Post-atomic Auralities: A practice-based study of sound and atmospheric effects

Thesis submitted in partial fulfilment of the requirements for the
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i. **Abstract**

This practice-based research investigates the aural connections of sound, temperature, radioactivity and atmosphere. It is sustained by a central question that asks: What are the connections between sound and the nuclear, and how might novel methodologies for sound arts practice activate these relationships?

This research aims to discover how sound and atmospheric conditions interact within sites of nuclear significance and explores the often complex and unique cultures and consequences that emerge from them. This process includes exploring places that are imbued with nuclear histories, many of which remain active sites with complex and unique cultural heritages. The practice I present navigates a path from a series of experimentations with Geiger counters within my workshop space, to citizen data projects and remote sensing, to the development of a 'nuclear archive', where digital-material representations of radionuclides and sonic ethnographies of Cold War era bunkers are combined. I explore the geological, historical, cultural, and technological significance of the nuclear to develop new methodologies for sound arts practice that document and attune to the many interrelations of sound and the post-atomic - a term that is widely accepted as descriptive of everything that has existed or occurred after the advent of nuclear weapons.

Through my practice I will introduce 'documentation as praxis' as an approach for reconfiguring the roles and function of the site and act of making, while querying the boundaries of documentation in arts practice. In conducting this aural investigation, I aim at discovering where the timelines and consequences of radioactive materials and their enduring cultural effects can be revealed by their sonic potential. This thesis coalesces in the development of my concept of 'noise-prints', where documentation and recorded media are activated as wayfinding instruments that are made traceable to the post-atomic auralities that I have uncovered.

ii. **Thesis Media**

This thesis includes a USB flash drive that is formatted (ExFat) to be readable on all commonly used computer operating systems, the files on the drive are also all universal media file types (.tiff, .pdf, .mp4, and .wav). The drive contains all referenced image, audio, and video files that are linked to throughout the document and contribute to the portfolio of practice produced during this research. In addition, there is a digital sample copy of two of the books within the *Radionuclide Websites: Binary Code Book Set* that is referenced in the Fourth Chapter, a pdf copy of the 'Remote Sensing Symposium' publication, which I introduce in the Third Chapter, and a digital copy of *The Nuclear Archive: Sound Map*.

This research is carried out in adherence with the University of the Arts London's 'Code of Practice on Research Ethics', which outlines the standards of professional practice in respect of the informed consent of individuals, privacy, confidentiality, and data protection. All external participants to this research are referenced and acknowledged throughout this document. Where any direct contribution has been made, individuals have been briefed as to the intention and limitations of the use of audio recordings, interviews, transcriptions, or any other information identifiable to them within this research. A written statement to this effect was also included in the signed audio permission forms that were acquired for each recorded interview that appears in film, sound, or text format within this thesis and any other practice related to or included in this research.

While every effort has been made to maintain the quality of these media files, the requirement to compress the films for presentation and ease of playback within this thesis means that these files should each be considered as reference copies of the original works.

NB - All images and media are created by the author, unless otherwise stated.

iii. **USB Drive: List of Contents**

Audio >

Track1-The_Toads_of_Trinity.wav*
Track2-Pete-in_hutch_A1.wav
Track3-Charles-What_Will_Last.wav

Film >

1-Writing_for_Window_Boxes.mp4
2-Geiger_Environs.mp4
3-Geiger_Composition-Washing_Machine.mp4
4-Geiger_Composition-Lunch_Making.mp4
5-37degsN_night.mp4
6-Bunker_D11.mp4
7-TPAE_digi_2k.mp4
8-The_Nuclear_Archive.mp4

Image >

See, 'List of Illustrations'.

