² It is one thing for a community to volunteer for and accept the construction of a GDF within their vicinity, but it must also integrate into their culture, their traditions, and their understanding. Without this, knowledge transfer is immediately met with hostility and roadblocks and increases risk to future generations.³⁶³

³⁶⁰ As a reminder, the *Hibakusha* are the survivors of the Nagasaki and Hiroshima bombings, defined by their lived experience of the atrocities.

³⁶¹ Fox, *Heizer*, p. 173.

³⁶² A similar recommendation for the use of local materials is also specified in the Human Interference Task Force report. Human Interference Task Force, ‘Reducing the Likelihood’, p. 64.

³⁶³ This is perhaps why the communities of West Cumbria remain one of the few areas of the UK that have entertained the possibility of a GDF in their region – nuclear power and reprocessing have been a part of community culture for over 70 years now.

Witnessing

The community plays an integral part in knowledge transfer, evidenced by the frequency with which the RK&M report refers to local community. However, Peter van Wyck is more sceptical of their potential in this role, instead suggesting individual experience to be more important. Van Wyck has been a long-time critic of the nuclear semiotics problem, denouncing it as a futile endeavour. He has dismissed Sebeok's 'relay system' approach as hubris, instead shifting focus towards 'fragile, marginal, unasked and unheard' stories and narratives that may be formed by the materials themselves.³⁶⁴ This indicates a move away from community roles and towards individual, embodied *witnessing*.

Van Wyck's notion of 'witnesses' and 'witnessing' is a valuable point of view that is an important building block in my arguments for stewardship of radioactive art, and GDF knowledge. For van Wyck, witnessing is a doubled practice. On the one hand, nuclear materials may bear witness to themselves, acting as archives of themselves when language and memory have failed to remember or recall the circumstances that surround them. This marries well with my speculative realist stance towards the ontological potential that is baked into nuclear materials at the moment of their conception. On the other hand, for van Wyck, there is the human witness; those that bear witness to harmful pasts, whether they be affected communities or researchers. Just as we have seen with Eleey's encounter with *0.5 Microcurie Radiation Installation*, and Marita's encounter with *Uranyl Nitrate*, researchers and those who seek the facts are witnesses.³⁶⁵

Time is affective in nuclear witnessing. It is a 'slow motion catastrophe' that resists communication and is rich in trauma.³⁶⁶ Whilst time is problematic to semiotic communicative approaches to marking a GDF, devised or invented 'solutions' give way to the readable and materially inscribed landscape according to van Wyck.³⁶⁷ The indexicality of radioactive materials is the traceable component of a nuclear message. Whilst van Wyck speaks more towards the journey of uranium from ore to bomb, his emphasis on a narrative formed by transportation is based in the inter-relations between materials, topography and memory. As such, the landscape is a witness and becomes a *trace* of danger, superior in

³⁶⁴ Peter C. Van Wyck, 'Canada's Forgotten Role in the Manhattan Project', (Concordia University, 2015).

³⁶⁵ Though it must be noted that those that conduct research inevitably leave out information that does not support their methodology, intended findings, or experience. The archive can become unreliable in this case and may be contested for truthfulness. Whilst this may seem problematic, I counter that inaccuracy or biased research may naturally promote opposing views where the truth may be revealed somewhere in the middle.

³⁶⁶ Peter C. Van Wyck, 'The American Monument: The Slow Motion Catastrophe of the Nuclear', in *ICS Speaker Series*, (Bowling Green State University, 1998).

³⁶⁷ Peter C. Van Wyck, *The Highway of the Atom*, (Montreal: McGill-Queen's University Press, 2010).

marking than any symbol that is *about* danger. For van Wyck, the body and psyche therefore become the 'relay,' or mediator of radiological trauma. Transgenerational witnessing in a community, van Wyck argues, is the inheritance of biological and social trauma.³⁶⁸ It may be an individual's experience of cancer caused by toxic environments, for example, that forms the human act of witnessing, and less so by the collective community. As such, van Wyck's notion can be categorised into two distinct modes of material witnessing: ecological and somatic. In ecological contexts, the environment becomes an archive of radiological contamination, not to be read as a sign in itself, but as an ecological disruption. It can be read as an accumulation of change. Toxicity and otherness are to be decoded in the registers of change in flora and fauna, mutated growth patterns, or an absence of life.³⁶⁹ Material witnessing is decoded at the somatic level, no longer relying on an epistemological conscious awareness or observation of radiation's invisible forces. Instead, radiation's persistent energetic force, forces itself on the body as its witness. It is decoded through its indelible trace on the body.

Van Wyck's arguments inform my anachronistic approach with the view that we must shift thinking from *how to warn people of the future*, to a view that asks *the future is already contaminated, what does this demand that we do in the present?* This aligns with Volkmar's 'care approach,' insisting on action, or bearing witness to our responsibilities at any given moment in time. But what happens when there are breaks in this care? Van Wyck is all too aware of this likelihood and asserts that there may be times when there are no future witnesses.

Van Wyck shifts the argument from intentional marking to one of landscape testimony. This shift is vital to the argument that has been formulating, linking leakiness and entropy with the landscape as a form of slowly violent signification. Instability must be assumed as not just likely, but a forgone conclusion.³⁷⁰ The decay of containers – those in GDFs, or the institutional containers of radiological artworks – is inevitable. Who then, when the radioactive materials spill and migrate, contains them with information? In other words, what are the parameters for understanding spatially undefined toxicity? I speculate that when a physical component of a radioactive art marker decays in the future, the landscape becomes the 'witness' to this new state in which the art marker finds itself. This is not to say

³⁶⁸ Van Wyck, 'Canada's Forgotten Role'.

³⁶⁹ For example, the Eastern tree frog has undergone a rapid evolutionary change in the Chernobyl region. Shifting from its typically bright green colouring to a highly-melanated, pitch black colouring as an adaptation to increased radiation in the environment through natural selection. Pablo Burraco and Germán Orizaola, 'Ionizing Radiation and Melanism in Chornobyl Tree Frogs', *Evolutionary Applications*, 15 (2022).

³⁷⁰ Even if this is simply planning for the worst-case scenario. It is of course preferable that GDFs do not leak, but if they do (and discourse frequently points to this probability over the specified duration), it is best practice to anticipate and plan for that now.

the art marker has failed when it reaches this state – rather, this should be intentional if it is already deemed to be unavoidable. It must be a characteristic and feature of radiological art marker design. Uncontainment is inevitable. And whilst van Wyck may perceive the landscape as being richer in narrative at inception than I do, our points align that the landscape is the indexical witness that people of the future can turn to for their source of understanding. When language has broken down; when communities have lost their cohesion, and iconography has been lost, witnesses need no longer be human. The ontology of drifting radioactive materials will carry their meaning until/if they are rediscovered.

For atomic communities – the often marginalised, oppressed, indigenous peoples of lands – being a witness is a difficult if not impossible task.³⁷¹ Not because they are incapable of doing so but because they are unlikely to be heard. Van Wyck's doubled approach to witnessing observes the value of material witnessing. Where Rob Nixon's *Slow Violence* focuses on more immediate timescales of decades and centuries, van Wyck extends this into deep-time violence. Both writers acknowledge the ethical role of testimony and observe the problems of institutional obstruction of communities that bear the most reliable witness. As Christophe Jacobs stated earlier, communities must have control of their heritage, even when contained and controlled by museological institutions.³⁷² This institutional obstruction reflects Nixon's argument that the slowness of toxic violence renders the environmental struggles of marginalised communities invisible to wider audiences. Because these low-income and indigenous communities lack the capital or media visibility to draw attention to the spectacle-deficient injustices they face, their ongoing slow trauma is easily ignored by official political narratives. Reclaiming control over narratives through stewardship is therefore not only simply an exercise in cultural preservation, but a radical political act that directly counters the deliberate socio-economic silencing that Nixon observes in the environmentalism of the poor.

Robert Jacobs also emphasises the oppressed voices of atomic communities. For Jacobs, oral histories, lived experiences, and to borrow Thereas Deichert's usage of the term, *place-thought* are where witnessing occurs.³⁷³ For Jacobs, contamination of both bodies and landscape are the loci of violence and memory production, echoing van Wyck's sentiments. Where Nixon rightly centres community voices as authoritative narratives, van Wyck's

³⁷¹ Nixon, *Slow Violence*.

³⁷² Jacobs, 'Archival and Museum Curatorship Challenges', p. 79.

³⁷³ Deichert builds on the term originally coined by Vanessa Watts. Watts lays a foundation for the agency of the landscape, framing it as alive and thinking. Deichert's expansion introduces an environmental ethic to the concept, asserting the landscape as a witness, but also that humans have a moral duty to 'listen' to the landscape. Vanessa Watts, 'Indigenous Place-Thought and Agency Amongst Humans and Non Humans (First Woman and Sky Woman Go On a European World Tour!)', *Decolonization: Indigeneity, Education & Society*, 2 (2013); Deichert, 'Contested Sites, Contested Bodies', pp. 77-112.

anachronistic view of constant responsibility is more applicable to our argument. For Jacobs, van Wyck, and Nixon there is a cohesive argument that community voices are a locus of authentic knowledge, yet are most at risk of being silenced. Testimony emerges from lived experience, and this is where Jacobs re-grounds van Wyck's deep-time ethics in what I propose to be a *witnessing crisis*. To even become close to resolving this crisis, we need an anachronistic ethical approach to deep-time that prefaces material testimony and landscape narratives with community memory. The trauma of slow violence must not, or cannot, be inferred by monuments, and must instead be confronted head on with material encounters. This is an entropic approach that provides space for emerging testimonies, changeable meanings, and leaky topographic narratives.

None of these radioactive artworks overtly present as monuments of signs, symbols or language, of which van Wyck would denounce the long-term functionality. Instead, communication is by more subtle, less perceptible, ethical violations into bodies and lives. Whether any of these works can, in their present form, ontologically survive the entropy of their context, we cannot be sure. Nevertheless, there are observable clues that fit our train of thought for pre-emptive decay that traverses multiple stages of community custodianship into landscape intervention.

Looking to our selected artworks for guidance on how such an entropic, slowly violent radioactive artwork might look or operate on the percipient, we do see some examples of installation practices, documentation, and material function that we can implement into further recommendations for honing the Art Mechanism. Witnessing is very different between Robert Barry's radioactive pieces and the remaining artists' pieces. We see two distinct eras in art history: the first, where Barry tests our limits of perception and our ability to witness what we cannot detect; the second, a post-Fukushima focus on material witnessing and geological trauma. I would posit that Barry's uses of radioactive materials stem from his interest in invisible communication. His use of radio waves and gases in the same period point to his testing of the limits of perceptibility in art, and the documentation required to communicate this. Barry's pieces came before a number of high-profile nuclear reactor accidents and incidents (Three-mile Island (1979), Chernobyl (1986), Fukushima (2011)) and were therefore unrelated to the resultant geological trauma that would follow. In 1969, when Barry devised his radioactive pieces, the cultural meaning of radioactivity was rooted more in warfare (notably in Japan). For the post-Fukushima artists, radiation is explored in the context of material legacy, radiological geotrauma, and with a greater emphasis on the ethics of deep-time memory than Barry had done 45 years prior.

For Barry, concealment and withdrawal emphasised the public's *lack* of witnessing. Only when they encounter documentation and mediators would they become aware of the present danger. In contrast, Paglen's *Trinity Cube* is in direct antithesis of Barry's material uses. Paglen's cube invites us to bear witness to its materiality: a core of trinitite from the first atomic bomb test layered in irradiated glass from the Fukushima exclusion zone. The cube is a confluence of traumatic origins which are there to be witnessed. The installation setting, inside of the Fukushima exclusion zone draws attention to the withdrawn characteristics of the civil nuclear industry, and its uninhabitability when things go wrong. This makes it difficult to bear witness, but *Trinity Cube*'s absence draws our attention to the absence of the Fukushima region from access, *the away* acting as the sign of danger. This withdrawal is supported by non-sites, documentation, and the *Non-Visitor Centre* satellite exhibitions. Rumour's centrality as a mechanism for knowledge transfer in the *Don't Follow the Wind* exhibition, and the 'uncontainment' of withheld information and shared testimony mirrors the uncontainment of radiological contamination. It draws attention to toxic drift where containment has failed. Witnessing in the context of Paglen's piece is therefore dually social and material.

Berger and Keto's *Inheritance* provides us with a different kind of witnessing. With an emphasis on ritualism and social relay, *Inheritance* leans more towards a Sebeokian transfer than it does to van Wyck. However, its heirloomic quality infers a more individualistic transfer, than it does community adoption. As an object, it builds story and narrative with each generation. Ritualist witnessing is intentional and infers some level of reliability and stability in its repetition. The object has a defined audience and recipient with prescribed responsibilities which alleviates some of van Wyck's concerns about the potential lack of future witnesses. However, there is only ever a recipient for one or two generations in the future at any given time.³⁷⁴ Beyond such time, we re-encounter van Wyck's undefined future witness, and at which point, the art object returns to its own material witnessing. Documents bear witness to the materiality of the artwork's radioactivity, particularly through the production of autoradiographs. Whilst these require labour and care by stewards, there is the material *potential* that is forever inherent in the materials of the work. This strongly supports the argument for radioactive materials in an art marker as the eternal energy emitted from them can be witnessed at any point by human interaction. Ontologically, a radioactive art marker can forever bear witness to itself as a temporal beacon that does not lose its meaning if it is forgotten about. The message remains unchanged irrespective of entropy of language or symbol. It is constant. It 'just' needs to be observed. The doubling of

³⁷⁴ This is true for van Wyck's linear-time argument, though I would argue a different anachronistic perspective.

both human and material witnessing is therefore shaping up to be an important consideration for future recommendations towards art marker refinements.

Atomic Landscapes

Let us now return to toxic drift and leaky GDFs by looking towards deep-time narratives. The RK&M Toolkit views the Art Mechanism as being appropriate for the short- to medium-term, and whilst it identifies scope for extending to the long-term, this has not yet been fully envisioned.³⁷⁵ However, it is presumed that radioactive materials in artworks, just as with their vitrified and encapsulated counterparts in the GDF, will leak and migrate into the surrounding landscape.³⁷⁶ This is to occur long after the artwork has decayed, and likely after its original intended meaning has been lost – a magnitude of thousands or tens-of-thousands of years. As I argued in the first chapter, we should envisage the narrative of the toxic drift of radioactive art not as a contingent but a predictable characteristic of the entropic decay these packets of radioactivity will experience. As radiation leaks and permeates the surrounding ecologies, new narratives are formed that are beyond the original intentions of the artist. A reminder of Rosemary Joyce’s observation: ‘Those things that last usually, if not always, do so in ways that exceed human intention. They may perversely violate intentions.’³⁷⁷ Anachronistic thinking pushes us to think about failure, uncontainment, and the inevitable contamination of the surrounding landscapes of GDFs, of radiological art markers, and the ecologies they support.³⁷⁸ What changes do we envisage? Will people notice? If so, *how* will they notice? Will its strangeness and anachronism be heeded as a warning or sign of danger?

Japanese photographer and anthropologist Chihiro Minato has written extensively on the psychogeography of radiologically contaminated land, specifically in post-2011 Fukushima. Primarily interested in the issues facing nuclear aesthetics, Minato is concerned with the difficulty of adequately representing slow violence after the spectacle of the nuclear disaster has passed. Speaking of the spiritual invisibility of the landscape that includes gods, ghosts and spirits – beliefs that are deeply rooted in the cultural identity of the Fukushima region – Minato uses the term ‘double invisible landscape’ to describe how radiation adds a second

³⁷⁵ Nuclear Energy Agency, ‘Preservation of RK&M’, p. 145.

³⁷⁶ Either through carelessness and damage, erosion and weathering, uncontainment, institutional reconfiguration, or radioactive decay. The likelihood is increased over extreme lengths of time.

³⁷⁷ Joyce, *The Future of Nuclear Waste*, p. 14.

³⁷⁸ Contamination by leak will be by the radionuclides with the longest half-lives. Strontium-90 and Cesium-137 will have dissipated to low-level activity over a few thousand years (both with a half-life of around 30 years). Uranium-235 and Uranium-238 have half-lives of 700 million years and 4.5 billion years respectively.

layer of invisibility.³⁷⁹ In *The Life of Particles*, Minato argues that artistic (not necessarily visual) representations must confront the invisibility of radioactive contamination, not by pretending it does not exist but by finding ways to gesture towards it.³⁸⁰ After looking at images from nuclear accident sites, Minato observed the natural beauty of the spaces, in the autumn colours, idyllic landscapes, and their serenity. Minato states ‘the visibility of radioactivity is in the beauty of nature.’³⁸¹ Minato separates the human responsibility of contamination of the Fukushima region from the natural disaster that led to it – the separation of the failure of anthropogenic systems from the earthquake and tsunami. In short, it is not nature’s fault, it is humankind’s fault. Nature is not to be feared, according to Minato, not even when made toxic, as he paves the way for a new human-landscape ethic.

Minato’s observation of the mythical and spiritual landscape in radiation-affected areas of the Fukushima region opens up considerations for how the introduction of radiological contamination through leaks may be perceived and reasoned in the distant future. Irrespective of the cultural specificity, this is a topic where stepping into the speculative methodology with both feet can open up narratives that we *must* envisage now before we set mechanisms on their trajectories. Imagining a force that emerges, invisibly from the land below that is observably powerful in its effects yet imperceptible save for its registers of change can conceivably enter the realms of mystic gods, ghosts or spirits. A radioactive art marker, already more accessible and more exposed than its GDF counterparts, can be designed to enter and enmesh with the environment to continue its narrative after any observable trace has long gone. The beginning of this trajectory is observable in *Uranyl Nitrate*, freely disbursed and likely beyond the possibility of finding any specific point of radiation emission but more likely to be more represented as an increased level of radiation in its surrounding environs.³⁸² *Uranyl Nitrate* shows how the migratory nature of a radioactive artwork can be set in motion from the outset. In *Chronik*, Ines Marita shows us how that uncertainty can spark enquiry. She further impresses upon us that uncertainty and mystique must be maintained as a malevolent force whether it is really there or not.