Reference Documents >

Cs134-Binary-code-book.pdf
JQuery-Binary-code-book.pdf
Remote_Sensing-publication.pdf†

Sound Map >

> Audio Referenced in Thesis

1-Firehouse-Audio_1.wav
2-Firehouse-Audio_2.wav
3-Firehouse-Audio_3.wav
4-Firehouse-Audio_4.wav
5-Firehouse-Audio_5.wav
6-Firehouse-Audio_6.wav
7-Containers-Audio_1.wav
8-Containers-Audio_2.wav
9-Bunker_D11-Audio_1.wav
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12-Bunker_D11-Audio_4.wav

Nuclear_Archive-Sound_Map.pdf

[*] Audio file copyright Jeff Rice and Montana State University; Use of this audio file is allowed in accordance with the Creative Commons Attribution-Noncommercial-No Derivative Works 3.0 United States License; http://creativecommons.org/licenses/by-nc-nd/3.0/us/

[†] Devised and edited by Dr Rachel Emily Taylor and Dr Leah Fusco, design by work-form. Remote Sensing 2021 was supported by the CCW staff research fund and The Illustration Programme at Camberwell College of Arts. See, https://remote--sensing.co.uk/publications/remote-sensing-2021/.

iv. **List of Illustrations**

* Used with permission from the artist: Leeson, Lynn Hershman. 2016. ‘Roberta Breitmore - Interim Driver’s License’ (lynnhershman.com) https://www.lynnhershman.com/project/roberta-breitmore/

† Used with permission from the rights holder: Lang, Hannes. 2011. ‘Peak’ (Germany: unafilm).

‡ Shared under a CC BY 4.0 Deed Attribution 4.0 International license - https://creativecommons.org/licenses/by/4.0/ Source: Sophie Dyer and Sasha Engelmann - http://www.sashaengelmann.com/amateur-radio.

§ & ¶ Courtesy of The British Film Institute.

All other images created by the author.

v. **Acknowledgements**

To my supervisors Prof Angus Carlyle and Dr Mark Peter Wright, I offer my sincerest thanks. Thank you for your considered advice and insight, for sticking with me, pulling me out of rabbit holes, and for your unwavering support and enthusiasm throughout. Thank you to Techne (AHRC) for funding this research and to all of the members and students at the Creative Research in Sound Arts Practice (CRiSAP). I want to extend a special thanks to Pete Sharp for his incredible generosity sharing his recollections as a nuclear armourer. My thanks to all of the laboratory and archive staff at the BFI, Barry Dixon, Patrick Russell, Helen Edmunds, Frank Horn, Jo Molyneux, Russell Brooks, and Charles Fairall and to my programmers Apoorv Khandelwal and Mathew Davies for their valued contribution to the making of the *Radionuclide Websites*. Finally, I wish to thank my family, my partner Rachel, and baby Oren. Thank you for your patience, for listening, and for your loving support.

Table of Contents

Introduction to Thesis

0.1 - Research Question

What are the connections between sound and the nuclear, and how might novel methodologies for sound arts practice activate these relationships?

Although there are many examples of sound artists and composers that have and continue to explore sound and its energy exchanges, there are few direct engagements within sound arts practice that focus on the potential for sound to reveal the atomic. The relative silence of nuclear cultural outputs contrasts unfavourably with the many examples of visual artists, authors, poets, or photographers (be they documentarians or artists), that provide many compelling and vital accounts of the experiences and consequences of nuclear events. This lack of audibility is especially surprising given the inseparability of sound from the realities of these events - the historical record is rich with examples of sound's activeness in the stories of nuclear history. Aurality is defined as 'the quality, condition, or degree of being aural,'[1] within this research processes of audition (hearing, recording, and playback) are combined with an experimental sound arts practice to discover where sound and post-atomic effects can overlap and combine to form post-atomic auralities. This thesis explores the influence of the aural remnants of nuclear events, from the 'frogs' that Frank Oppenheimer[2] describes had 'squalled all night long'[3] on the night before the first successful nuclear bomb test, which took place on July 15th, 1945, to the recollections of the bombings of Hiroshima and Nagasaki, recounted by hibakusha.[4] Through my sound arts practice I will discover the sounding environments of nuclear events and investigate sites of both

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[1] [N.d.-b]. *Collinsdictionary.com* https://www.collinsdictionary.com/dictionary/english/aurality [accessed 3 June 2024].

[2] Frank Oppenheimer was the brother of Robert Oppenheimer, known as the 'the father of the bomb' for his role in developing the nuclear weapons that would later cause devastation in Hiroshima and Nagasaki.

[3] Rice, Jeff. 2018. 'The Toads of Trinity: Witnesses to the Atomic Age', *WBUR* https://www.wbur.org/hereandnow/2018/07/16/trinity-nuclear-test-toads [accessed 26 February 2024]

[4] Hibakusha is a Japanese term given to the survivors of the attacks on Nagasaki and Hiroshima.

current and former nuclear activities. My portfolio of practice engages the inherent aurality of post-atomic events, places, and their cultural consequences.

Throughout my research the associations between sound and radioactivity are framed through an understanding of the nuclear in contemporary art practice, including the emergence of 'nuclear culture' as a field of study. Nuclear cultural research traces early engagements of the atomic within arts practice, through to the development of Cold War technologies, and the many techno-cultural transfigurations that emerged from it to the present-day examination of the definition of a nuclear Anthropocene. Nuclear culture studies investigate the enduring legacies of nuclear incidents, irradiated landscapes, and materials, while framing them in the context of their associated cultural outputs. It is the concern of this research to explore how these nuclear cultures can be revealed by sound through an understanding of their atmospheric influences. In my experimental sound practice, I will uncover the ways in which sound can commune with the atomic and how this practice can take shape and challenge the limits of sonic atmospheric and energetic encounters.

0.2 - Thesis Structure

This thesis is constructed of five chapters, in each chapter a selection of practice outcomes is considered in their connection to the methodological approaches of documentation as praxis, and sonic atmospheric attunement that I will outline as key to the post-atomic practice that I describe throughout the research. In Chapter One I present my practice pieces, *Geiger Counter Compositions* (2021) and *Geiger Environs* (2020), as demonstrations of the practice methodology that I have developed throughout this research. This practice extends to a nuclear context in chapters two and three with an installation titled *37°N* (2021) and a series of web-based works titled *Radionuclide Websites* (2022). Further to this presentation of original artworks, Peter Cusack's project *Sounds from Dangerous Places* and Jacob Kirkegaard's *4 Rooms* are introduced as examples of sound arts practice that are directly engaged with the site, people, and cultures of the Chernobyl exclusion zone. This opens an enquiry into the potential and alternatives for both sonic ethnography and other techno-oriented

sound arts practice within the complex and often contested sites and landscapes of nuclear era events. The final two chapters of the thesis present practice from my Techne partnership at the British Film Institute (BFI),[5] which includes a sound mapping project and media-based exploration of the BFI National Film and Television Archive. This research is funded and supported by Techne, a division of the Arts and Humanities Research Council (AHRC) Doctoral Training Partnership in the UK. Techne describe partnerships in doctoral research, such as the one I have undertaken with the BFI, as a 'mutually supportive knowledge exchange and professional development between doctoral students.'[6] In the final chapter and conclusion to this thesis I will describe how this partnership developed and the potential for its continuation beyond this period of research.

This thesis is presented as both document and practice and is joined in print by an artwork that consists of a hand-bound set of books and an audio booklet titled *The Nuclear Archive: Sound Map,* which forms the basis of the Fourth Chapter of the thesis. In addition to this I present a series of artworks that include media representations of radioactive materials, sound recordings, 35mm film, web-based artworks, and digital and analogue videotape. Throughout the opening chapters of this thesis, I include web-links to audiovisual practice pieces that are accompanied by written attunements; short prose pieces that should be considered as part of the practice I present. Digital copies of all of the files included in the thesis are also provided on the USB storage media. The subject of the five chapters of this thesis are as follows:

Chapter 1: Documentation as Praxis

This chapter concentrates on the early experimental phase of my research, including the presentation of three practice pieces that demonstrate and activate the Geiger counter as a sonic agent within the contexts of my site of practice. These practice examples inform an analysis of the documentation as praxis approach that I have

[5] The British Film Institute are the custodians of Britain's National Film and Television Archive and a charitable organisation for the promotion and distribution of British film heritage and film productions.
[6] 'Partners'. [n.d.]. *Techne.ac.uk* https://www.techne.ac.uk/partners/ [accessed 8 May 2024].

developed as a methodological tool for this research. My practice is contextualised through the work of sound arts practitioners working in irradiated landscapes and concludes with a theoretical analysis of documentation in arts practice and its functioning within my praxis-based methodology.

Chapter 2: Sound and Radiance

I introduce my web-based installation *37°N,* a digital work that utilises community data platforms in close proximity to the Fukushima Daiichi Nuclear Power Plant and the streamed video of the decommissioning of the plant's reactor core. Focussing on the definitions of site-based practice, the chapter questions the purpose of digital repositories and considers the role of citizen data projects in understanding the consequences of nuclear events. In this chapter, I focus on the energy exchanges that occur as nuclear events such as Fukushima unfold and explore the potential for thermal environments and their effects to elicit post-atomic auralities.

Chapter 3: Atmosphere

This third chapter asks how digital spaces can be used to host works that become effective communicators for a new definition of 'atomicity'. My practice *Radionuclide Websites* investigates the interrelations of air, atmosphere, and radiation within the context of sound and arts practice, and digital and audiovisual media. Contextualised through Sasha Engelmann's 'elemental lures', and the writing of Hibakusha (survivors of the atom bomb), sound is also considered in its ability to act as an atmospheric carrier of that which is both 'in' and 'of' the air.

Chapter 4: Fieldwork: British Film Institute

The fourth chapter describes the research I have undertaken in partnership with the British Film Institute (BFI), documenting the development of a fieldwork that leads to the production of a further practice piece, *The Nuclear Archive: Sound Map.* The work is an audio booklet that explores the BFI National Film and Television Archive in Gaydon, Warwickshire. The archive is situated within the grounds of a former Ministry

of Defence (MOD) weapons 'clutch', a Cold War era nuclear bomb storage and assembly facility.

Chapter 5: The Nuclear Archive

The final chapter of the thesis brings together three artworks that combine elements of the *Radionuclide Websites,* and *The Nuclear Archive: Sound Map*, where a multi-media-format engagement with the BFI archive site, its archivists, history, and technologies are presented as active examples of the post-atomic auralities that this research sets out to define. Within this chapter I further explore the potential of my concept of 'noise-prints' as a way of accessing and recording these auralities and describe how the exhibition and presentation of my work at a symposium on nuclear waste storage in Dessel, Belgium, opened up a new site of practice for my digital radionuclides.

0.3 - The Academic Field: Nuclear Culture & Sound Arts Research

The term 'nuclear culture' is widely used to describe the military, scientific, social, and historical influences of post-atomic nuclear activities. These historical narratives are often driven by national associations, for example, in the development of the 'V-Force'[7] Cold War era nuclear equipped aircraft in the UK and the decommissioning of power stations and the storage of their waste products in Belgium. Each proffer a unique set of enquiries that are specific to the 'nuclear culture' of their respective nations and both the UK's V-Force bombers and Belgian nuclear waste storage appear within my practice in the final two chapters of this thesis. However, rather than viewing the atomic in its historicity or by way of its national identity, this research instead considers the nuclear from the perspective of the outputs of artists, curators, and authors whose concern it is to engage their practice in nuclear cultural enquiries.