A radioactive art marker imagined in deep-time is likely to be lacking its referents that might have been devised at its inception. Any associated documents or non-sites are likely to be lost. This is all but unmitigable. Just as we cannot reasonably assume that any language or pictograph we might devise will be understood in the distant future, nor should we expect

³⁷⁹ Kodwo Eshun and Anjalika Sagar, 'The Radiant, The Otolith Group', ed. by Projekt Atol (documenta (13), Kassel, 2012).

³⁸⁰ *The Life of Particles*, dir. by Angela Melitopoulos and Maurizio Lazzarato (Germany, 2013).

³⁸¹ Angela Melitopoulos and Maurizio Lazzarato, 'Thesis Annex', (n.d.), (p. 58).

³⁸² Albeit likely very weak.

any supporting documents to traverse time beyond a few thousand years. It pays to be realistic in these assumptions rather than blindly assuming this is possible – things *do* get lost. If we return to Cray's maxim that once an object or space has been imbued, so it shall remain, we can perhaps pin some hopes on the life of imbuelement, or in other words, the artistic communication or intent through radiological environmental intervention.³⁸³ Whilst Cray stops short of articulating what happens when the fabric that contains the imbued space crumbles, it is a worthwhile thought experiment. It is quite reasonable to extrapolate imbued spaces into imbued landscapes. In the not-too-distant future, when bulldozers clear away the ruins of the Kunsthalle Bern that contains Robert Barry's intervention, the container is lost, but the imbuelement is not. It becomes more freely distributed. It is buried or reused; it becomes hardcore for roads. It becomes something else. The capability of the human as a witness of the space is arguably lost. No one can point to the radiologically imbued space and identify it as Robert Barry's *Uranyl Nitrate* any longer. Witnessing therefore shifts to the materials themselves. Trace amounts of radiological contamination are emitted from the road where the rubble will be reused. It leaches into the surrounding ground. Subtle changes occur to life around it. New signifiers emerge; the landscape (by proxy) has become imbued. The human witness reemerges to observe the radiological marker as something different. The materials emit memory, even where human memory is lost.³⁸⁴

Elizabeth England states 'landscapes themselves are memory houses, which archivists use as loci for establishing relationships and contexts.'³⁸⁵ England continues:

Structures and landscapes contain rich histories, often layered on top of one another. These memories and multitude of meanings must be preserved, as the physical sites tend to undergo changes, whether through purposeful destruction or passive degradation. Furthermore, documentation about landscapes must be carefully considered for objectivity and reliability.³⁸⁶

This layering of memory and histories is constantly evolving. The withdrawal and reemergence of toxic, imbued landscapes is all but guaranteed over long periods of time. As Morton points out, contamination cannot be removed, only redistributed – usually to *the away*.³⁸⁷ In other words, radiologically imbued spaces will remain so forever, whether in

³⁸³ Cray, 'Conceptual Art, Ideas, and Ontology', pp. 239-240.

³⁸⁴ Given the paucity of the uranyl nitrate that was distributed, this is probably an embellishment on what might actually happen. But had there been a more substantial deposit of the radioactive powder, or the choice of isotope was made based on its type of decay and half-life, this narrative becomes more possible.

³⁸⁵ Elizabeth England, 'The Archive of Place and Land Art as Archive: A Case Study of Spiral Jetty', *The American Archivist*, 80 (2017), p. 339.

³⁸⁶ England, 'Archive of Place', p. 342.

³⁸⁷ Morton, *Hyperobjects*, p. 120.

their artistic containers, or in their ruinous state.³⁸⁸ Memory may therefore be stubbornly resolute thanks to the ontologically persistent material. Its testimony emerges from the materials, regardless of redistribution or concealment, ready to be witnessed again by new humans.

This idea of the landscape holding memory is explored in Aldo Leopold's book, *Think Like a Mountain*.³⁸⁹ In the section, 'On a Monument to the Pigeon,' Leopold writes about the extinction of the passenger pigeon. Crucially, the memory of the natural world is given primacy over 'book-pigeons,' stating that images and texts about pigeons are mere 'effigies [...] dead to all hardships and delights. [...] They know no urge of seasons; they feel no kiss of sun, no lash of wind and weather.'³⁹⁰ The memory of the extinct passenger pigeon passes from men, to trees, to the oldest oaks and finally 'at long last only the hills will know.'³⁹¹ Leopold's view echoes Minato's projection of deep-time in the landscape rather than the ecology that it supports. Whilst Leopold acknowledges that ecologies change, whether by human influence or by natural selection, the memory of that change is retained the longest by the slow temporal rhythms of the landscape. This slowness of the landscape mirrors the temporal scale of the violent materials we intend to bury within it. Leopold suggests that the land, more than any other medium, registers and interprets the behaviour, actions, and ecological roles of individuals (human, animal, or plant). Considering the earlier discussion on Kyveli Mavrokordopoulou and Ruby de Vos's stance on deprivileging the visible as a means to translating the invisible, Leopold might suggest that we convey the nuclear age and its effects through the memory of the landscape.³⁹² This would not necessarily be a positive action, it may be conveyed just as well through a negative ecological intervention – the radiation itself. Leopold concludes:

I have purposely presented the land ethic as a product of social evolution because nothing so important as an ethic is ever 'written'. Only the most superficial student of history supposes that Moses 'wrote' the Decalogue; it evolved in the minds of a thinking community, and Moses wrote a tentative summary of it for a 'seminar'. I say tentative because evolution never stops.³⁹³

³⁸⁸ During the 'clean up' of Fukushima prefecture, the Japanese government removed the top layer of soil from agricultural and residential areas. This contaminated soil is currently stored in temporary facilities ready for recycling, destined for uses such as road embankments. By 2045, the remaining soil will be disposed of outside of the prefecture. International Atomic Energy Agency, 'Japan's Fukushima Soil Recycling and Disposal Plan Meets Safety Standards, IAEA Says', (Vienna: IAEA, 2024). This evidences the argument that there is no 'away,' only redistribution. Furthermore, this layer of history, whilst removed from its site, is not lost, rather it is redistributed elsewhere.

³⁸⁹ For clarity, I refer to the 'Essays from A Sand County Almanac' version of *Think Like a Mountain*, not the essay 'Thinking Like a Mountain'.

³⁹⁰ Aldo Leopold, *Think Like a Mountain*, (London: Penguin Books, 2020), p. 19.

³⁹¹ Leopold, *Think Like a Mountain*, p. 19.

³⁹² Kunstlicht, *Nuclear Aesthetics*, pp. 6-7.

³⁹³ Leopold, *Think Like a Mountain*, p. 84.

Finally, Leopold suggests that the community mind is more influential than the individual mind, and that a land ethic exists in a shared approach towards the landscape. This leans more towards a Sebeokian relay than a van Wyckian. Nevertheless, a case for a human-landscape relationship is building, whether it be a singular individual experience or a community of mythologies and beliefs in relation to changing land. While the memory of a GDF will die with the landscape – according to Leopold – it begins with the community who make the invisible tangible, if not visible. Stories and mythology that begin with the community are translated over the generations into stories that are bound to the topography and features of the land, and it is the short-term social approach that leads to the long-term transfer towards the landscape. Earlier, Spaid spoke of the enduring nature of ecoventionist art practice. She states that art projects that impact local communities since the late 1950s remain visible still. Due to their site-specificity, continues Spaid, the way ecoventionist art impacts local communities ensures that they remain local, as opposed to being transported from one community to another.³⁹⁴

The ecoventionist approach, which is often characterised by the local, aids in its adoption by atomic communities. An artistic ecological intervention that functions as a GDF marker that adopts Spaid's approach is arguably gentler and more acceptable to atomic communities than a radiological intervention. The latter emphasises the geotrauma of the region, and its inhospitability. In some respects, a radiological intervention is to a GDF's benefit, acting as the repulsive power.

We can turn to Alberto Burri's *Cretto di Burri* (1984-2015) for an example of a work of land art that wears its geotrauma on its sleeve (fig. 4.5). Burri's 350 × 280 metre concrete labyrinth commemorates the Sicilian city of Gibellina that was destroyed in an earthquake in 1968.³⁹⁵ Burri collected the debris of buildings, cars, toys, and everything left behind and encased the ruins in concrete blocks with cracks (*cretto*) that mimicked the original streets of the fallen city. Burri famously defined this work as an 'archaeology of the future' echoing Joyce's premise for us to think like archaeologists, allowing for the past, present and future to collide together.³⁹⁶ The suggestion by Burri, here, is that the artwork is not permanent, and it too will fall into ruin. Burri embraces entropy as a mechanism of revelation and communication to future generations. It goes so far as to provide rewards to future

³⁹⁴ Spaid, *Ecovention*, pp. 12-13.

³⁹⁵ Following the earthquake disaster, the town was rebuilt just a few miles away. As part of the new town's reopening, an arts programme was launched to which Burri was invited to contribute. Burri eventually accepted the invitation provided that he could create a monument on the site of the old town.

³⁹⁶ Judy Rozner, 'Comparative study of two large scale commemorative sculptures: Alberto Burri: Gibellina Cretto, Sicily, 1981 -1997, and Peter Eisenman: Memorial to the murdered Jews of Europe, Berlin 1997 -2005', (BA (Hons) Thesis, University of Melbourne, 2007).

‘archaeologists’ – its future visitors – who will glimpse relics of the past as the blocks crumble. In many ways, *Cretto* should serve as an example for visual art marker design. It communicates catastrophe without the use of symbols, it is deliberate and abnormal within its landscape, it exudes memory from its materials, it embraces entropy, aging legibly, and it encourages the embodied experience by forcing visitors to walk to it, around it, and through it. There is a great deal of potential for the incorporation of *Cretto* as an analogue into marker design. However, it is a short- to medium-term solution at best, and this contracted temporality comes as a result of its physicality. This is why we have repeatedly turned to the obduracy and persistence of radioactive materials. Material decay robs us of opportunities to learn about the past. The longer a story goes undiscovered or unnoticed, the more likely it is to be lost. The use of radioactive materials as, or in, an artistic GDF marker shifts us from encouraging future generations to become archaeologists to more simply observers of change and otherness.



FIG 4.5. Alberto Burri, *Cretto di Burri*, 1984-2015, cement, 1.5 x 350 x 280 metres, Gibellina, Sicily.

Despite *Cretto*'s many suitable features for GDF marking, land art approaches fall short of communicating toxic legacy. They can be rich in communicating local geotrauma but are better suited to physical representations of concrete catastrophes. Imperceptible geotrauma lacks a voice. In the long-term, the landscape will be the most affected as contaminants leach into ecologies, are distributed through waterways, and taken up by roots. The landscape can

be given the loudest and longest voice to communicate the otherness in which it exists and that exists within it; in its atypical environment. As Leopold states, the landscape will hold the memory of this trauma for the longest. This will be the most effective and affective deep-time art communicator for the purposes of marking a GDF.

Conclusion

Stewardship and ‘care’ are essential for RK&M transmission. The recipient must always be anticipated whether one generation from now or in 400 generations. In the relatively early stages (the first few hundred to a few thousand years) the role of the community and their experience of radiological hazard and the threat it presents is deeply valuable and powerful for setting the course of knowledge transfer into deep-time. How a community is encouraged to engage with radioactivity is predominantly determined by the artist and how much or how little information and experience they present to the viewer. Whether a community is encouraged to care for a radioactive object or ensure it is kept safely *away*, these all feed into the narrative that begins to unfold into deep-time.

We must also anticipate gaps and losses in intergenerational processes. These may be from RK&M failures or as a result of radiophobia, for example. If we are to burden future generations with witnessing as modes of transmission, then we must also build in redundancy for when human knowledge and memory fail. Material witnessing points to a potential solution for these gaps. Imperceptible energetic materials maintain their own ontology. If they are forgotten by humans, they continue to act until such time that they are observed again. For such observation to occur in a GDF, a breach of containment would be required along with migratory media capable of transporting contaminants to the surface where they can begin to act upon local ecologies to produce signifiers. Stability of the chosen GDF site is a primary concern in RWM, and geological characteristics are scrutinised intensively to determine suitability. And yet as has been said before, toxic drift is still anticipated. An art marker that pre-empts and precedes this by slowly decaying over time as RK&M almost inevitably fades and reemerges in the landscape signifies the warning that we so readily seek. The anticipation of all generations who are tasked with the care of a radiological art marker must also include the landscape as a steward of material register. We must allow the landscape to absorb the memory of what has occurred and what is hidden so that it may retell the warning to future generations who may have not got the memo.

4.

Towards a Revised Art Mechanism

The previous chapters have laid the temporal groundwork that must be anticipated if we are to address the actors and witnesses of radioactive communication equally. As a reminder, RK&M defines the success of conveying necessary information not by a message's arrival at an end point in time, but by its interpretability (and the awareness of its interpretant of their responsibilities) at any given moment in time. Volkmar's care approach imposes responsibilities on the receiver of the message which raises ethical considerations in itself. However, as van Wyck points out, there may not always be seamless continuity of human witnessing, and instead an approach that encompasses material witnessing is beneficial. This final chapter will attest to how my proposed reframing toward conceptual modes of communication shifts physical labour towards didactic transfer over time through preconceived entropic processes.

It would be premature to lay out a design a specification for an Art Mechanism at this stage (although a thought experiment will follow in an epilogue). Instead, this chapter is presented in a similar manner to Volkmar's closing chapter, following Deleuze's dictum, as a text that 'brings forth problems and questions that concern us rather than provide answers.'³⁹⁷ This chapter will not be a definitive list of functions and characteristics of an Art Mechanism. The function of this chapter is to provide topics of consideration for further thought experiments and for new thinking around the interactions between art and humans, and the trajectories of deep-time communication with a view to decay and integration into the landscape, both physically and metaphorically. In this manner, the remaining discussions and thoughts arrive at the same speculative close as many critical thinkers in nuclear semiotics. Crucially, this chapter brings together the themes of temporal matter, spatial withdrawal, and human stewardship to be resolved through the lens of experience. Experience has shown to be a motivating factor in temporal projects (*The Clock of the Long Now* for example). It has further shown to be a repulsive factor, as with the photographer for *Uranyl Nitrate* recommissioning at Swiss Institute. How radiological threat, the institutional and contextual influence, and withdrawal each shape human interaction and experience will all be considered in this chapter.

³⁹⁷ Gregory Flaxman, 'The Brain is the Screen: Deleuze and the Philosophy of Cinema', (Minneapolis: University of Minnesota Press, 2000), (p. 367).

The Vitality of Radioactive Materials

This thesis began with the notional possibility of utilising radioactive material as a communicator of itself when marking a GDF. This idea was then extrapolated into the use of radioactive materials in the RK&M Toolkit's recommendation for Art as a contributor to the preservation of knowledge about the existence and dangers of a GDF. My research has not revealed any suggestions previously made for the usage of radioactive materials in art markers.³⁹⁸ Toister and Astarhan allude to the electromagnetic spectrum as 'the fundamental principle with which not only art but also all human communication is made possible.'³⁹⁹ However, their proposed applications were not specific to GDF marking. This lacuna in nuclear semiotic thinking offers an opportunity for exploration of the concept. Toister and Astarhan began the discussion that conceptual artforms align more with the withdrawn imperceptibility of radioactivity and the dangers posed by a GDF than visual artforms do. My perception that visual modalities are functionally inferior to conceptual forms over long time periods allows for a divergence from the primacy given to visual forms by nuclear semiotic studies and analogues – continuing from where Toister and Astarhan left off.

The usage of radioactive materials in comparatively small, mediated quantities is controversial as a communication technique. It goes against the *modus operandi* of containing the harmfulness of radiation posed by the contents of a GDF. To allow uncontainment is oxymoronic. Yet the nuclear semiotic problem is never fully resolved by linguistic nor by iconographic approaches. Long-term deep-time communication may find beneficial supplementary support from the inclusion of artistically devised radiological intervention, and the effects that may bring. Furthermore, it is the ontological condition of radiation and radioactivity that gives it a vitality that traverses the ebb and flow of knowledge. The slow violence of toxic drift that will undoubtedly permeate ecologies and signify an underlying sinister malignancy, one that adapts to change and is not static on its course presents a readable signification of threat that perpetuates the question of safety.

Artists who work in conjunction with RWM are unlikely to be short of material options that provide different effects on bodies and environments. The six example artworks each use different radioactive materials, each with their own temporal and energetic characteristics.

³⁹⁸ The presence of radiation external to a GDF has been suggested, but never has it been specifically aligned with artistic practice.

³⁹⁹ Toister and Astarhan, 'Spectral Choreographies', p. 191.

The source of the materials has also shown to be important, *Trinity Cube*'s use of Trinitite from the very first nuclear test and materials from the Fukushima zone bookend and contract the narrative of the atomic age to date. The type of radioactive source to be used in an art marker is crucial for communicating in the way that we intend. It must be of the correct durational half-life and must signify itself through changes in its surroundings. A strong gamma emitter is likely to be more suitable than a low-penetration beta emitter by virtue of its greater potential to effect registers of change in its environment. But what changes we aim to effect should receive a great deal of consideration. The type of radio-emission should not be so little as to be deemed inconsequential like a long-haul flight, but to contrast that, is causing death too much or too far? How about bleeding gums, or multi-limbed amphibians? The ways in which both bodily and environmental signification are registered are crucial.