[7] The V-Force aircraft (Valiant, Victor, and Vulcan Bombers) were nuclear capable Royal Air Force (RAF) jets, recognised by their distinctive 'V' shaped wing design. See, Jones, Barry. 2000. *V-Bombers: Valiant, Vulcan and Victor* (Ramsbury: Crowood Press).

The blockbuster biopic 'Oppenheimer' (2023) and the television series 'Chernobyl' (2019) are recent examples of cultural outputs that shine a light on some of the defining moments within the history of the atomic era. Instead of focussing on these historical depictions of nuclear events, or other popular culture and military references to 'the bomb', this research instead learns from the development of a sound arts practice that is aimed at uncovering a network of nuclear cultural effects. Through my sound arts practice I will investigate how these effects endure and have influence, with the aim to observe and make available the atmospheric and cultural connections of sound and the nuclear.

One example of the enduring legacies of our nuclear actions within this area of study is the 'nuclear Anthropocene', which establishes the notion that the onset of the human-epoch or 'Anthropocene' can be traced to the presence of manmade radioactive materials in the geologic record. In *The Nuclear Culture Source Book* (2016), Ele Carpenter makes clear the importance of documenting theoretical and artistic engagements with the Anthropocene within nuclear culture in the following way: 'The Anthropocene discourse alerts us to human impact on the planet and our symbiotic relationship to the environment, as well as encouraging a non-human essentialist view to understand the planet on its own terms, anticipating a non-human future.'[8] Whether focussed on the geologic consequences of the release and record of the presence of human-made radioactive isotopes or the breakdown and storage of the waste materials and radioactive by-products of the nuclear energy industry, Carpenter argues that the nuclear Anthropocene allows us to consider 'deep timescales' leading us to 'think beyond the human, and to see the world from a non-human essentialist perspective.'[9]

Carpenter's 'deep timescales' are explored within this research through the development of several time-specific, long-duration artworks, which develop a sound arts practice that is in direct engagement with the half-lives of nuclear materials and the legacies of nuclear events. Through the development of my practice of 'sonic

[8] Carpenter, Ele (ed.). 2016. *The Nuclear Culture Source Book* (London: Black Dog Publishing). p.14.
[9] Ibid.

atmospheric attunement', I will offer challenges to this reification of the geologic within nuclear cultural research and ask if there are other ways to explore the impacts and consequences of our nuclear actions. Atmospheric attunement is a term described by the anthropologist Kathleen Stewart as a method for 'tuning-into' and learning from lived sensory moments, an atmospheric attunement can also be a written account of these moments. Stewart describes 'attending' to atmospheric attunements as 'chronicling how incommensurate elements hang together in a scene.'[10] In an attunement to these 'scenes' the atmospheric is revealed as 'not an effect of other forces but a lived affect'[11] that can be accessed through our paying attention to what Stewart describes as 'the sentience of a situation.'[12] As I navigate my practice throughout this thesis, I include a number of short written attunements that are focussed on the aural evocations of the site, and act of making, as well as the atmospheric influences that surround my practice. Throughout this thesis I use these aurally focussed atmospheric attunements as both an analytical and creative technique that frames and uncovers post-atomic timelines - 'not as the dead or reeling effects of distant systems but as lived affects with tempos, sensory knowledges, orientations, transmutations, habits, rogue force fields.'[13]

The significance of timescales within the post-atomic are explored in the Third Chapter of the thesis and is represented in practice by my digital work titled *Radionuclide Websites* (2022). This online artwork consists of a series of websites designed to evenly cycle through the 16,777,216 colours within the RBG colour spectrum and emit audible frequencies across the whole range of human hearing. The duration of the websites' audio-visual cycle is linked to the half-life of radionuclides, such as Caesium-137, a radioactive substance that is a by-product of nuclear energy production and nuclear weapons testing that has a half-life of 30.17 years. Radionuclides are radioactive materials that contain a nuclide with excess numbers of protons and neutrons, and emit alpha, beta, or gamma radiation. They can occur both naturally and through human nuclear actions, such as in the production of nuclear energy and in the