Further consideration should be given to containment, and whether an artistic radiological intervention is contained, as it is with *Inheritance*, *Black Square*, and to a lesser extent *Cesium 137*. Or whether the intervention should be dispersed, or poorly shielded, as is the case with *Uranyl Nitrate*, or that it may or may not exist within the boundaries of an off-limits controlled zone, as with *Trinity Cube*. With *Trinity Cube* we also see the accumulation of external radiation caused by its placement in a contaminated space. Form, or lack thereof, are still vastly open to artistic exploration. Containment and uncontainment both have their virtues and drawbacks. Ultimately, a Smithsonian approach to entropy should be an integral characteristic of any radioactive art marker. It should perhaps stop short of a total return to nothingness as proposed by Gustav Metzger, but future lively narratives must always be encouraged for the sources of communicative radioactive materials used by artists.

This liveliness is essential to the development of the argument. It emerges from radiation's perpetual ontological condition. Jane Bennett in her book *Vibrant Matter: A Political Ecology of Things*, argues that matter possesses a kind of 'vitality' or 'thing-power.'⁴⁰⁰ 'Things' are not inert; they have agency that is distributed across assemblages of human-nonhuman networks. Things, for Bennett, cannot be exhausted by their semiotics yet are not fully withdrawn from access in a New Materialism sense. Bennett's approach provides a useful perspective to start with for this revisionist chapter. After all, what could have more vitality than radioactive material? Bennett states 'a vital materiality can never really be thrown "away," for it continues its activities even as a discarded or unwanted commodity.'⁴⁰¹

⁴⁰⁰ Jane Bennett, *Vibrant Matter: A Political Ecology of Things*, (Durham: Duke University Press, 2010), pp. 2, 18.

⁴⁰¹ Bennett, *Vibrant Matter*, p. 6.

This view emphasises the lively power of radioactive materials and their ability to act upon and influence the world around them. Bennett's decentring of anthropos makes way for an animated network of non-human inter-relations, echoing Aldo Leopold's earlier decentring of human exceptionalism.⁴⁰² If we follow Leopold's advice, we as humans must learn to see from the mountain's perspective as part of an interconnected system. The human perspective must be humbled and make room for ecological ethics. Bennett and Leopold present arguments for a new ecological ethical perspective that rejects the dualism of human and nature. Instead, a radiological art marker design must recognise the relational entanglement of the human/non-human web of assemblages. These new ecological perspectives afford us temporal frames that have previously focused on arresting entropy of messages. Going forwards, we should encourage the web of anachronistic interrelations between beings and humans, envisaging how the inevitable toxic drift can emerge and create new warning signs in the readable landscape.

However, we must remember that the goal of RK&M is to warn *humans* about the dangers of radioactive waste burials. We cannot communicate to the land, to the animals, or to the mountains; our obligation is to warn people. As such, we cannot fully decentre humans as per Bennett's approach. Instead, Leopold offers us a view that humans, whilst not exceptional, act as stewards of the land and as a part of the network of beings that may be affected by toxic drift, but with an ethical agency and morality. Leopold writes 'a thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise.'⁴⁰³ If burying radioactive waste within the landscape is regarded as unquestionably necessary, rightly or wrongly, its toxicity must remain observable and legible for generations if this land ethic is to be adopted. The remoteness of a GDF, coupled with its forbidding and potentially foreboding construction is suggestive of the presence of danger. Burial and the underground are suggestive of underworldliness. The use of the name *Hades* – the Greek god of the underworld – for nuclear decommissioning and geological storage laboratories in the UK and Belgium respectively sets the tone for the mythic, deathly vision of nuclear waste management. The future 'wrongness' of the land around a GDF should serve as a warning of instability and maladaptiveness for future generations.

Toxic drift will inevitably occur for GDFs, more likely on the register of tens of thousands of years than centuries or millennia. A radioactive art marker, designed to decay and sully the

⁴⁰² Leopold does not go quite so far as to fully reject the human but instead envisions humans as stewards of the land.

⁴⁰³ Leopold, *Think Like a Mountain*, p. 84.

land can pre-empt this inevitable occurrence on a smaller scale, serving as a warning of what is below and what is to come. This approach evokes the suggestion in 1993 by Team A of the WIPP markers panel to display ‘small amounts [...] of low-level radioactive materials with long lifetimes.’⁴⁰⁴ Persistent, energetic mediators that act upon their surroundings, independently of their human-relation ontological condition, offer an approach that no longer relies on language or semiotics but operates on a scale of slow violence on the landscape visible to all. Crucially, the vitality of near-perpetual energy as auto-signifier allows for material witnessing and bypasses the problem of inconsistency in human witnessing.

The true location of the art in conceptual art praxis – as has already been established – is deeply contested. However, deep-timescales and a deeply stretched temporal material make the locus of the art clear in radiological interventions. As documentation and non-sites decay or are lost, the endurance and perpetuality of radioactive materials is evidently the art. Artists imbue these materials with meaning and significance. The vitality of electromagnetism, according to Toister and Astarhan emerges directly from its energetic transmission:

To the extent that an artwork requires ‘materiality’ to be manifested and that it is still of concern, the only materiality that can be ascribed here is that of the infrastructure(s) for energy transmission. Put differently, nothing about the materiality of the work is the work itself. Nothing about the artefact (if such even exists) is the artwork.⁴⁰⁵

For Toister and Astarhan, it is the energetic vitality that is the art. Deliberate mediation is secondary:

Without flows of energy, these [electromagnetic spectrum] artworks are like a prism in the dark – extant but stripped of transformative potentialities; present perhaps, but absent nonetheless. Importantly, the energy perpetuated or implied by these works cannot be attributed to objecthood. [...] Just like light breaking through a prism, it denotes not only the activation of an electromagnetic spectrum, but also a spectrum of possibilities for non-artefactual artmaking.⁴⁰⁶

Toister and Astarhan give primacy to the energetic potential of the electromagnetic spectrum to reconfigure perception. Mediation only draws our attention to this and is not the art itself. To be clear, it is the vitality of spectral energy that acts as a temporal extension of artistic intention, signifying and drawing attention to differences and otherness that are important

⁴⁰⁴ Trauth, Hora, and Guzowski, ‘Expert Judgment on Markers’, p. F95.

⁴⁰⁵ Toister and Astarhan, ‘Spectral Choreographies’, p. 191.

⁴⁰⁶ Toister and Astarhan, ‘Spectral Choreographies’, pp. 194-195.

that our descendants observe. As energetic communication shifts from mediation via documents and non-sites to mediation via the landscape, irrespective of the slowness of this flux, observing the mediators and interim interlocutors is pertinent for broad, temporally distributed anachronistic dissemination.

Documents, Mediation and Non-Sites

Documents have repeatedly functioned and been treated akin to treasure maps in the example artworks in this thesis. Photographs in particular have been used to locate imperceptible objects, guided by written information provided in supporting literature. They have been an impetus for further research and have been the source of heuristic discovery by virtue of their availability, access and relative proximity to the site itself. Photographs have shown to add value to ruinous artworks, acting as a parallax for pinpointing what once was. For both the imperceptible and for ruins, they serve as reminders of imbued spaces.

Towards the close of writing this thesis in 2025, Thomas Keating and Anna Storm produced a Key Information File (KIF) for the Spent Nuclear Fuel Repository in Sweden. The KIF summarises key information regarding a GDF at the level of a layperson. They are a key component of the RK&M Toolkit and are intended to be updated regularly to maintain their suitability and legibility. It is acknowledged in Sweden's KIF that there is no organisation that is formally responsible for updating it. Instead, it places an emphasis on the personal responsibility of the reader and provides a methodological approach for doing this: *the SHIRE method*.⁴⁰⁷ Standing for 'Share – Imagine – Renew,' the onus is on the reader to 'keep memory alive' through sharing the file with others, imagining new ways to keep the KIF relevant, and renewing the document to match current knowledge, contemporary media, and societal organisation. The latter tasks the reader with contacting 'at least one of SKB, SSM, the Swedish government, or the party currently holding formal responsibility for updating this KIF, to make sure they continue to renew the contents of this document.'⁴⁰⁸ It also warns that:

If this KIF is not updated and shared at regular intervals, it will not stay understandable, relevant and remembered. If this happens, future generations will not be able to act in an informed way in relation to the potential radioactive hazards posed by the [GDF].⁴⁰⁹

⁴⁰⁷ Keating and Storm, 'Key Information File', p. 20.

⁴⁰⁸ SKB: Svensk Kärnbränslehantering AB (The Swedish Nuclear Fuel and Waste Management Company) SSM: Strål Sakerhets Myndigheten (The Swedish Radiation Safety Authority)

⁴⁰⁹ Keating and Storm, 'Key Information File', p. 23.

Keating and Storm highlight the importance of human responsibility and response to the threat of knowledge loss. The *Imagine* instruction gives a great deal of autonomy to the viewer to adapt, change and *REnew* knowledge. That said, the KIF also presupposes the continued existence and assumed responsibility of organisations, which in my view is unlikely to last beyond a few hundred years. This is not a criticism of the KIF, it is a short-term approach to RK&M that adopts a Sebeokian relay and is valid in a systemic approach. Keating and Storm emphasise the human-to-human mode of transmission, but van Wyck has carved out the reasons why this cannot be relied upon. The focus of this thesis is on radioactive materials' potential for communication across all temporalities, going beyond record loss and entering a long-term phase of non-anthropocentric communication.

In the previous chapter, Christophe Jacobs argued the importance of the role of the community in knowledge production in concurrence with the institution responsible for its heritage.⁴¹⁰ He further argued that the institutional age was a stepping stone in heritage transfer, inferring its return back into the community and out of institutional control. The life of heritage transfer in the hands of the community is a critical consideration. The updating of documentation is an important short-term practice in RK&M maintenance but is a very short-lived practice on the deep-time scales of RWM. Analogue studies show that the maintenance of physical objects beyond 2000-5000 years, irrespective of their importance to us now, is likely to decline or be affected by external factors that severely impact or cease those updates.⁴¹¹ The SHIRE method, whilst a novel approach, is in my view, one such example of a stepping stone to community adoption into local culture. A care approach that becomes more democratic and routine-based preferences (K)nowledge and (M)emory over physical (R)ecords. The loss of records should be expected over time. They may periodically reappear as people embark upon treasure hunts to corroborate rumours or seek authenticity, but they are far from stable. Their loss can certainly be a catalyst for renewal and replacement – *Inheritance* shows us that reproduction of a non-site autoradiograph eludes the pitfalls of linguistic updates and instead encourages the production of indexical non-sites with a high degree of authenticity. However, the informality of community care for K&M is likely to offer a greater deal of continuity than the formal care of R. Social willingness and local stewardship by atomic communities provide the structure for a much more dynamic, adaptive and culturally shaped durability of message. In this sense, whether a GDF is viewed similarly to an underworld, like *Hades*, or as a source of life-giving energy or

⁴¹⁰ Jacobs, 'Archival and Museum Curatorship Challenges', pp. 79-80.

⁴¹¹ A.E. Milodowski and others, *A Catalogue of Analogues for Radioactive Waste Management* (CR/15/106), Radioactive Waste Management, 2016).

powers (both of which narratives have entered present-day popular culture), variable contexts and emerging social conditions in as-yet unforeseen futures still continue to shape knowledge and memory.⁴¹² In other words, they are less likely to be destroyed or abandoned as physical relics are liable to.

Whilst non-sites and documents are powerful catalysts for reaching cultural adoption with mythic depth, they are still a product of the institutional age of radiological art interventions before toxic drift redistributes and reconfigures meaning and signs of register. Non-sites and documents will give way to the self-signifying mode of change in the landscape and environment and no longer be reliant upon literal or iconographic mediation. The decline of non-sites alludes to a change in experiential access. In such case, radiological interventions are no longer functioning as conceptual artworks as we have come to define them. The institution no longer provides the contextual placement that imbued spaces had been dependent on once drift has occurred or begins to occur. The shedding of literal mediation must coincide with its replacement by linguistic mediation – rumour, mythology, ritual. Literal mediation gets us to this point, and whilst I acknowledge this is a very deterministic view in its temporal trajectory, it is also predetermined that the presence and suitability of records will decline. The change of state from literal to linguistic mediation therefore occurs in a relatively very short timeframe and on a rigid trajectory before its very non-deterministic and democratic entry back into community heritage takes over. As toxic drift occurs, the specificity and hyper-locality of non-sites give way to the broader, more distributed topological mediator. Each form has its role in mediation but is temporally contracted in the former and elongated in the latter. The point we must keep returning to is who is being addressed and how the changes in mediation bear the addressee in mind as the *longue durée* of topological register takes over.

Anthropos vs Landscape

The speculative methodological approach has provided opportunities for pushing the boundaries of human/non-human relations and entanglements in RK&M thinking. However, there has been a frequent wrestle with the (de)centring of Anthropos throughout this thesis. Humans and human activity are responsible for the proposed change in epoch, and the permanent radiological stratigraphic marker of our presence. We have been

⁴¹² C. Holtorf and A. Högberg, 'Lessons From Archaeology and Heritage Studies for the Long-Term Preservation of Records, Knowledge and Memory Concerning Deep Geological Disposal Sites for Nuclear Waste', *Safety of Nuclear Waste Disposal*, 1 (2021).

indelible, leaving a treacherous legacy for all present and future living beings. Our inter- and intra-actions with the atom have emerged as expressions of irresponsibility. And yet we are – and remain – entirely responsible. I have at times in this thesis used Karen Barad’s term ‘intra-actions’ to differentiate the conditions and products of radiological contamination through a temporal lens as opposed to the otherwise implied linearity of ‘interactions.’ Barad’s agential realism model would seem like a good fit for resolving some of my thinking, yet I cannot fully adopt Barad’s onto-epistemological condition.⁴¹³ Barad collapses linearity across space and time, which is ideal for our adoption of anachronistic considerations. Barad’s model distributes agency and denies the closure of ethical responsibility which is arguably favourable to the spatio-temporal model of deep-time communication used in this thesis. However, this causes issues for the RK&M definition of successful communication as it removes individual culpability and counters any possible adoption of a Sebeokian relay, which, along with Volkmar’s ‘care’ approach, has been central to this thesis. As much as Barad’s decentring of Anthropos would seem appropriate in this final chapter, we must always return to the need to communicate back to humans. Human inquisitiveness is exceptional and this is the problem nuclear semiotics seeks to address. Despite the many positive aspects Barad presents to challenging nuclear semiotics thinking, the remit of this thesis’s enquiry into RK&M is constrained by RK&M definitions. Despite a hesitance in this thesis to accept it over deep-time and therefore in anachronistic thinking, RK&M transmission is generally regarded as being human-to-human. We can, however, address the potential non-human interlocutors of messages between present day humans, and humans of the future.

The RK&M Final Report predates the surge in progress in artificial intelligence (AI) that has occurred in the 2020s. Until recently, human-to-human transfer was always assumed to be the most likely communicator-receiver combination. However, a paradigm shift in knowledge access and acquisition sees a significant increase in the role of AI. The oversight of documents is well placed for management and updates by AI. In a contribution to thinking about the library of *The Clock of the Long Now*, computer scientist and artist Jaron Lanier writes that the persistence of religious texts such as the Hebrew Torah is due to it being ‘read and copied constantly, not merely on an as-needed basis.’⁴¹⁴ The Torah, and other religious texts, are exceptional to the example of a GDF which asks that we remember to forget it. Once again, van Wyck’s criticism of human witnessing continuity calls into question the stability of updating religious texts – at least by humans. Lanier – who has long had an outspoken aversion to AI – posits that AI would be well suited to maintaining documents

⁴¹³ Barad, *Meeting the Universe Halfway*, p. 185.

⁴¹⁴ Jaron Lanier, ‘Clock Thoughts’, (n.d.).

and information in perpetuity until such time that they are accessed again by humans.⁴¹⁵ Clearly this requires a digital copy of the document, not a physical one, but it raises an interesting question as to *how* the documents are updated.

If AI is tasked with doing the updating, it calls into question who is the audience? Is AI updating texts for an AI audience alone? Or is it updating it with a human audience in mind? Machine-to-machine language parameters are very different to how humans communicate. We must therefore be very critical of the appropriateness of allowing non-human documentation updates. As an emerging field, AI seems to have been largely ignored by RK&M discourse, as unproven, being too technologically leaning, and for providing little certainty compared to more substantial, concrete examples of knowledge transfer. Artist Agnès Villette produced a 2019 ‘experimental [repository] marker’ that ‘consists of a hybrid myth generated by artificial intelligence and spread on social media that revisits a medieval legend.’⁴¹⁶ In practice, Villette’s machine-led document management was flawed and within a few days, social media bots prevented her AI from posting any further. The AI approach is fascinating, particularly as it is an emerging field with many new applications and consequences yet to be discovered. Yet, for it to work, it requires a symbiosis between AI and humans. At present, AI is useful to humans but in a hypothetical James Cameron-esque future where AI becomes sentient, and decides it has other ideas, our entrustment of AI to be the custodian of our knowledge may be to our detriment.

Anthropos is and always will be the audience; there is no escaping this. It is us that must warn ourselves – our descendants. We are the stewards of the knowledge of the dangers we have created. The value ascribed to anthropos should, however, be on a sliding scale. The Art Mechanism in the RK&M Toolkit defines its remit as being within the short- to medium-term timescale. This view has been shaped by the primarily visual art examples and their likely decline into indecipherability. Yet radioactive materials extend this timescale into the long- to very-long term. The inherent increase of signification as radioactive artworks drift and enmesh with interrelationships within local ecologies pre-empts the decay of knowledge with the inverse mechanism of increasing ecological signs. As mediation transitions from documents and non-sites to environmental registers, new actors and non-human interlocutors bare the message that humans must observe and heed. Following Leopold’s dictum to ‘think like a mountain,’ where any perceived certainty of message continuity fails in due course, the landscape picks up and carries the baton of signification. This shift

⁴¹⁵ Lanier, ‘Clock Thoughts’.