[10] Stewart, Kathleen. 2011. 'Atmospheric Attunements', *Environment and Planning. D, Society & Space*, 29.3: 445–53 https://doi.org/10.1068/d9109. p. 452.
[11] Ibid.
[12] Ibid., p.449.
[13] Ibid., p.446.

detonation of nuclear bombs.[14] Alpha, beta, and Gamma radiation are all types of ionizing radiation that are released as certain radioactive materials decay. It is a high energy form of electromagnetic radiation that differs from the radiant effects of infrared, which we perceive as heat. While ionizing radiation is less perceptible than infrared radiation, it has the potential to alter the atomic or molecular structures of the materials that it passes through, and it is this that poses the greatest risks to environments and bodies that are exposed to it. Throughout this thesis I seek out what Stewart describes as 'sensory knowledges' and 'rogue force fields', using my sound arts practice as an observation of the interactions of sound and radioactive materials.

My practice highlights the importance of understanding the fluid timescales of the post-atomic, such as the radioactive half-lives of objects and materials, community records and health effects, as well as the significance of dates in a calendar; July 6th, 1945.[15] The half-lives of radioactive materials produce enduring legacies that often require complex control systems, monitoring technologies and storage solutions. This process of handling, monitoring, and understanding nuclear materials is an expansive one that includes the generation of information that deserves equal care and consideration in this respect. This research explores beyond the immediate consequences of radioactive materials, bodies, and environments, to discover how the 'anthropogenic agency of nuclear materials' and 'discourse of invisibility',[16] that Carpenter describes, interact to produce cultural by-products with material consequences of their own, such as in the development of nuclear archives and community data sets. This will be explored in detail in the final chapter of this thesis, which focusses on the potential for the digital spaces of *Radionuclide Websites* to be converted or 'transduced' to a marker and carrier of post-atomic auralities.

As a sound focussed investigation this research utilises the methods, tools, and theories of sound arts research. Throughout this thesis I will present the work of sound practitioners who have looked to bridge the sonic divide between radioactive

[14] Us Epa, Oar. 2014. 'Radionuclides' https://www.epa.gov/radiation/radionuclides [accessed 28 May 2024].
[15] July 6th, 1945 is the date of the Trinity Test, which saw the detonation of a device named 'Gadget' and the first successful nuclear explosion.
[16] Carpenter, 'The Nuclear Culture Sourcebook', p. 49.

landscapes, nuclear materials, and post-atomic events. Taking R Murray Schafer's 'World Soundscape Project', and the nuclear sonic practices of both Jacob Kirkegaard and Peter Cusack as a point of debate, I will explore how existing sonic ethnographies, such as Cusack's 'sonic journalism' call for alternative modes of listening to the post-atomic. Following a series of practice-based experiments with Geiger counters, digital data sets, and sound documentation, I use my practice in the early stages of this research to explore the consequences of sonic ethnographies within nuclear landscapes. Through a combination of remote digital works and a series of sonic atmospheric attunements to home-work, my site of practice moves into a more conventional fieldwork at the archives of the British Film Institute, where field recordings combine with interviews and the sonic architectures of Cold War era bunkers. The practice that I present in this thesis aligns with Marina Peterson and Vicki Brennan's (2020) call for 'a sonic ethnography that starts with and dwells in the moment of listening.'[17] This research coalesces in the development of my concept of 'noise-prints', a novel method for sound arts practice that activates recorded media as a wayfinding instrument for post-atomic consequences.

0.4 – Key Terms and Neologisms

Throughout this thesis several key terms re-occur; where 'nuclear culture' and 'sonic ethnography' are well established in both academic research and arts practice, ideas and theories that include 'the post-atomic' or 'atomicity' may, at least for now, require more of a conceptual leap of faith to understand in the context of their use here. It is for this reason that I wish to explain my use of these words as I navigate through this thesis. Although it is important that my reasoning and description of them is clear, I will stop short of a finite definition of these terms and leave some room for the interpretation of their meaning on the merits of the practice I present further into this thesis. In addition to this I will provide a brief introduction to two new terms included in this thesis, 'documentation as praxis' and 'noise-prints'.

[17] Peterson, Marina L., and Vicki L. Brennan. 2020. 'A Sonic Ethnography', *Resonance*, 1.4: 371-75 https://doi.org/10.1525/res.2020.1.4.371. p. 371.

0.4.1. - Key terms: The Post-atomic, and Atomicity

The term 'nuclear culture' encompasses the many overlapping cultural consequences and timelines that are borne from our discovery of, and interaction with nuclear materials. Nuclear cultures, therefore, proliferate outward from the material, and they do this via strands that include, but are not limited to, art practice, technological advancements, media, community, and political and social actions. Nuclear culture research interrogates these connections and faces the challenge of pulling focus between the slow fade of nuclear material half-lives and the realities of the lived experiences of radiation. This material-source, or source-material, dictates that engaging in nuclear culture research requires an understanding of both the causes of radiation and their effects. It is with this in mind that the methodological bases for this research are outlined in this thesis and are established in consideration of sound's capacity to cross energetic boundaries, to reveal and amplify the presence and significance of our post-atomic timelines. Representations of the atomic within the arts have a complex timeline, and the practice that I present as integral to this research contributes to this body of work. Artistic renderings of the atomic can be traced back to before the bombings of Hiroshima and Nagasaki, and even before the Trinity Test saw the first large-scale release of manmade radioactive isotopes into the environment and atmosphere.[18]

In *Invisible Colors: The Arts of the Atomic Age* (2018), Gabrielle Decamous describes an epistemological framework for the interpretation of the nuclear in the arts that consists of five 'compounds' she states these as 'the good/evil use of the atom; the civilian/military use (which differs slightly from the good/evil use); and the East and West, in art and science, and in political and apolitical arenas.'[19] She further describes the development of atomic references in arts and culture as transitioning from 'good/evil' to 'civilian/military' and that these are represented 'in artworks ranging from radium dances, literature based on stories of the Radium Girls, and tales of

[18] The Trinity Test was the first successful nuclear bomb test, which was carried out by the USA at the Trinity Test Site in New Mexico, on July 15th, 1945.
[19] Decamous, Gabrielle. 2019. *Invisible Colors: The Arts of the Atomic Age* (London: MIT Press). p. 4.

radium bandits to early imaginaries of atom-powered aircraft, weapons dreamed up by mad scientists, and societies subject to change for better or worse.'[20]

For Decamous, it was not until Hiroshima that good/evil narratives were 'dissolved into full-fledged responses to the atom's civilian/military use.'[21] From this moment the bombing of Hiroshima and Nagasaki fundamentally changed the way that the atomic age was represented in the arts, shifting the viewpoint of the atomic from one of good/evil or military/civilian, to one of Eastern/Western and artistic/scientific. The compounds she describes form a timeline of interrelating elements that are dependent on the conditions of the artist, artwork, and environment as well as the associated atomic event or outcome. Through this compounding of geographic, political, and cultural influences we can begin to rethink what one might consider as 'post-atomic'. Decamous argues that the bombings conducted by the West on lands in the East, as well as indigenous lands in the US and pacific islands, are emblematic of a history of colonial violence which, despite pre-dating the discovery of radioactivity, are ever pervasive and vital to understanding current events in the timeline of the atomic.