⁴¹⁶ Volkmar, ‘Wicked Complexity’, p. 196. Villette was commissioned by Volkmar as part of Volkmar’s PhD thesis.

represents the sliding decline of anthropocentric communication to communication by assemblages of non-human networks.

Chihiro Minato reaffirms this shift in favour of ecological timescales as modes of signification, not human ones. Meaning arises from delayed biological affects, according to Minato, revealing hidden relationships between land and energy such that the landscape becomes legible through its otherness.⁴¹⁷ The combined thinking of Minato and Leopold can help us to envisage an ethic of relational observation and thinking. Signification no longer becomes the problem for nuclear semiotics; it is the surrendering of human exceptionalism to the perpetual language of toxicity and change that emerges from the landscape. It is in this regard that anthropocentrism has remained a complex topic in this research, but this thesis finds value in the gradual increase of non-human actors in mediation that minimises our exceptionalism.

This brings us back to the contestable ethics of contamination as communicator. My recommendations are rooted in the likely inevitability of toxic drift. Living with toxicity is not simply a human condition, it is primarily an ecological one. Just as Minato fails to acknowledge radiological contamination as the death of a landscape, Anna Tsing asserts the emergence of collaborative narrative from damaged and disturbed landscapes.⁴¹⁸ Both Minato and Tsing foreground multi-species assemblages in the landscape, that deprivilege the human as the master of meaning production. Both authors encourage us to live with damage, asserting that we should not aim to erase or 'clean-up' contamination but exist and coexist in the register of uncertain conditions. To reintroduce Joyce to this discussion, it seems there is a broad consensus that toxic landscapes encourage us to observe emergent narratives and understandings beyond our control, particularly as multi-species networks reveal the story in multi-temporalities.

At present, RK&M only envisages the decline of messages, but the proposal for radioactive art markers predicts the changes of register from the human relay system to the inevitable decline of human transmission and the increasing emergence of new temporalities in the landscape caused by toxic drift. It is for these reasons that the anthropocentricity of RK&M approaches – albeit specifically of the Art Mechanism – progressively shed their direct communicative modalities and shift towards more fundamental and universal forms of basic

⁴¹⁷ Museum of Anthropology and University of British Columbia, 'A Future of Memory: Conversations with Masao Okabe and Chihiro Minato', (2021), p. <https://www.youtube.com/watch?v=HvPlFRraAXo>; Eshun and Sagar, 'The Radiant'.

⁴¹⁸ Anna Tsing and others, 'Arts of Living on a Damaged Planet', (Minneapolis: University of Minnesota Press, 2017), (p. G2).

communication. The entropy of communication and its 'solutions' are unavoidable. Solutions to entropy beyond comparatively few generations are doomed to be flawed. Let us accept this and let us work with this.

Threat as Experience

Now that a semblance of the timeline and entropic narrative of a radioactive art marker has been established, let us zoom back in on the effects of radioactive threat as a means of repulsion. Peter van Wyck's notion of radiological threat focuses on the *longue durée* of trauma, stressing that it is always and inescapably present in the future. The spectre of radiological threat haunts us, according to van Wyck. Where imperceptibility interrupts our observance of the spectre, van Wyck ascribes this failure to narrative construction and its inability to resolve the absolute invisibility of radiation.⁴¹⁹ This absolute invisibility perpetuates the threat. By way of contrast, Theresa Deichert extends radiological threat beyond van Wyck's anthropocentric view into the realm of active collaboration, and adopts Vanessa Watts's concept, 'place-thought' to describe the liveliness and agency of the toxic landscape in its own narrative.⁴²⁰ Van Wyck describes the short-term early stages of radiological threat and how it may be mobilised as a tool for setting the course for deep-time communication. Deichert is at the opposite end of the scale, going from the fully withdrawn van Wyckian perspective to the emergence and expressiveness of toxicity. The key comparison is the centrality of humans in van Wyck's view and the non-human centrality in Deichert's view. Both treat the experience of threat very differently, but both are applicable across a deep-time narrative.

Writing about radioactive artworks that use contaminated foodstuffs grown in the Fukushima region, Deichert pinpoints the meaningful effects of human-contamination collaboration in illustrating radioactive threat.⁴²¹ Her focus on human/non-human collaborations serves as a thought experiment that decentres artistic authorship, allowing the experience of contamination to take centre stage, not art-historical context. 'Radiological experience' is the primary focus of the artistic expression. For Deichert:

⁴¹⁹ Van Wyck, *Signs of Danger* p. 29.

⁴²⁰ Deichert, 'Contested Sites, Contested Bodies', p. 89.

⁴²¹ Deichert, 'Contested Sites, Contested Bodies', p. 94.

The presence of [the radioactive object] forces the viewer to grapple with anxiety as she becomes conscious of her own permeability as an organism. She recognises that she is in fact made up of the environment that surrounds her, as it becomes her through metabolism.⁴²²

Exposure as experience forces the percipient to assess their own vulnerability through the human/non-human collaboration. In a contaminated space, the human may see themselves as alien to the environment as the environment penetrates their body, violently rejecting them. Importantly, for the artworks that Deichert studied (*Flow in Red* (2014) by Kyun-Chome and *Does This Soup Taste Ambivalent?* (2014) by United Brothers), (figs. 5.1 and 5.2) the message must be conveyed first: this is (potentially) contaminated; this is radioactive.⁴²³ This message was transmitted verbally, and viewers could choose whether to ingest or not to ingest the food. In this case, we see the use of social transfer and rumour to convey the presence of radioactive threat. The notion that an artist would willingly serve radioactively contaminated foodstuffs causes one to raise an ethical eyebrow as to whether it really is contaminated. Artworks that make provision for testing this threat may prove beneficial to corroboration of rumour, such as the case with *Inheritance* where simple tools for testing radioactivity are included with the artwork. However, the *ambivalence* of the threat, transmitted by rumour, is the mechanism of interest and intrigue production in Deichert's examples.

⁴²² Deichert, 'Contested Sites, Contested Bodies', p. 94.

⁴²³ Irradiation of food is a common sterilisation practice. 'Authorities in at least 69 different countries have approved the irradiation of over 60 kinds of foods, including spices, chicken, beef, seafood, fruit, vegetables and other food products.' Monika Shifotoka, 'What is Food Irradiation and Why is it Important?', (International Atomic Energy Agency, 2025). The difference between radiologically sterilised food and contaminated food is the sterilisation does not make the food radioactive itself. Whereas contaminated food from the Fukushima region for example, has absorbed (or may have absorbed) much more hazardous radionuclides that is *inside* the food.



FIG 5.1. Kyun-Chome, *Flow in Red*, 2014, rice, plaster, warning tape, video, Taro Okamoto Memorial Museum, Tokyo.

Following Deichert, the sublimity and immediacy of radioactive threat strike a balance between the attractive and repulsive forces required for creating interest and intrigue whilst limiting proximity to a GDF. In *Inheritance*, we observe this in practice. The willingness to expose oneself for potential reward (the jewellery), but inevitably (because the jewellery will be radioactive for many generations to come), the instruction to reestablish the protective barriers and containers around the artwork must be followed to prevent prolonged exposure. One cannot enjoy these artworks for long, their threatening energy is repulsive, but for a short period of time, we may experience the frisson of radiological exposure.



FIG 5.2. United Brothers, *Does This Soup Taste Ambivalent?*, 2014, miso soup, Frieze Art Fair, London.

Van Wyck writes that ‘the register of the visual and the material idiom of the monument must convey the visceral.’⁴²⁴ In other words, danger and its co-conspirator, fear, must be conveyed in a marker. Radioactivity, as has been well established, is not visual and this is where documentation must do the literal work of the concept. Van Wyck continues:

[We must] hope that the semiotic decomposition of the sign will take place at a slower rate than the nuclear decomposition of the waste. The sign must outlive the waste; a question of half-lives (waste vs. meaning).⁴²⁵

The notion of a semiotic half-life extending beyond that of a radiation half-life is open to far too much unpredictability.⁴²⁶ On the other hand, radiation itself is markedly specific with its half-life durations and is best placed for signifying itself. Jacobs argues:

We wrestle with what instructions to leave beside the waste – instructions we imagine will help protect people in the future – oblivious to the face that the presence of our waste in their world is the message.⁴²⁷

⁴²⁴ Van Wyck, *Signs of Danger* p. xvi.

⁴²⁵ Van Wyck, *Signs of Danger* p. xvi.

⁴²⁶ At least of a radioisotope selected for the obdurate characteristics necessary for marking a GDF.

⁴²⁷ Jacobs, *Nuclear Bodies*, p. xii.

For Jacobs, we need no longer be concerned about the half-life of signification being incompatibly shorter than the waste, as they are one and the same. The difficulty, though, is in its perception, not its interpretation which then becomes the cyclical problem of conveying the imperceptible through semiotic means. Nevertheless, van Wyck concludes:

[The monument] can only allow the past to be present in the form of a threat to life [which] cannot fully consign the threat to a past, any past.⁴²⁸

The threat must be present, un-ending, and always be conveyed as such. There is a disconnect, however, in being able to fully convey the absolute invisibility of radiation according to van Wyck. Semiotics will fail; communication will fail. Van Wyck's pessimism of potential semiotic solutions is understandable. The impermanence of documentation and non-sites dictates that the human-to-human register of signs will entropy to nothingness long before the threat of radioactivity ceases. Documents and non-sites certainly have their place in disclosure in the short-term, even if they fail at aestheticisation. However, documents and non-sites must give way to a Deichertian approach that adopts interconnectedness as a sign of register in the long-term if we are to believe that we can 'mark' a toxic landscape on deep-time scales.

Social discourse takes over for Deichert, fuelled by observance and uncertainty of signs of radiological threat. To that end, perceptiveness is the experience. By the time a GDF has leaked, toxicity will have reduced somewhat. Threat will be present as life-afflicting but perhaps not life-threatening. This can be pre-empted by a radiological art marker on a smaller scale. Signs of register will be evident in adaptation and otherness in the surrounding environment and ecologies. These signs replace the documents that will have long since failed. The requirement or provision for a Sebeokian relay becomes redundant, as the register of signs is persistent, alien, and provocative. The broad scepticism of the long-term efficacy of Sebeok's Atomic Priesthood need not be a concern. The Sebeokian relay fulfils an early step in a long journey in the establishment of a radioactive narrative. How people of the future observe and engage with evidence of toxicity, and toxicity itself is the remit of those who are most affected by it. Those that live with the slow violence, either by choice or circumstance, have historically had their voices minimised as nuclear-affected people. They live with a profound disruption in their relationship with time, land, and their own bodies. Nixon, Jacobs and van Wyck all write about these ethical considerations. I do not believe that this will change for people of the future who find themselves as inhabitants of toxic places, or in the realm of a leaking GDF. However, examples of marginalisation of affected

⁴²⁸ Van Wyck, *Signs of Danger* pp. 123-124.

peoples emerge from disasters, bomb tests, and toxic waste disposal. There is scope for exploring what the intentional interjection of meaning and heritage through artistic praxis does to influence the inhabitants and beholders of the radiologically contaminated landscape.

Nixon's concept of slow violence addresses the delay of toxic register. Toxicity may emerge from a GDF in tens-of-thousands of years from now (but on the scale of 100,000 years, we may only be 10 or 20% of the way through the proposed duration we must wait before it is 'safe' to be in contact with). A pre-emptive artistic radiological intervention that prefaces toxic drift may establish a relationship between a toxic landscape and its inhabitants on a more controlled scale. Bodies become archives; flora become records. Waiting is still very much a part of the experience, but attention is brought sooner than the inevitably more serious leaks that are predicted to come. In this way, we can further address van Wyck's 'witnessing' concerns. There are certainly benefits to having a self-witnessing material, and radioactive materials make provision for this when human witnessing fails. But witnessing as an event when experienced as permanent toxicity and its signification in the landscape afford further stability to the message. What we are describing here, Jacobs would term '*Global Hibakusha*,' people who are forced to live with radioactivity.⁴²⁹ Atomic communities, Jacobs argues, are marginalised and othered *because* of their contaminated bodies. They experience radiological discrimination. It seems more important, then, that an atomic community *chooses* this, and that it is not a product of nuclear colonialism, or that they and their land must be sacrificed for the 'greater good.' Nixon, Jacobs and van Wyck all describe the experience of toxicity for marginalised people as being 'powerless.' It is important that power be restored to these atomic communities so that they may shape the narrative themselves, defining what it is to live with toxicity – telling their stories and sharing their experiences. By restoring narrative agency to atomic communities, conditions for a nuclear aesthetic can emerge from those whose nuclear experiences are most likely to be silenced. A post-conceptual radioactive art marker must therefore operate as more than a temporal curiosity; it must actively subvert the socio-environmental inequality that originally designated these marginalised communities as sacrificial zones. Refining the Art Mechanism requires an explicit recognition that deep-time communication is inescapably political, and that the sovereignty of atomic communities is defended and uplifted as both a marker and a warning of toxic industrial legacy.

⁴²⁹ Jacobs, *Nuclear Bodies*, p. 8.

Escaping Art History

As we near the end of this chapter, we must finally turn to the question of how ‘arty’ should an art marker be? In the WIPP Expert Judgement report, Jon Lomberg notes:

[Art] exists only to be experienced. If people of the future view the WIPP Marker as a piece of art, they are less likely to try to interpret it as conveying a particular message rather than as some elaborate “artistic statement”.⁴³⁰

Lomberg was clearly writing about the marker itself, not the supporting role of an *art* marker, but his reasoning still stands that any perceived artistic intent may complicate interpretation.⁴³¹ Arguably, the role of the artist is to set the message and material in motion, and to assert its mythic, ritualistic, and/or energetic depth. In so doing, the artist provides the supporting devices that allow knowledge and mythology to be built around radiological interventions. In the short-term, the gallery or art institution acts as a contributor to this and facilitator of dissemination. However, institutional support must succumb to the inevitability that nuclear semiotics fights against. Radioactive art markers are not to be defined by their institutional and art-historical frameworks. The loss of art-historical context and artistic authorship is likely to be beneficial to the deep-time survival of the message. An art marker must not be seen as a monument to the nuclear industries; it must not glorify the toxic legacy we leave.

Celebratory imagery and iconography have had a tendency to be contested, given enough time. The toppling of colonialist monuments in the UK, and confederate monuments in the US in 2020 are excellent examples of the shifting perspectives of previous ‘glories’ and ‘victories.’ The monument to the Confederate General Thomas ‘Stonewall’ Jackson, toppled in 2020 during Black Lives Matter protests was physically reconfigured and reappropriated by artist Kara Walker into her 2025 piece, ‘Unmanned Drone’ (fig. 5.3(b)). What was once considered a heroic symbol of Confederacy was reappropriated to represent the legacy of the victims of those who were subjugated under Confederate rule. Not only has the meaning been changed, but the physical distortion now represents Jackson as twisted and defeated akin to a David Cronenberg body horror character. A hard move away from representationalism, iconography and monumentalism alleviates some concerns over

⁴³⁰ Trauth, Hora, and Guzowski, ‘Expert Judgment on Markers’, p. G85.

⁴³¹ The distinction being that a ‘marker’ should mark the site, somewhat centrally to the GDFs location. An ‘art marker’ is not necessarily central, but I have so far argued that an art marker should be located close by so that it can be adopted by the host community.

reappropriation by any descendants angered by our present-day actions. Being non-visual and non-representational will assist in this.



FIG 5.3(a). The former Tomas Jackson monument, bronze, Charlottesville, Virginia, USA.

5.3(b) Kara Walker, *Unmanned Drone*, 2023, bronze, 134 x 153 ½ x 55 inches, Museum of Contemporary Art, Los Angeles, USA.

To expunge art-historical context is certainly not simple, but perhaps not impossible. According to Taryn Simon's reading of Kazimir Malevich's *Black Square* from which she draws inspiration for her own *Black Square* series, Malevich's 'simple composition represented both an end and a beginning in art history: an attempt to create a new abstraction devoid of overt social or political meaning.'⁴³² Of course, this statement alone is fraught with art-historical influence and interjected meaning, and one cannot analyse a piece by Malevich (or any other artist) without the influence and context of art history. Composition and abstraction will always follow art-historical movements that precede an artwork and therefore are in response to prior tastes and ideals – art history clings on. The

⁴³² Marina Garcia-Vasquez, 'Nuclear Waste is Art in the Work of Taryn Simon', (Vice, 2015).

author of an artwork is the primary influence in perceived meaning before one even investigates influences in temporal and geographical location, politics, society etc. It is incredibly difficult to escape the viscosity of art history, but the first step is to anonymise the design of an art marker.

Art value is of further concern. The ‘dematerialisation’ of conceptual art in the late 1960s into the 1970s was, in part, a direct response to the value-ascribing art market. A ‘nothing’ art presents a problem for ascribing value. Equally, Robert Barry stated that ‘nothing seems to me the most potent thing in the world.’⁴³³ ‘Nothing’ (to a degree) prevents possession or ownership.⁴³⁴ It is freer to enter a life of democratic interpretation as ‘nothing art’ is conceptually instructional and process driven. Lippard observes the power of conceptualism as not about *how much* materiality a work has, but what the artist is doing with it. She goes on to say that it is the *conditions* imposed upon phenomena that constitutes the art.⁴³⁵ Of course, conveying these conditions has typically involved either performance or documentation. Whilst the latter has accrued value and is therefore problematic, the former foregrounds the artist which I have argued against. However, the performance of conditions is the important divergence from visual modes – these performances are democratic, observable and repeatable. They do not need to be repeated by an artist and can therefore be suitable for cultural absorption than physical works can. Authorship and art value can quickly fade away when ‘nothing’ is the art.

Cultural theorist Sylvère Lotringer argues a similar point. In a discussion on art in the Anthropocene, Lotringer stated that ‘so much art today is inflated and replaceable that it might as well have no author.’ The antidote to which, he postulates, is to usher in an age of,

[...] doing away with the artist, but not with the art [...] Unlike ready-mades, un-made art wouldn’t be displaced and recontextualised, but would remain in place to fulfil its function. It would have no name, and no pre-conceived intentions but exist in some kind of collective form.⁴³⁶

⁴³³ Lippard, *Six Years*, p. xx.

⁴³⁴ Whilst uncommon, nothingness *can* be purchasable but is controversial in the art world. For instance, Salvatore Garau’s *Io Sono* (I am) sold in 2021 for over 15000 euros. The purchaser received a certificate of authenticity and display instructions for an empty 5x5 ft space. However, speculation in the art world is rife that ‘overpayment’ for art is simply a way of avoiding tax, which may be an explanation for these kinds of sales. Taylor Dafoe, ‘An Italian Artist Auctioned Off an ‘Invisible Sculpture’ for \$18,300. It’s Made Literally of Nothing’, (Artnet, 2021).

⁴³⁵ Lippard, *Six Years*, pp. 6–7.

⁴³⁶ Sylvère Lotringer, ‘The Last Political Scene’, in *Art in the Anthropocene: Encounters Among Aesthetics, Politics, Environments and Epistemologies* ed. by Etienne Turpin Heather Davis (London: Open Humanities Press, 2015), pp. 370–378 (p. 372).

Whilst the degree of simplicity in permanence of meaning is potentially overstated by Lotringer, his suggestion would be a move in the right direction for increasing meaning durability. Furthermore, an artwork that exists in collective consciousness, owned by everyone who perceives it, is beneficial for social exchange of individual experience.⁴³⁷ Art that encourages thought as opposed to art that provides an aesthetic experience is therefore more appropriate for conveying a message into deep-time by circumventing aesthetic taste. However, the paucity of analogues for art without art history only draws attention to the difficulty of escaping the confusion Lomborg was concerned about. To find examples and analogues, one must look to the beginnings of art in cave paintings. In an article on the present-day perspective of early earth art, John Dixon notes that prehistoric art was 'not made for investigation by art historians.'⁴³⁸ Prehistoric art, by its nomenclature, is the only known analogue for art without art history, but whether a message from the artist(s) was intended is unknowable. We cannot produce an artwork that is pre-art-historic. What we can do is strip it of its 'arty-ness,' its contexts, its authorship, its visuality. Again, ridding an art marker of art-historical context is difficult, but not impossible. Lomborg's view may offer a way to achieve this – by not looking like art at all but using artistic principles – particularly those of conceptual art – to cognitively address the percipient. Conceptual art typically does not *look* like art – or at least the type of visual art most people think of when asked what art looks like – and therefore offers a gateway into circumventing changing tastes and perceptions of art and aesthetics in the future. Conceptual art can be conceived of as a way to provoke thought in the percipient and may not even be interpreted as art at all which would be beneficial to the longevity of an art marker.

It appears that there is support within nuclear semiotics and epoch discourse for taking a view that art history is likely to be problematic for interpretation. Eschewing art history would also limit or remove the 'insidious manipulation' of the role of the curator.⁴³⁹ No longer would the art institution influence meaning but instead would release these art markers from their 'glass case of art history.'⁴⁴⁰ This would allow other disciplines to critically enquire their meaning in the future, freeing them to be 'handled and passed around by those in other domains, in precisely the kind of cooperative transdisciplinary manoeuvres that the Anthropocene demands.'⁴⁴¹ In this way, the message or warning set in motion by an

⁴³⁷ Robert Barry stated that the entirety of an art is unknowable because its whole is constituted of each individual's experience of it. Duchamp made a similar proclamation in his 1957 speech at the American Federation of Arts convention: '[...] the creative act is not performed by the artist alone; the spectator brings the work in contact with the external world by deciphering and interpreting its inner qualifications and thus adds [their] contribution to the creative act.' Barry: Lippard, *Six Years*, p. 113. Duchamp: Marcel Duchamp, 'The Creative Act', in *American Federation of Arts convention*, (Houston, TX: Philadelphia Museum of Art, 1957).

⁴³⁸ John W. Dixon, 'Towards an Aesthetic of Early Earth Art', *Art Journal*, 42 (1982), p. 195.

⁴³⁹ Groys, *Art Power*, p. 45.

⁴⁴⁰ Ballard and Linden, 'Geo-aesthetics', p. 14.

⁴⁴¹ Ballard and Linden, 'Geo-aesthetics', p. 14.

artist is no longer solely the remit of art historians and gallerists. It can enter the domains of physicists, geologists, ecologists, humanitarians, and so on. Escaping art history may allow an art marker to perform its 'function' as Lotringer says. A conceptual art marker circumnavigates a number of the concerns around art-historical contextual problems and encourages community engagement and social transfer. This is important for the promotion of the next stage of an art markers life, from the 'institutional age,' to the long-term conservation role that communities play.

Interestingly, Lotringer's suggestion for 'un-made art' not only diverges away from authorship, but away from making itself: 'an art that would be produced for reasons other than aesthetic.'⁴⁴² The physical component of a radioactive art marker – no matter how temporary – should not be indexical to the artist. Any form must not imply the closeness of the artist's hand but instead infer a machinic quality that removes any suggestion of being handmade and ergo, handling. (The lead wrapper around *Cesium 137* with its evidently malleable form is an example of the opposite of what should be produced for an art marker.) Closeness in production should be eliminated so as not to infer safety in close proximity. We can further this thought and state that an inference of mechanistic installation methods is also preferable. The romanticism of past-present human connection in handprints, brushstrokes and gestural marks will be lost. It is acknowledged that this has a potentially detrimental effect on garnering interest. However, an art object and art concept that infers 'advanced' culture and capabilities, and that is symbolically human either mitigates this or provides an alternative pathway towards techno-romanticism through the techno-sublime.

The Closed Gallery

There has been a very critical stance towards the role of galleries and institutions for conceptual art markers in this thesis. The escape of institutional control and critique is crucial in bolstering the chances of survival of a radioactive art marker. Yet it is also necessary at its outset for providing context and interpretive support. It is a necessary evil in the short-term. Whilst this is accepted, it would be pertinent to devise curatorial practices that would attenuate the over-reliance on, and over-influence by, the art institution.

The closed gallery exhibition trope offers a subversive approach that limits the museum/gallery input, deprivileges the visual and emphasises conceptual modality. The

⁴⁴² Lotringer, 'Art in the Anthropocene', p. 372.

Don't Follow the Wind exhibition is the preeminent example of exclusion by radioactivity. It transforms a zone of uninhabitability into a curated space of meaning production but remains isolated from view. It does not signify emptiness but instead an inaccessible interior within which is contained hazardous objects and conditions. This is similarly observable in *Uranyl Nitrate* – ‘nothingness’ occupies a space which of course cannot be seen. The altered state of the ‘empty’ space implies inaccessibility of the art. The percipient infers nothingness. These are voids of exclusion but are active and rich with energetic power that are capable of transitioning between human witnessing and object witnessing as necessary. A refusal to fully yield their contents emboldens these active voids as performative spaces where experience can be had but not immediately perceived.

The Non-Visitor Centres adopted this trope in part, but I foresee the potential to extend this further. Rumour was central to the NVC approach to communication. The closed gallery trope’s denial of access shifts aesthetic witnessing to social witnessing. This could prove to be a fantastic engine for rumour – discussions about what cannot be seen, what is removed from access, what could potentially be present (if anything). The ambiguity of presence, as evidenced in *Chronik* only furthers the rumour mill. Robert Barry produced three closed gallery exhibitions throughout 1969 and 1970. For Barry, these artworks were an attack on the gallery system, deliberately subverting and antagonising the gallery’s functionality in the art world system. Mathieu Copeland writes:

The statement that the closure itself was the work makes this piece a fundamental milestone of conceptual art. The statement substitutes for the whole and shapes its form. The sentence deliberately annuls the traditional location of art – the gallery.⁴⁴³

It is this relocation of art that is of particular value for art marker purposes. The closed gallery dislocates the institutional support structure. It is common for closed gallery exhibitions to ‘exhibit’ nothing or nothingness within their walls. There are plenty of potential arguments that could assert that closure is irrelevant as the ‘exhibition’ still continues within, therefore relying on institutional support. Still, it is not merely the art that is displaced, but also the viewer. Denial and exclusion are part of the viewer’s experience of the closed exhibition. ‘Experience’ can even be called into question as it could further be argued that the closed gallery estranges them from the art. Has the viewer even experienced the art if it really is occurring behind closed doors? Is the artist’s imposition of denial upon the viewer the art, or not art? Does the experience lie in their exclusion from the space?

⁴⁴³ Mathieu Copeland, ‘A Restrospective of Closed Exhibitions (1964-2016)’, in *The Anti-Museum*, ed. by Mathieu Copeland and Balthazar Lovay (London: Koenig Books, 2016), (p. 35).

These tensions play into the mechanisms that hold value for dislocating art to outside of the purview of museological conditions and dislocating the experience for the viewer. Closed exhibitions are frustrating, but this is not a negative characteristic. Art historian Ana Bilbao writes that the closed exhibition offers the possibility for exercising collective curiosity, and a byproduct of stretching public engagement timescales can be deeper reflection and the creation of communities around cultural production, acknowledging the importance of time and patience.⁴⁴⁴ Rumour and speculation as a product of waiting (a prime characteristic of all radioactive artworks) are encouraged by this frustrating trope. Spatial withdrawal of an art marker mirrors the withdrawal and inaccessibility of a GDF. This works in conjunction with the stretched temporality of the radioactive materials. Frustration is born from these two factors that distance us from fully engaging and experiencing the work but through this frustration, the work seems incomplete. One may feel the need to return to it in the hope of observing changes or gleaning more information, ‘renewing the interest.’ In the same way a number of the selected artworks feel ‘incomplete,’ our interest is renewed when tasked with periodic measurement and completion duties.

The concealment offered by the closed gallery trope may also offer a metaphorical *slow reveal*. Similarly to *slow violence*, a *slow reveal* would provide a gradual unfolding of its contents. Prohibition of access would subside as the radioactivity of its contents slowly dissipates. This was an important point earlier in this thesis, that radioactive objects and artworks have more future in front of them which will be revealed in greater depth as they become less prohibitive of access. As Bilbao points out, this stretched engagement that promotes patience alleviates a degree of despondence over deep-time communication as the *slow reveal* acts as the pay-off for patience. Spatial withdrawal in this sense is not permanent but an early characteristic on the temporal scale of *the away*. It is a mechanism that works in conjunction with *slow violence* that slowly provides experience and answers as time elapses.

Conclusion

The Doomsday Clock has edged closer to midnight throughout my research. In 2020, when I began my research, we were 100 seconds to midnight. In 2026, we are now just 85 seconds to midnight. The Doomsday Clock is a metaphorical framing device for humanity’s proximity to anthropogenic global catastrophe. It should not be deemed as a fatalistic metaphor, but a

⁴⁴⁴ Ana Edurne Bilbao Yarto, ‘The Closed Exhibition: When Form Needs A Break’, *Revista de História Da Arte*, 14 (2019), pp. 141-142.

call to action: to wind the hands back by undoing environmental damage and moving towards a cleaner, more peaceful coexistence with the planet and each other.

To that end, the slow violence of the nuclear industries and the waste produced by them causes an ethical tension between what has already been done, and the obligation for us to continue violating the environment as remediation – that is to say, the problem of waste persists. Even if a global transition to renewable energy sources were achieved today, the material legacy of the nuclear industries remains an inescapable imposition that spans deep-time, binding hundreds of future generations to contemporary energetic choices and actions. In prioritising immediate human safety through geological containment, the politics of disposal effectively shifts the long-term physical burden of risk onto the subterranean environment. Crucially, this strategy exposes a profound systemic evasion of future culpability. Should unpredicted geomechanical or hydrogeological shifts compromise the repository and accelerate toxic drift, the technocratic framework allows the failure to be rhetorically outsourced to nature itself. By treating administrative due diligence (expert reports, mathematical modelling, regulatory compliance etc.) as morally and ethically absolute, the contemporary GDF and its markers attempt to decouple present day political and economic actions from their unpredictable deep-time consequences.

Technological solutions that aim to alleviate some of the ecological burden we place on the earth are insufficient. Small Modular Reactors (SMRs) aim to make significant improvements to the nuclear power industry by scaling reactors down, increasing passive safety systems, and significantly reducing the potential for environmental catastrophe in the event of an accident. These improvements are welcomed, however, nuclear power production chains still disproportionately affect marginalised populations, either through radioactive tailings (the hazardous dust and debris left by uranium mining), or through the disposal of nuclear waste in lands in *the away*. Those who benefit most from these nuclear inequalities are those in the present, typically in affluent urban centres that consume the electricity produced by reactors. The slow violence of nuclear energy production extends far beyond those who benefit from it, temporally and spatially.

There is a distinct urgency surrounding the requirements to devise and implement GDF markers and marker strategies. Finland's Onkalo Spent Nuclear Fuel Repository entered its operational phase in 2026. It is the first GDF of its kind in the world for the storage of High Level Waste.⁴⁴⁵ Posiva, the repository's operator has long-debated potential marker

⁴⁴⁵ The WIPP in the US has been operational since 1999 but is primarily restricted to Low Level Waste that is handleable without machinic or robotic assistance.

strategies but at present is pursuing the option to leave the repository unmarked.⁴⁴⁶ Finland also requires that a 'back door' be left open for the retrieval of the waste in case a new treatment method is invented. This door is envisaged as being left open for the 100 year operational phase.⁴⁴⁷ Clearly, warning systems and strategies are urgently needed. Whilst these choices seem correct for Finland and Posiva today, I have my doubts, aligning with the RK&M report, that this unmarked strategy will be maintained, and that some form of marker will be mandated and implemented – the risks of not doing so are just too high. Nevertheless, now that Onkalo is in its operational phase, if markers *are* to be implemented, the RK&M report insists that it must begin now.

The RK&M report differentiates between pre-operational, operational, and post-operational phases, demarking the periods of construction, deposition, and closure. If a radioactive artwork is deemed to be a marker (that is to say, a surface marker, monument, sub-surface marker, deep geological marker, or a surface trace) primarily aimed at providing information locally, then the RK&M report stresses the importance of implementing these mechanisms in the operational and pre-closure period.⁴⁴⁸ The report identifies an even greater urgency for the pre-operational implementation of art and cultural mechanisms.⁴⁴⁹ More and more countries are beginning construction, or in the advanced preparatory stages of GDF consultation. Sweden broke ground on their Forsmark facility in 2025. France, Canada and Switzerland are all following suit. Strategies must be devised and implemented with an undeniable sense of urgency, otherwise inadvertent catastrophe could be just around the corner.

The conceptual art practices examined in this thesis have provided an offer of a more resilient paradigm to art marker approaches – erring away from marking with 'something,' and towards almost nothing, embracing demateriality or close to it. This shift makes way for a slow drift away from initial anthropocentrism to a non-anthropocentric mode of communication. Conceptual approaches do not fight against the myth-making nature of nuclearity; they embrace it. This is on the understanding that the endurance of fixed messages is inherently limited in both temporality and durability, but a compelling question

⁴⁴⁶ The RK&M report explicitly states this is a poor choice: 'In the United States, the Hanford site was established in 1943 as part of the Manhattan Project [...] During 1945-1975, radioactive waste was buried away from the facilities. It was disposed at a place that, at the time, was considered to be "far away", to prevent unintended intrusion. It was not marked to avoid drawing attention to its existence below its well-revegetated surface. However, the waste was discovered when excavating for other purposes. This is a case where radioactive waste itself got "lost" and regrettably, it is not the only instance worldwide where this has happened. [...] Hiding and trying to forget is not a good way to prevent inadvertent intrusion. Moreover, while RK&M preservation may seem irrelevant at one time, it may become useful or needed at later times.' Nuclear Energy Agency, 'Preservation of RK&M', p. 36.

⁴⁴⁷ Posiva, 'Geological Final Disposal', (n.d.).

⁴⁴⁸ Nuclear Energy Agency, 'Preservation of RK&M', p. 65.

⁴⁴⁹ Nuclear Energy Agency, 'Preservation of RK&M', p. 75.

can live forever. The goal of long-term nuclear stewardship, therefore, should not be the preservation of a static *answer* or a stable *record*, but the active *stewardship of a question*. Incompleteness, the withdrawal of truthfulness, promotion of uncertainty, and rumour are the catalysts for the enduring question. The unresolved nature of these qualities fosters the labour of maintenance. Narratives are seeded through doubt which in turn create ‘rumour engines’ that leverage ambiguity in a self-perpetuating cycle of storytelling, speculation, searching, and social memory. Human stewardship therefore is only briefly physical on the scale of deep-time, and extends into a stewardship of ambiguity, representing a more realistic and simplistic mode of care. This requires a shift in focus from the material permanence of a marker to the semiotic resilience of the myth it generates. It acknowledges the limits of our control over meaning and instead places its faith in the enduring power of human and non-human narratives of spectral relations with otherness. It is a strategy that recognises that the most durable legacy we can leave is not literal but emboldened by the inter-relations of the toxic heritage we leave behind.

Radioactive materials as autosignifiers offer vastly underexplored possibilities for deep-time communication of nuclearity. The RK&M recommendation for the provision of increasingly detailed information as one approaches a GDF is an agreeable principle but undermines radiological experience as a mediator of itself. Radioactive materials do not *represent* danger, they *enact* it. RK&M provisions facilitate the pursuit of knowledge and reward the GDF intruder with increasingly detailed information the closer they encroach. RK&M views this increasing depth of warning as a repellent, but it may function equally as much as an enticement. Radioactivity and the nuclear sublime on the other hand have the opposite effect. Proximal threat along with proximal increases in information may offer the robustness of experience in presently perceived solutions to deep-time communication of radiological threat. In so doing, we transition from the linguistic act of ‘warning’ to a more deeply ethically considered mode of ‘witnessing.’ A shift towards a land-ethic in the long-term and into deep-time addresses the human exceptionalism associated with nuclear semiotics.

The need for this shift is made more urgent by the now ubiquitous prevalence of polluting industries, primarily across the Global North.⁴⁵⁰ The ecological crises of toxic planetary contamination are not merely technical puzzles to be solved by STEM technocrats, but are fundamentally cultural, ethical, and narrative crises. By moving away from the assumption that the environment is a passive, inert backdrop to human engineering, an environmental

⁴⁵⁰ Although the rapid industrialisation of developing countries (such as China and India) is shifting this balance for CO₂ emissions.

humanities framework treats the landscape as an active, enmeshed participant in deep-time meaning-making. The anthropocentrism of RK&M and nuclear semiotics has been a tightly limiting constraint in my research. The commitment of environmental humanities perspectives to decentring human exceptionalism and the recognition of entangled futures of multi-species assemblages is something that nuclear semiotics must learn to recognise in marker strategies.

The benefit of framing nuclear waste through an environmental humanities lens is the shift of analytical focus from strict semiotics to a material narrative. Instead of treating radioactive toxicity as an abstract statistic, technoscientific problem, or an isolated subterranean threat, it is understood as an enduring toxic heritage that continuously recalibrates human and non-human relationships on a planetary scale. Burying waste does not nullify its existence. It is alive and energetic and will continue to shape ecologies for millennia to come. Synthesising conceptual art modalities with the lively, vibrant matter of radioactive elements contributes a novel aesthetic-ethical paradigm to the field of nuclear semiotics. It demonstrates that cultural practices can move beyond the mere passive representation of environmental geotrauma, participating instead in the slow, multi-generational processes of environmental care, landscape imbuelement, and deep-time planetary co-habitation with the toxic heritage we curse our descendants with.

To the question, ‘so, what is the answer?’ in light of this research, the most honest reply remains: ‘there isn’t one.’ This investigative research has deliberately focused on speculative futures, seeking iterative progress to hone the RK&M Toolkit rather than aiming to provide a new blueprint for the Art Mechanism. However, when we synthesise the threads of slow violence, community care, and environmental perspectives, I propose a new addition to the RK&M Toolkit in respect of ecoventions: an atomic garden.

Plants have a long, documented history as indicators of radiation exposure.⁴⁵¹ In the 1950s, under the US government’s ‘Atoms for Peace’ programme citizens began irradiating seeds with cobalt-60. Dr. Clarence J. Speas, a dentist from Tennessee was a leader in this citizen science experiment. In the UK, Muriel Howorth established The Atomic Garden Society in the UK which throughout the 1950s and 60s encouraged everyday people to grow fruits and vegetables from irradiated seeds under the premise of mutant, high-yielding super crop variations. More recently, in 2020, artist Gabriella Hirst revived this civilian practice with her *How to Make a Bomb* project. In her short pamphlet, Hirst provides information on how

⁴⁵¹ Rusli Ibrahim and others, ‘Plants as warning signal for exposure to low dose radiation’, in *Research and Development Seminar 2012*, (Bangi, Malaysia: International Atomic Energy Agency, 2012).

to propagate the rare ‘Atomic Bomb’ cultivar of *Rosa floribunda*.⁴⁵² This rose was first created in 1953 during the Cold War period of fascination with atomic technologies. In *How to Make a Bomb*, Hirst encourages us to propagate, plant, and grow the Atomic Bomb rose as a means of ‘reflection and diffusion of atomic-era anxiety.’⁴⁵³

A contemporary approach to the atomic garden would take the form of a place radiologically imbued with artistic meaning. Situated local to a GDF, this garden would extricate artistic ecological intervention from the constraints of museums and galleries. It could happily exist in *the away*, encouraging pilgrimage to tend to it, especially if hardy plants with somewhat minimal care needs are chosen. Rarity of cultivars could provide the excitement that Ukeles demanded the provision of. The plants may be bred to be dependent or thrive on toxicity specific to that area; or they may signify toxicity and otherness through their radiobiological difference. Taxonomic classification would identify them as other and rare. Radiobiological difference would infer indexicality and authenticity of the energetic forces close by. If the garden is planted with fruits and vegetables, this may lead to a stark reminder of toxicity by virtue of the embodiment of radiation. In this sense, the garden would be evocative of Eden, and the forbidden fruit – should that story still survive and be relevant. It also mirrors *Does this Soup Taste Ambivalent* and the artist challenging our trust and beliefs. A garden can inspire shared authorship through communal care, and constant change and renewal by custodians and stewards. It requires little specialist knowledge (corroborated by Hirst’s short pamphlet) and is compatible with a ‘routine art’ approach that allows for care approaches and dominant modes of maintenance to emerge from the garden itself.

Furthermore, a garden would exist as a multi-species entanglement – an ecology of toxicity-affected beings, collapsing the artificial binary of anthropogenically toxic artefacts and the natural world. It shifts out understanding of marking from purely human-centric communicative acts and devices to a co-authored ecological narrative where flora, soils, and radioisotopes collectively perform a shared labour of deep-time witnessing. By engaging with a collaborative survival in a damaged landscape, the garden transforms a zone of ultimate industrial rejection into a living ecosystem where the boundaries of organic and somatic permeability are laid bare.

Decoding this marker in the future will not depend on linguistic literacy or the survival of 20th century codes, but on a sensory, behavioural, and ecological reading of the land.

⁴⁵² Hirst’s pamphlet is beautifully designed in (what I perceive to be) a nod to the Protect and Survive pamphlet’s simple and austere utilitarian aesthetic.

⁴⁵³ Gabriella Hirst, ‘How To Make A Bomb’, (Bombshelltoe, 2020).

Percipients will decode the site through the morphological legibility of its botanical mutations: pigment shifts, gigantism, unusual configurations – signalling localised otherness in a zone of energetic exceptionalism. Over generations, these observations may translate into folklore and somatic memory. The costs of consumption of the gardens produce, balanced by the value associated with the rarity of the new mutant varieties.

This thought experiment is by no means perfect. It does not fulfil all the criteria I have laid out in this thesis. I offer it as a way to visualise the shift towards the radiologically imbued landscape far into the future.

Appendix

1.1 No Show Museum (Only available in German language version of the website – written in English)

<https://www.noshowmuseum.com/de/1og-b/robert-barry#info>

The gamma dose rate measurements with a dose rate meter type automess 6150 AD 6 with scintillator probe type automess 6150 AD-b resulted in:

Background: 60 nSv/h Head height: 63 nSv/h At the box: 600 nSv/h

The box therefore contained a radioactive source. The museum management then dismantled the box and opened it with extreme caution, given its enormous value. No sign of radiation or any indication of radioactivity was visible anywhere! What emerged was a lead sheet measuring approximately 12 cm x 4 cm (2 x 1 mm thick), pressed shut at the ends.

Contamination checks using wipe samples and analysis with the Berthold LB 110 and Herfurth Minicont contamination detection devices produced negative results; the gamma dose rate on the lead sheet was 950 nSv/h. A comparative measurement with a Cs-137 test source of known activity from our inventory, wrapped with a piece of lead sheet of the same thickness as the test object, yielded an activity of approximately 24 kBq. This value was thus well below the exemption limit of the currently valid (November 1999) Radiation Protection Ordinance of 500 kBq for Cs-137. Since there was no acute radiation hazard due to its nature, activity, dose rate, and installation, the art object was resealed and installed in its original location. (Operational report "Radioactive Emitter as Art Object" by the ABC-Zug Karlsruhe-Stadt, 1999)

1.2 RK&M Final Report Toolkit: Art

Mechanism	Art				
Approach	Culture, Education and Art				
Definition/Description	This broad mechanism includes public art, visual arts (drawing, painting, sculpture, photography, video, filmmaking, internet art), socially engaged art, design, craft, architecture, music, performing arts (dance, theatre) and literature inspired by nuclear (waste) culture.				
How does this mechanism contribute to RK&M preservation/ How can it be implemented?	The nuclear field has been a source of inspiration for many artists, producing artworks exhibited in public space, museums, preserved in public collections and documented in publications. Art can support RK&M preservation as it can help and stimulate the exploration of speculative futures and the visualisation of the immaterial and invisible (see Carpenter, 2016 and NEA, 2015, pp. 110-136). Works of art may be commissioned to respond to a particular nuclear site, to engage a local community, make public nuclear archives, facilitate interdisciplinary dialogue or convey a particular message. As such, art may relay cultural knowledge, information or awareness from one generation to another or aim to communicate directly to the future. Art competitions can be a useful tool to collect new ideas and provide multiple perspectives on RK&M preservation and RWM. If the proposals are published and archived and the artworks executed and preserved, they also contribute directly to RK&M preservation. A “Percent for Art” scheme can be implemented, where from the start of the project some percentage of the project cost is set aside to fund and install public art.				
Scope	Does the mechanism mainly preserve information, records, knowledge, memory, or awareness?				
	Information:	Records:	Knowledge:	Memory: X	Awareness: X
	Art contributes to preserving memory and awareness. It also aims to preserve cultural knowledge related to the repository and RWM in general. Artworks themselves, when kept with the appropriate context, can be seen as a record.				
	What is the level of detail addressed/provided by the mechanism?				
	Low level of detail: X		High level of detail:		
	With respect to radioactivity and radioactive waste disposal, art would normally be expected to transmit messages with low levels of detail.				
	What is the main geographical or administrative-political scope (development/implementation/operation) of the mechanism? On which scale does the mechanism notably enable RK&M preservation? [Note also the field “International dimension” further below.]				
	Local:	Regional: X	National: X	International: X	Virtual: X
	If not connected to a building or monument (cf. the respective mechanisms), art is most often not connected to a site, but could be displayed, performed, etc. at various places. In this sense, art works on a national, international and virtual scale. Museums with permanent exhibitions may have a regional (or even national) influence.				

Timescales	Which timescale(s) is this mechanism mainly aimed at (target timescale)?					
	Long term:	Medium term: X	Short term: X	Very short term:		
	Although the focus of art is on the timescale of decades or centuries, it can also address RK&M creation and transfer in the very short term, and its influence may extend to the long term.					
	When should this mechanism be implemented? This may or may not be equal to the target timescale.					
	Pre-operational:	Operational: X	Pre-closure: X	Post-closure:		
	The making of individual pieces of art in the repository context may peak in the operational phase. Preliminary work for RK&M preservation purposes, supported before the repository is operated, may be considered as part of the concept development (see hereunder).					
	When should this mechanism be developed? This may or may not be equal to the implementation timescale.					
	Done: X	Pre-operational: X	Operational: X	Pre-closure: X		
	The concept of Art as a means to foster knowledge and memory already exists. But as a component of a strategy it may still be further developed. The making of individual pieces of art is considered here as implementation (see above).					
Characteristics	Should the mechanism be implemented intentionally (e.g. time capsules) or is its emergence largely unintentional (e.g. surface traces) or can it not be fully controlled (e.g. art work)?					
	Intentional: X	Unintentional:	Cannot be controlled: X			
	As an intentional RK&M preservation mechanism, works of art may be commissioned, art competitions can be organised and a “Percent for Art” scheme can be implemented. Apart from that, it cannot be controlled.					
	Is the mechanism mainly tangible or intangible?					
	Tangible: X		Intangible: X			
	This mechanism covers both tangible (e.g. visual arts, literature) and intangible (e.g. performance art, dance) art.					
	Does the mechanism mainly rely on mediated transmission or non-mediated transmission?					
	Mediated transmission: X		Non-mediated transmission: X			
	Art may operate as mediated transmission relaying cultural knowledge, information or awareness from one generation to another; or as non-mediated transmission producing cultural artefacts and public artworks (e.g. in the form of markers) which intend to communicate a message directly to a future audience.					
Actors	Works of art may be commissioned from artists and artist collectives, e.g. by the implementing agency, a museum, public arts organisation, local community or heritage organisation, at a local, regional, national and international level. A dedicated, inter- and transdisciplinary committee could be set up.					

Main strengths/benefits	Visual arts are a powerful means for mediation with the public. They can help expand awareness of radioactive waste issues to a large public, and may act as an introduction or a pointer to more specific information. Depending on the type of artwork and media, visual art may document changing perceptions of RWM and bring together academic research and professional knowledge from different disciplines and industrial sectors, engaging diverse parts of the population over many years. Non-linguistic communication avoids the drawbacks associated with languages (translation, obsolescence, etc.), has the potential to deliver complex ideas and messages, and include archive and documentary material. Contemporary visual art is concerned with critical awareness of visual culture, landscape, architecture exploring conceptual and invisible concerns such as radiation and geological disposal. Artists are also experimenting with durable sustainable formats such as distributed online networks, microfiche, land-art, gesso and stone carving.
Specific issues/challenges	Very often, the primary purpose of art is neither to last nor to inform, and artistic freedom is highly valued. Art with the dedicated goal of RK&M preservation should thus preferably be specifically commissioned in partnership with art museums and agencies. The level of public engagement, and the message delivered, may vary greatly, and their impact may be experienced many years after production. When the work of art is created to convey a specific message, this message can be very basic (“Danger!”) or very complex, such as “the psychic haunting” of radiation. As non-verbal communication is typically vague and imprecise, it allows multiple readings and cannot be completely culture-independent. Art works relying on verbal communication, such as films, poetry or novels, may not be understood after a certain period of time. Works of art placed in the public space serve an aesthetic and symbolic function. They are typically subject to the opinion of the public and may be removed if they no longer correspond to the prevailing taste. They may also become political symbols and be destroyed for that reason. The media, materials and processes used in visual arts have a direct impact on their longevity. For some types of works, such as films, videos or computer art, specific equipment or software is necessary, and needs to be preserved to support the artwork.
International dimension	Art is typically able to deliver messages to an international audience. Various international art platforms exist (e.g. international art festivals).
Connection to other approaches/mechanisms	Memory Institutions: Museums Culture, Education and Art: Industrial Heritage; Alternative Reuse of the Disposal Site/Infrastructure; Intangible cultural heritage Markers
Information resources issued by the RK&M initiative	NEA (2015), Radioactive Waste Management and Constructing Memory for Future Generations. Proceedings of the International Conference and Debate, 15-17 September, 2014, Verdun, France. Part III: Contributions from Artists and Posters. pp. 109-136. OECD, Paris.

	H. Codée & E. Verhoef, Using art, stories and cultural heritage to preserve knowledge and memory. In: NEA (2015), Radioactive Waste Management and Constructing Memory for Future Generations: Proceedings of the International Conference and Debate - 15-17 September 2014, Verdun, France, p. 55 (explaining how, in the Netherlands, COVRA collaborates with regional museums by acting as a storage facility for collections that are not on display), OECD, Paris.
Other information resources	- Anderson, K. (2005), Designing for deep time: how art history is used to mark nuclear waste. A thesis submitted in partial fulfilment of the requirements for the degree of Master of Science in Theory, Criticism and History of Art, Design and Architecture within the joint degree M.S./M.F.A. program School of Art and Design Pratt Institute October 2005. www.kellianderson.com/MSthesis.pdf http://nuclear.artscatalyst.org/ - Carpenter, E. (Ed.) (2016). The Nuclear Culture Source Book. Black Dog Publishing, London. - Graham, N., Zook, K., Wilkinson, J., Pietrzak, A. (2018). Nuclear, Landmarker for a Waste Isolation Site: International Architecture Competition. WM2018 Conference, Phoenix, Arizona, USA.
Examples	- Markers designed for WIPP (Landscape of Thorns, Menacing earthworks, Spike field, etc.) www.wipp.energy.gov/picsprog/articles/wipp_exhibit_message_to_12,000_a_d.htm - Andra's programme on visual arts e.g. www.andra.fr/memoire-et-art/reglement_appel.pdf www.cecilemassart.com/ - Films such as "Into Eternity", "Containment", "Journey to the safest place on earth" - Erich Berger and Mari Keto, "Inheritance" http://inheritance-project.net/ - Thomson & Craighead, "Temporary Index". This project is about creating a series of real-time numeric counters expressing radioactive decay. Each display will countdown in seconds, showing the time remaining before the given item of waste or a particular site is considered to be safe. As a first step, data projections have been displayed in art galleries. The next step will be to establish a network of these counters online, which can later be attached to places such as Google Earth. Ultimately, possibilities of building semi-permanent physical counters in the places referred to will be investigated, with a view to making them self (solar) powered. See www.thomson-craighead.net/temporary_index.html - Nuclear Culture project: http://nuclear.artscatalyst.org/ - The Center for Land Use Interpretation: www.clui.org/ - Schemes such as Percent for Art: 1% of the total project costs are allocated to the development of public artwork. The advantage of this

	scheme is that the real costs of artwork are accounted for at the very start of the project, rather than as an additional afterthought. This model could be very valuable for ensuring RK&M is implemented from the start. • Various works held in collections of Contemporary Art: Tate Gallery, UK; Museum of Modern Art, New York; Living Art Museum, Iceland. Examples of long-term art projects outside of the RWM field • The Long Now Foundation, established in 1996 to develop the 10,000 Year Clock and Library projects, including a “Rosetta disk” (a nickel disk micro-etched with information in thousands of languages), as well as to become the seed of a very long-term cultural institution. The Long Now Foundation hopes to provide a counterpoint to today's accelerating culture and help make long-term thinking more common. http://longnow.org/ • Jem Finer, Long Player, London. A 1000 yearlong composition, started in 1999, scheduled to end in 2999. https://longplayer.org/ • Organ/ASLSP (As SLOW as Possible). www.aslsp.org/de/
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Bibliography

- Agency for Toxic Substances and Disease Registry, 'Public Health Statement: Strontium', (Atlanta, GA: United States Department of Health and Human Services, 2004).
- Allport, Gordon W., and Leo Postman, 'An Analysis of Rumor', *Public Opinion Quarterly*, 10.4 (1946), pp. 501-517, doi:10.1093/poq/10.4.501.
- American Chemical Society, 'Uranyl Nitrate' (2024) <<https://www.acs.org/molecule-of-the-week/archive/u/uranyl-nitrate.html>> [Accessed 18 Nov 2024].
- Anders, Günther 'Ten Theses on Chernobyl', *Ecologie & Politique*, 1.32 (2006), pp. 169-177, doi:10.3917/ecopo.032.0169.
- Arms Control Association, 'The Nuclear Testing Tally' (2025) <<https://www.armscontrol.org/factsheets/nuclear-testing-tally>> [Accessed 19 Feb 2026].
- Augé, Marc, *Non-Places: Introduction to an Anthropology of Supermodernity* (London: Verso, 1995).
- Ballard, Su, and L. Linden, 'Spiral Jetty, geoaesthetics, and art: Writing the Anthropocene', *The Anthropocene Review*, 6.1-2 (2019), pp. 142-161, doi:10.1177/2053019619839443.
- Barad, Karen, *Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning* (Durham: Duke University Press, 2007).
- Barthes, Roland, *Mythologies*. trans. Jonathan Cape (New York: Noonday Press, 1972).
- Benjamin, Walter, *The Work of Art in the Age of Mechanical Reproduction*. trans. J. A. Underwood (London: Penguin Books, 2008).
- Bennett, Jane, *Vibrant Matter: A Political Ecology of Things* (Durham: Duke University Press, 2010).
- Berger, Christian, 'Douglas Huebler and the Photographic Document', *Visual Resources*, 32.3-4 (2016), pp. 210-229, doi:10.1080/01973762.2016.1229318.
- , 'Wholly Obsolete or Always a Possibility?: Past and Present Trajectories of a 'Dematerialization' of Art', in *Conceptualism and Materiality: Matters of Art and Politics*, ed. by Christian Berger (Leiden & Boston: Brill, 2019), pp. 15-53.
- Berger, Erich, 'Spectral Landscapes' (n.d.) <<https://randomseed.org/web/spectral.html>> [Accessed 31 Dec 2025].

- Bilbao Yarto, Ana Edurne, 'The Closed Exhibition: When Form Needs A Break', *Revista de História Da Arte*, 14 (2019), pp. 126-143,
- Brand, Stewart, *The Clock of the Long Now: Time and Responsibility* (London: Phoenix, 2000).
- Braudel, Fernand, and Immanuel Wallerstein, 'History and the Social Sciences: The Longue Durée', *Review (Fernand Braudel Center)*, 32 (2009), pp. 171-203,
- Brown, Angela, 'Obscuring the Index', Gagosian, (2017)
<<https://gagosian.com/quarterly/2016/10/05/obscuring-index/>> [Accessed 2 Sep 2025].
- Buchloh, Benjamin, 'Conceptual Art 1962-1969: From the Aesthetic of Administration to the Critique of Institutions', *October*, 55 (1990), pp. 105-143, doi:10.2307/778941.
- Burraco, Pablo, and Germán Orizaola, 'Ionizing Radiation and Melanism in Chornobyl Tree Frogs', *Evolutionary Applications*, 15.9 (2022), pp. 1469-1479, doi:10.1111/eva.13476.
- Carpenter, Ele, *The Nuclear Culture Source Book* (London: Black Dog Publishing, 2016).
- Ciocci, Margherita, Email to the author, 9 Feb 2023.
- Codée, Hans, and Ewoud Verhoef, 'What's the Story? Using Art, Stories and Cultural Heritage to Preserve Knowledge and Memory', in *Radioactive Waste Management and Constructing Memory for Future Generations* (Verdun, France: Nuclear Energy Agency 2014).
- Collins, S., and S. Murayama, 'Nuclear Sanctuary' (Thesis Programme, The Royal Danish Academy of Fine Arts, 2020).
- Colpitt, Frances, and Phyllis Plous, *Knowledge: Aspects of Conceptual Art* (Seattle, WA: University of Washington Press, 1992).
- Copeland, Mathieu, 'Ideas Come Out of Objects, Interview with Robert Barry', in *Voids: A Retrospective*, ed. by John Armleder, Mathieu Copeland, Gustav Metzger, Mai-Thu Perret and Clive Phillpot (Switzerland: JRP Ringier, 2009), pp. 79-91.
- , 'A Restrospective of Closed Exhibitions (1964-2016)', in *The Anti-Museum*, ed. by Mathieu Copeland and Balthazar Lovay (London: Koenig Books, 2016).
- COVRA, *Long-Term Research Programme for Geological Disposal of Radioactive Waste: Overall Research Programme and Work Programme for 2020-2025* (Nieuwdorp, Netherlands: 2020).
- Cowan, Harrison J., *Time and its Measurement: From the Stone Age to the Nuclear Age* (Cleveland, OH: World Publishing Company, 1958).

- Cray, Wesley D., 'Conceptual Art, Ideas, and Ontology', *The Journal of Aesthetics and Art Criticism*, 72.3 (2014), pp. 235-245,
- Critical Art Ensemble, *Aesthetics, Necropolitics, and Environmental Struggle* (New York, NY: Autonomedia, 2018).
- Crutzen, P., 'Geology of Mankind', *Nature*, 415.23 (2002), doi:10.1038/415023a.
- Culbert, John, 'Negative Ecology: Robert Smithson's Spiral Jetty at 50', *Postmodern Culture*, 30.3 (2020), doi:10.1353/pmc.2020.0011.
- Davenport, James, 'The Federal Structure: Can Congress Commandeer Nevada to Participate in its Federal High Level Waste Disposal Program?', *Virginia Environmental Law Journal*, 12.4 (1993), pp. 539-571,
- Davis, Heather, and Etienne Turpin, eds., *Art in the Anthropocene: Encounters Among Aesthetics, Politics, Environments and Epistemologies* (London: Open Humanities Press, 2015).
- Dean, Tacita, *Trying to Find the Spiral Jetty*, (1998) Audio Cassette.
- Deichert, Theresa, 'Contested Sites, Contested Bodies: Post-3.11 Collaborations, Agency, and Metabolic Ecologies in Japanese Art', *Journal of Transcultural Studies*, 11.2 (2021), pp. 77-112, doi:10.17885/heiup.jts.2020.2.24246.
- Department for Environment, Food and Rural Affairs, *Managing Radioactive Waste Safely: A Framework for Implementing Geological Disposal* (Cm 7386), (London: Crown Copyright, 2008).
- Derrida, Jacques 'Of an Apocalyptic Tone Recently Adopted in Philosophy', *Oxford Literary Review*, 6.2 (1984), pp. 3-37, doi:10.3366/olr.1984.001.
- Derrida, Jacques, Catherine Porter, and Philip Lewis, 'No Apocalypse, Not Now (Full Speed Ahead, Seven Missiles, Seven Missives)', *Diacritics*, 14.2 (1984), pp. 20-31, doi:10.2307/464756.
- Didi-Huberman, Georges, 'Before the Image, Before Time: The Sovereignty of Anachronism', in *Compelling Visuality: The Work of Art in and out of History*, ed. by Claire Farago and Robert Zwijnenberg (Minnesota: University of Minnesota Press, 2003), pp. 31-44.
- Dixon, John W., 'Towards an Aesthetic of Early Earth Art', *Art Journal*, 42.3 (1982), pp. 195-199,
- Duchamp, Marcel, 'The Creative Act', in *American Federation of Arts convention* (Houston, TX: Philadelphia Museum of Art, 1957).
- Eco, Umberto, *The Search for the Perfect Language*. trans. James Fentress (Oxford: Blackwell, 1995).

- Eleey, Peter, 'Thursday', in *The Quick and the Dead*, ed. by Peter Eleey (Minneapolis: Walker Art Center, 2009), pp. 31-56.
- Eliade, M., *The Sacred and the Profane: The Nature of Religion*. trans. Willard R. Trask (New York, NY: Harcourt, 1959).
- England, Elizabeth, 'The Archive of Place and Land Art as Archive: A Case Study of Spiral Jetty', *The American Archivist*, 80.2 (2017), pp. 336-354, doi:10.17723/0360-9081-80.2.336.
- Eshun, Kodwo, and Anjalika Sagar, 'The Radiant, The Otolith Group' (2012) <<https://projekt-atol.si/en/work/the-radiant/>> [Accessed 10 Oct 2024].
- EURIDICE: European Underground Research Infrastructure for Disposal of nuclear waste in Clay Environment, 'The HADES Underground Research Laboratory' (n.d.) <<https://www.euridice.be/en/node/428>> [Accessed 17 Dec 2025].
- Felshin, Nina, *Disarming Images: Art for Nuclear Disarmament* (New York: Adama Books, 1984).
- Ferguson, Frances, 'The Nuclear Sublime', *Diacritics*, 14.2 (1984), pp. 4-10, doi:10.2307/464754.
- Flam, Jack, ed., *Robert Smithson: The Collected Writings* (California: University of California Press, 1996).
- Flaxman, Gregory, ed., *The Brain is the Screen: Deleuze and the Philosophy of Cinema* (Minneapolis: University of Minnesota Press, 2000).
- Flint, James, James Acord, Mark Waller, and Carey Young, *Atomic : James Acord, Mark Waller, Carey Young* (London: The Arts Catalyst, 1998).
- Fox, William L., 'Going to Ground: Performing Land Art as a Photograph', in *Gianfranco Gorgoni: Land Art Photographs*, ed. by Ann Wolfe, Germano Celant and William L. Fox (New York: Monacelli Press, 2021), pp. 127-143.
- , *Michael Heizer: The Once and Future Monuments* (New York: The Manacelli Press, 2019).
- Garage Museum of Contemporary Art, 'Taryn Simon: Black Square XVIII', *Garage Gazette* 2015.
- Garcia-Vasquez, Marina, 'Nuclear Waste is Art in the Work of Taryn Simon', *Vice*, (2015) <<https://www.vice.com/en/article/nuclear-waste-is-art-in-the-work-of-taryn-simon/>> [Accessed 16 Nov 2022].
- Geras'kin, S.A., S.V. Fesenko, and R.M. Alexakhin, 'Effects of Non-Human Species Irradiation After the Chernobyl NPP Accident', *Environment International*, 34.6 (2008), pp. 880-897, doi:10.1016/j.envint.2007.12.012.

Godfrey, Tony, *Conceptual Art* (London: Phaidon, 1998).

Grayson, Richard, Clare Carolin, and Roger Cardinal, eds., *A Secret Service: Art, Compulsion, Concealment* (London: Hayward Gallery, 2006).

Groys, Boris, *Art power* (Cambridge, Mass.: MIT Press, 2013).

Haraway, Donna, 'Anthropocene, Capitalocene, Plantationocene, Chthulucene: Making Kin', *Environmental Humanities*, 6.1 (2015), pp. 159-165, doi:10.1215/22011919-3615934.

Harman, Graham, *Art and objects* (Cambridge; Medford: Polity, 2020).

———, *Object-Oriented Ontology : A New Theory of Everything* (UK: Pelican, 2018).

———, 'Undermining, Overmining, and Duomining: A Critique', in *ADD Metaphysics*, ed. by Jenna Sutela (Finland: Aalto Univeristy Design Research Laboratory, 2013).

Hecht, Gabrielle, *Being Nuclear: Africans and the Global Uranium Trade* (Cambridge, London: MIT Press, 2012).

———, 'The Power of Nuclear Things', *Technology and culture*, 51.1 (2009), pp. 1-30, doi:10.1353/tech.0.0396.

Henderson, P., 'Hazards in the Curation and Display of Mineral & Rock Specimens with Especial Emphasis on Radioactivity', *The Geological Curator*, 3.5 (1982), pp. 292-296,

Hicks, R. Paul, 'The Public Exhibition of Uranium Minerals: A Novel Technique', *The Geological Curator*, 3.5 (1982), pp. 297-299,

Hirsch, Nikolaus, and Jason Waite, eds., *Don't Follow the Wind* (Berlin: Sternberg Press, 2021).

Hirst, Gabriella, 'How To Make A Bomb', (Bombshelltoe, 2020).

Hitt, Christopher, 'Toward an Ecological Sublime', *New Literary History*, 30.3 (1999), pp. 603-623, doi:10.1353/nlh.1999.0037.

Hogan, Erin, *Spiral Jetta: A Road Trip through the Land Art of the American West* (Chicago: The University of Chicago Press, 2008).

Holmes, Arthur, *The Age of the Earth* (London: Harper & Brothers, 1913).

Holtorf, C., and A. Högberg, 'Lessons From Archaeology and Heritage Studies for the Long-Term Preservation of Records, Knowledge and Memory Concerning Deep Geological Disposal Sites for Nuclear Waste', *Safety of Nuclear Waste Disposal*, 1 (2021), pp. 287-288, doi:10.5194/sand-1-287-2021.

———, eds., *Cultural Heritage and the Future* (London: Routledge, 2021).

Hora, Stephen C., Detlof von Winterfeldt, and Kathleen M. Trauth, *Expert Judgement on Inadvertent Human Intrusion into the Waste Isolation Pilot Plant* (Albuquerque, New Mexico: Sandia National Laboratories/United States Department of Energy, 1991).

Horvat, Srečko, *After the Apocalypse* (Cambridge: Polity Press, 2021).

Human Interference Task Force, *Reducing the Likelihood of Future Human Activities That Could Affect Geological High-Level Waste Repositories* (Columbus, OH: United States Department of Energy, 1984) doi:10.2172/6799619.

Ialenti, V., *Deep Time Reckoning: How Future Thinking Can Help Earth Now* (Cambridge, Mass.: MIT Press, 2020).

Institute for Language and Semiotics, 'And for all eternity: Communication over 10,000 years: How do we tell our children's children where the nuclear waste is?', in *Journal of Semiotics* (Tübingen, Germany: 1984).

International Atomic Energy Agency, *Code of Practice on the International Transboundary Movement of Radioactive Waste* (Vienna: IAEA, 1990).

———, 'Japan's Fukushima Soil Recycling and Disposal Plan Meets Safety Standards, IAEA Says', IAEA, (2024) <<https://www.iaea.org/newscenter/pressreleases/japans-fukushima-soil-recycling-and-disposal-plan-meets-safety-standards-iaea-says#:~:text=%E2%80%9CThe%20recycling%20and%20disposal%20of,and%20disposal%20process%20in%202025.>> [Accessed 10 Nov 2025].

———, *The Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management* (Vienna: IAEA, 2024).

———, 'Power Reactor Information System' (2026) <<https://pris.iaea.org/PRIS/home.aspx>> [Accessed 21 May 2026].

———, *Status and Trends in Spent Fuel and Radioactive Waste Management* (Vienna: IAEA, 2018).

Jacobs, Christophe, 'Archival and Museum Curatorship Challenges for RK&M Preservation', *International Conference and Debate on Radioactive Waste Management and Constructing Memory for Future Generations*, (Verdun, France: Nuclear Energy Agency 2014).

Jacobs, Robert A., *The Dragon's Tail: American Face the Atomic Age* (Amherst and Boston: University of Massachusetts Press, 2010).

———, *Nuclear Bodies: The Global Hibakusha* (New Haven: Yale University Press, 2022).

- Johnston, Tony, 'The Geographies of Thanatourism', *Geography*, 100.1 (2015), pp. 20-27,
- Joyce, R.A., *The Future of Nuclear Waste: What Art and Archaeology Can Tell Us about Securing the World's Most Hazardous Material* (Oxford University Press, 2020).
- Kappler, Charles Joseph, *Indian Affairs: Laws and Treaties Vol. 2 (Treaties)* (Washington: Government Printing Office, 1904).
- Kari, Mika, Matti JKojo, and Markku Lehtonen, 'Role of the host communities in final disposal of spent nuclear fuel in Finland and Sweden', *Progress in Nuclear Energy*, 133 (2021), doi:10.1016/j.pnucene.2021.103632.
- Keating, Thomas, and Anna Storm, *Key Information File: Essential Information on the Spent Nuclear Fuel Repository in Forsmark, Sweden* (Linköping: 2025) doi:10.3384/9789180758581.
- Keto, Mari, Interview with the author, 16 Nov 2022.
- Koerner, Natalie P., 'Il Grande Cretto and the Shifting Ground: Temporalities of the Geological Mode', *Emotion, Space and Society*, 33 (2019), doi:10.1016/j.emospa.2019.100619.
- Kotz, Liz, *Words To Be Looked At: Language in 1960s Art* (Cambridge Mass.: The MIT Press, 2010).
- Kubrick, Stanley, (dir.), *Dr. Strangelove or: How I Learned to Stop Worrying and Love the Bomb*, (USA, 1964).
- Kunstlicht, *Nuclear Aesthetics*. Vol. 39.3-4 (Amsterdam: Journal for Visual Art, Visual Culture, and Architecture, 2018).
- Lanier, Jaron, 'Clock Thoughts' (n.d.) <<https://www.jaronlanier.com/clockthoughts.html>> [Accessed 1 May 2024].
- Leopold, Aldo, *Think Like a Mountain* (London: Penguin Books, 2020).
- Lewis, Danny, 'X-Rays Unveil Hidden Paintings Beneath an Avant-Garde Classic', *Smithsonian Magazine*, (2015) <<https://www.smithsonianmag.com/smart-news/x-rays-unveil-two-hidden-paintings-beneath-classic-avant-garde-painting-180957279/>> [Accessed 31/12/22].
- Liboiron, Max, *Pollution is Colonialism* (Durham and London: Duke University Press, 2021).
- Liboiron, Max, and Josh Lepawsky, *Discard Studies: Wasting, Systems, and Power* (Cambridge, MA: The MIT Press, 2022).

Lippard, Lucy R., *Overlay: Contemporary Art and the Art of Prehistory* (New York, NY: Pantheon Books, 1983).

———, *Six years: The dematerialization of the art object from 1966-1972: A cross-reference book of information on some esthetic boundaries : consisting of a bibliography into which are inserted a fragmented text, art works, documents, interviews, and symposia, arranged chronologically and focused on so-called conceptual or information or idea art with mentions of such vaguely designated areas as minimal, anti-form, systems, earth, of process art, occurring now in the Americas, Europe, England, Australia, and Asia (with occasional political overtones)* (Berkeley: University of California Press, 2001).

Lotringer, Sylvère, 'The Last Political Scene', in *Art in the Anthropocene: Encounters Among Aesthetics, Politics, Environments and Epistemologies* ed. by Etienne Turpin Heather Davis (London: Open Humanities Press, 2015), pp. 370-378.

Lütticken, Sven, 'Radio-Activity', in *Don't Follow the Wind*, ed. by Nikolaus Hirsch and Jason Waite (Berlin: Sternberg Press, 2021), pp. 125-132.

———, 'Shattered Matter, Transformed Forms: Notes on Nuclear Aesthetics, Part 1', *e-flux journal*, 94 (2018), pp. 37-45,

Madsen, Michael, (dir.), *Into Eternity*, (Denmark, 2010).

Marita, Ines, Interview with the author, 21 Jul 2020.

———, 'The Radiation Piece - Chronik einer Suche' (2016)
<<http://www.inesmarita.ch/index.php/project/the-radiation-piece/>> [Accessed 1st Feb 2021].

Martinetti, Coelewijn, *Seth Siegelaub: Beyond Conceptual Art* (Amsterdam: Stedelijk Museum Amsterdam, 2016).

Mattern, Shannon, 'Maintenance and Care', *Places Journal*. (November 2018),
doi:10.22269/181120.

McDermott, Emily, 'Taryn Simon's Black Mass', Interview Magazine, (2015)
<<https://www.interviewmagazine.com/art/taryn-simons-black-mass>> [Accessed 5 June 2024].

Meillassoux, Quentin, *After Finitude: An Essay on the Necessity of Contingency*. trans. Ray Brassier (London: Continuum, 2008).

Melitopoulos, Angela, and Maurizio Lazzarato, (dir.), *The Life of Particles*, (Germany, 2013).

———, 'Thesis Annex', (n.d.)
<https://research.gold.ac.uk/id/eprint/19684/6/VIS_thesisAnnex_MelitopoulosA_2016.pdf> [Accessed 19 March 2026].

Melvin, Jo, 'Seth Siegelau and Studio International: Conceptual Art and Production', in *Seth Siegelau: Beyond Conceptual Art*, ed. by Coelewij Martinetti (Amsterdam: Stedelijk Museum Amsterdam, 2016), pp. 466-477.

Merritt, Daniel, Interview with the author, 22 July 2020.

Meyer, Ursula, 'Interview between Seth Siegelau and Ursula Meyer: "When you become aware of something, it immediately becomes part of you"', in *Seth Siegelau: Beyond Conceptual Art*, ed. by Coelewij Martinetti (Amsterdam: Stedelijk Museum Amsterdam, 1969), pp. 190-193.

Miliband, David, 'Radioactive Waste Management Report. Hansard: House of Commons Debates, vol. 450, col. 1519' (2006) <<https://hansard.parliament.uk/commons/2006-10-25/debates/06102570000004/RadioactiveWasteManagementReport>> [Accessed 21 May 2026].

Milodowski, A.E. , W.R. Alexander, J.M. West, R.P. Shaw, F.M. McEvoy, J.M. Scheidegger, and L.P. Field, *A Catalogue of Analogues for Radioactive Waste Management* (CR/15/106), Radioactive Waste Management, 2016).

Moore, Jason W., *Anthropocene or Capitalocene?: Nature, History, and the Crisis of Capitalism* (Oakland, CA: PM Press, 2016).

Morton, Timothy, *All Art is Ecological* (Penguin Books, 2018).

———, *Hyperobjects : Philosophy and Ecology After the End of the World* (Minneapolis, MN: University of Minnesota Press, 2013).

Mueller, Ellen, *Walking as Artistic Practice* (New York: State University of New York, 2023).

Murakami, Jimmy T., (dir.), *When the Wind Blows*, (United Kingdom, 1986).

Museum of Anthropology, and University of British Columbia, 'A Future of Memory: Conversations with Masao Okabe and Chihiro Minato', (2021) <<https://www.youtube.com/watch?v=HvPLFRaAXo>> [Accessed 26 Jan 2024].

Nancy, Jean-Luc, *After Fukushima: The Equivalence of Catastrophes*. trans. Charlotte Mandell (New York: Fordham University Press, 2015).

———, *The Sense of the World*. trans. Jeffrey S. Librett (Minneapolis: University of Minnesota Press, 1997).

Nixon, Rob, *Slow Violence and the Environmentalism of the Poor* (Cambridge, Mass.: Harvard University Press, 2013).

No Show Museum, 'Robert Barry' <<https://www.noshowmuseum.com/de/1og-b/robert-barry#info>> [Accessed 10 Oct 2022].

- Nuclear Decommissioning Authority, 'UK Radioactive Waste Inventory 2022' (2023)
<<https://www.gov.uk/government/publications/uk-radioactive-waste-and-material-inventory-2022/uk-radioactive-waste-inventory-2022>> [Accessed 6 Aug 2025].
- Nuclear Energy Agency, *Knowledge Consolidation and Transfer: The Vision and Expectations of the RWMC* (Paris: OECD, 2009).
- , *Preservation of Records, Knowledge and Memory (RK&M) Across Generations* (Paris: 2020) doi:10.1787/50292bbb-en.
- , 'The Preservation of Records, Knowledge and Memory (RK&M) Across Generations: Improving Our Understanding', (Issy-les-Moulineaux, France: OECD 2013).
- , 'Radioactive Waste Management and Constructing Memory for Future Generations Proceedings of the International Conference and Debate 15-17 September 2014 Verdun, France', (Verdun, France: OECD 2014).
- Nuclear Waste Services, '2022 Inventory for Geological Disposal: Summary' (2025)
<<https://www.gov.uk/government/publications/2022-inventory-for-geological-disposal/2022-inventory-for-geological-disposal-summary>> [Accessed 14 Nov 2025].
- O'Sullivan, S., 'Fictioning the Landscape: Robert Smithson and Ruins in Reverse', *Take On Art Magazine*, 3.3 (2017), pp. 60-63,
- ORAU Museum of Radiation and Radioactivity, 'Fiestaware (ca. 1930s)' (n.d.)
<<https://www.ora.gov.org/health-physics-museum/collection/consumer/ceramics/fiestaware.html>> [Accessed 16 Jan 2025].
- Osborne, Peter, *Conceptual Art* (London: Phaidon, 2002).
- Owens, Craig, 'Earthwords', *October*, 10 (1979), pp. 120-130, doi:10.2307/778632.
- PACE Gallery, 'Trevor Paglen, Trinity Cube, 2017', (New York: n.d.).
- Posiva, 'Geological Final Disposal' (n.d.)
<<https://www.posiva.fi/en/index/finaldisposal/geologicalfinaldisposal.html>> [Accessed 20 May 2026].
- Renck, Johan, (dir.), *Chernobyl*, (USA/UK, 2019).
- Richards, Judith, 'Oral history interview with Robert Barry, 2010 May 14-15', *Smithsonian - Archives of American Art* (2010),
- Rider, Alistair, 'The Routine Art', in *Specialism*, ed. by David Blamey (London: Open Editions, 2016), pp. 100-110.

Riegl, Alois, 'The Modern Cult of Monuments: Its Character and Its Origin', *Oppositions*, 25 (1982), pp. 21-51,

Rozner, Judy, 'Comparative study of two large scale commemorative sculptures: Alberto Burri: Gibellina Cretto, Sicily, 1981 -1997, and Peter Eisenman: Memorial to the murdered Jews of Europe, Berlin 1997 -2005' (BA (Hons) Thesis, University of Melbourne, 2007).

Rusli Ibrahim, Rosinah Hussin, Nur Suraijah Mohd, and Norhafiz Talib, 'Plants as warning signal for exposure to low dose radiation', in *Research and Development Seminar 2012* (Bangi, Malaysia: International Atomic Energy Agency, 2012).

Sawa, Dale Berning, 'At Art Basel Paris, Experimentalists and Their Big Ideas Are Celebrated', *The New York Times* 2025.

Schjeldahl, Peter, 'Wizard', *The New Yorker* 2019.

Sebeok, Thomas A., *Communication Measures to Bridge Ten Millennia* (BMI/ONWI--532), (Columbus, Ohio: U.S. Department of Energy, 1984) doi:10.2172/6705990.

Shifotoka, Monika, 'What is Food Irradiation and Why is it Important?', International Atomic Energy Agency, (2025) <<https://www.iaea.org/newscenter/news/what-is-food-irradiation-and-why-is-it-important>> [Accessed 6 Mar 2026].

Siegelaub, Seth, ed., *January 5-31, 1969* (New York: Seth Siegelaub, 1969).

Smithson, Robert, 'A Tour of the Monuments of Passaic, New Jersey', in *Robert Smithson: The Collected Writings*, ed. by Jack Flam (California: University of California Press, 1996).

Southwestern University, 'Southwestern Acquires Unusual Sculpture' (2011) <<https://www.southwestern.edu/live/news/5453-southwestern-acquires-unusual-sculpture>> [Accessed 7 Feb 2023].

Spaid, Sue, *Ecovention: Current Art to Transform Ecologies* (Cincinnati, OH: Contemporary Arts Center, 2002).

Stawkowski, Magdalena E., "'I am a radioactive mutant": Emergent biological subjectivities at Kazakhstan's Semipalatinsk Nuclear Test Site', *American Ethnologist*, 43.1 (2016), pp. 144-157, doi:10.1111/amet.12269.

Szeemann, Harald, 'Live in your head: When Attitudes Become Form. Works - Concepts - Processes - Situations - Information', ed. by Kunsthalle Bern (Bern: Kunsthalle Bern, 1969).

———, 'Transportart: Flugzeug New York (1)', (1969) <https://archiv.kunsthalle-bern.ch/en/search?people_all=6035&doc=1566> [Accessed 16 Feb 2022].

Takahashi, Makoto, 'Picturing the Invisible: Legacies of Fukushima in Art', *Bulletin of the Atomic Scientists*, (2023) <<https://thebulletin.org/2023/03/picturing-the-invisible-legacies-of-fukushima-in-art/>> [Accessed 13 Dec 2025].

Tate, *Gustav Metzger - Auto-destructive Art*, TateShots (2015)
<<https://www.youtube.com/watch?v=5ioYs20rnL8>> YouTube Video.

Taylor Dafoe, 'An Italian Artist Auctioned Off an 'Invisible Sculpture' for \$18,300. It's Made Literally of Nothing', *Artnet*, (2021) <<https://news.artnet.com/art-world/italian-artist-auctioned-off-invisible-sculpture-18300-literally-made-nothing-1976181>> [Accessed 31 Jan 2026].

The Center for Land Use Interpretation, 'A Journey to the Ends of Land Art - A Positive Spin Around a Double Negative' (2013) <<https://clui.org/newsletter/winter-2013/journey-ends-land-art>> [Accessed 28 May 2024].

The Long Now Foundation, 'The Clock of the Long Now' (2023) <<https://longnow.org/clock/>> [Accessed 22 Nov 2023].

The Royal Danish Collection, 'The Crown Jewels' (n.d.)
<<https://www.kongernessamling.dk/en/rosenborg/the-danish-crown-jewels/>> [Accessed 20 Nov 2022].

Toister, Yanai, and Nimrod Astarhan, 'Spectral Choreographies: Electromagnetism after Conceptual Art', *Proceedings of Politics of the Machines - Rogue Research 2021*, (2021) doi:10.14236/ewic/POM2021.25.

Trauth, Kathleen M., Stephen C. Hora, and Robert V. Guzowski, *Expert Judgment on Markers to Deter Inadvertent Human Intrusion into the Waste Isolation Pilot Plant* (Albuquerque, NM: Sandia National Laboratories/United States Department of Energy, 1993).

Tsing, Anna Lowenhaupt, *The Mushroom at the End of the World: On the Possibility of Life in Capitalist Ruins* (Princeton, NJ: Princeton University Press, 2015).

Tsing, Anna, Heather Swanson, Elaine Gan, and Nils Bubandt, eds., *Arts of Living on a Damaged Planet* (Minneapolis: University of Minnesota Press, 2017).

U.S. Department of Energy, *Permanent Markers Implementation Plan (DOE/WIPP-04-3302)* (Carlsbad, NM: Carlsbad Field Office Waste Isolation Pilot Plant, 2004) doi:10.2172/990726.

———, 'Safety Data Sheet Uranyl Nitrate Hexahydrate', (n.d.),

U.S. Department of Justice, 'Radiation Compensation Exposure Act', U.S. Department of Justice, (2025) <<https://www.justice.gov/civil/reca>> [Accessed 19 Feb 2026].

UK Parliament Committee of Public Accounts, 'Decommissioning Sellafield: Twenty-Eighth Report of Session 2024–25', (UK Parliament, 2025).

Ukeles, Mierle Laderman, 'Manifesto for Maintenance Art, 1969! ', in *Six years: The dematerialization of the art object from 1966-1972: A cross-reference book of information on some esthetic boundaries : consisting of a bibliography into which are inserted a fragmented text, art works, documents, interviews, and symposia, arranged chronologically and focused on so-called conceptual or information or idea art with mentions of such vaguely designated areas as minimal, anti-form, systems, earth, of process art, occurring now in the Americas, Europe, England, Australia, and Asia (with occasional political overtones)*, ed. by Lucy R. Lippard (Berkeley: The University of California Press, 1969), pp. 220-221.

United States Congress, 'H.R.2967 - Nuclear Waste Policy Amendments Act of 1987' (1987) <<https://www.congress.gov/bill/100th-congress/house-bill/2967/summary/18>> [Accessed 22 May 2026].

Van Wyck, Peter C., 'The American Monument: The Slow Motion Catastrophe of the Nuclear', in *ICS Speaker Series* (Bowling Green State University, 1998).

———, 'An Archive of Threat', *Future Anterior*, 9.2 (2012), pp. 53-80, doi:10.5749/futuante.9.2.0053.

———, 'Canada's Forgotten Role in the Manhattan Project', Concordia University, (2015) <<https://www.concordia.ca/cunews/main/stories/2015/08/06/anniversary-of-hiroshima-peter-van-wyck.html>> [Accessed 18 Oct 2025].

———, *The Highway of the Atom* (Montreal: McGill-Queen's University Press, 2010).

———, *Signs of Danger: Waste, Trauma, and Nuclear Threat* (Minneapolis: University of Minnesota Press, 2005).

Virilio, Paul, *Open Sky*. trans. Julie Rose (London: Verso, 1997).

Volkmar, Anna, 'Muddling Through Wicked Complexity: Why We Should Look at Art When We Talk About Nuclear Power ' (Universiteit Leiden 2020).

———, 'Why We Need Nuclear Art', *Leiden Arts in Society*, (2016) <<https://www.leidenartsinsocietyblog.nl/articles/why-we-need-nuclear-art>> [Accessed 26 Apr 2021 2021].

Watts, Vanessa, 'Indigenous Place-Thought and Agency Amongst Humans and Non Humans (First Woman and Sky Woman Go On a European World Tour!)', *Decolonization: Indigeneity, Education & Society*, 2.1 (2013), pp. 20-34,

We Make Money Not Art, 'Inheritance, a Precious Heirloom Made of Gold and Radioactive Stones' (2016) <<https://we-make-money-not-art.com/inheritance-a-precious-heirloom-made-of-gold-and-radioactive-stones/>> [Accessed 23 May 2022].

Weapons, International Campaign to Abolish Nuclear, 'Nuclear Arsenals' (n.d.) <https://www.icanw.org/nuclear_arsenals> [Accessed 21 May 2026].

Weir, Andy, 'Deep Decay: Into Diachronic Polychromatic Material Fictions', *PARSE.4* (2016), pp. 61-69, doi:10.70733/84bsfgeiuwqo.

Williams, R. C., *Artists in Revolution: Portraits of the Russian Avant-Garde. 1905-1925* (Bloomington & London: Indiana University Press, 1977).

Williams, Robert , and Bryan McGovern Wilson, *Cumbrian Alchemy* (Cumbria: UniPress Cumbria, 2013).

Wilson, Bryan McGovern, 'Atomic Priesthood: Black Rose Sun' (2017) <<https://www.theatomicpriesthoodproject.org/artists#/black-sun-rose-wipp>> [Accessed 13 Oct 2021].

Winkel, Camiel van, 'During the Exhibition the Gallery Will be Closed: Contemporary Art and the Paradoxes of Conceptualism' (Universiteit van Amsterdam, 2012).

Wollentz, Gustav, Sarah May, Cornelius Holtorf, and Anders Högberg, 'Toxic Heritage: Uncertain and unsafe', *Heritage Futures: Comparative Approaches to Natural and Cultural Heritage Practices* (2020), pp. 294-312, doi:10.2307/j.ctv13xps9m.25.

World Nuclear Association, 'Radioactive Waste Management' (2022) <<https://world-nuclear.org/information-library/nuclear-fuel-cycle/nuclear-waste/radioactive-waste-management>> [Accessed 6 Aug 2025].

Yablon, Nick, *Remembrance of Things Present: The Invention of the Time Capsule* (Chicago: The University of Chicago Press, 2019).

Ziani K, Ioniță-Mîndrican CB, Mititelu M, Neacșu SM, Negrei C, Moroșan E, Drăgănescu D, Preda OT., 'Microplastics: A Real Global Threat for Environment and Food Safety: A State of the Art Review', *Nutrients*, 25.15 (2023), doi:10.3390/nu15030617.

Zonnenberg, Nathalie, *Conceptual Art in a Curatorial Perspective: Between Dematerialization and Documentation* (Amsterdam, Netherlands: Valiz, 2019).