> Colonisation in the recent past - say, up to the end of the nineteenth century - may seem an irrelevant factor in the response to the current techno-nuclear activities simply because it preceded the discovery of radioactivity itself, but its heritage of land and resource appropriation, industrial practices, and art patronage is at the crux of the problem we must deal with in our post-Fukushima context because it still interferes with contemporary politics and energy policies.[22]

The term 'post-atomic' in the context of this research is not a claim that the atomic era has been and gone, that all that is left behind are the wounds, remnants, and memories of twentieth century depictions of mushroom clouds, weapons testing, and radioactive isotopes. Instead, the post-atomic, as described within this research, is a recognition of the enduring legacies of our interactions with nuclear materials; it is the 'post-Fukushima context' that Decamous describes, and a recognition that the timeline of the '*always*-effects' and fallout of nuclear events are wide reaching, and require an

[20] Ibid., p. 44.
[21] Ibid.
[22] Ibid., p. 55.

interrogation of their cultural, political, and environmental consequences. It is for this reason that I use the term '*always*-effects' in substitute for 'after-' throughout this thesis. The timelines of nuclear events are complicated by their enduring impacts, both in respect of the radioactive materials they produce and the cultural legacies that Decamous describes. Rather than offering a definitive new insight or expanded understanding of the nuclear within this thesis, I introduce *always*-effects as a reminder that the cultural and material consequences of our nuclear actions are continuously generative. Considering the post-atomic in this way recognises the deep-timescales of nuclear materials and forces the narrative of our current and future atomic encounters to include a sense of responsibility and a sensitivity to our actions; it leads us to a question of what shapes the before and after of atomic events.

To interrogate this question properly it is important to understand how the timeline of the atomic is a fluid one. Deciding on a single point of origin for the nuclear from which everything flows linearly into history and from it toward an understanding of its unfolding futures, is a temptation that has been taken up most notably in the debate and influence of 'Trinity', or for some, the bombing of Hiroshima, and Nagasaki as a marker, or 'Golden Spike' of the nuclear Anthropocene.[23] It is with the formation of markers, both physical and historical that 'the post-atomic' is commonly defined, such as in the design and production of large-scale monuments to nuclear energy waste repositories, memorial sites associated with the disasters of nuclear war and accident, or the buildings, bunkers, and machinery left behind in the wake of a Cold War. However, we cannot accurately communicate the significance of post-atomic influences or effectively learn from them without an inclusive understanding of their weaving with ecology, material, culture, and their societal impacts. We cannot fully understand Hiroshima, without knowing and acknowledging the story of Belgian mined pitchblende in the colonised lands of the Congo,[24] following its journey - its escape by boat from the clutches of Nazi occupying forces to the ports of Wales and its route across the Atlantic, to the mountains, sands and environments of the Nevada Trinity

[23] See, Van Wyke, Peter C. 'The Anthropocene's Signature' in *The Nuclear Culture Source Book*. 2016. (London: Black Dog Publishing). pp. 23 – 30.
[24] Swain, Frank. 2020. 'The Forgotten Mine That Built the Atomic Bomb', *BBC* (BBC) https://www.bbc.com/future/article/20200803-the-forgotten-mine-that-built-the-atomic-bomb [accessed 2 April 2024].

Test Site and the traditional land-use area of the Western Shoshone and South Paiute, to the *always*-effects of Hiroshima and Nagasaki.

It is for this reason that rather than containing a detailed study of the many ways in which artists have looked to make 'marks' or 'memories' of our nuclear actions, such as in Thomas Sebeok and Alvin Weinberg's 'atomic priesthood',[25] or Cécile Massart's 'artist guardianships',[26] this research instead looks to the ways in which post-atomic effects are transmitted and interpreted. I learned of the storied journey of Belgian mined pitchblende during the development of the practice described in chapters four and five of this thesis; the story was recounted to me with great generosity as a heroic tale of wartime success by Pete Sharp, a British Cold War era nuclear armourer, while we both took shelter in a nuclear bomb assembly bunker. It is the purpose of this research to argue that sound arts practice can play a vital part in exposing the post-atomic cultural and environmental effects of the nuclear, through an interrogation of our sensitivities to them. Decamous demonstrates this in her analysis of the nuclear and the art of the Pacific Islands, 'the art of the nuclear islands cannot be approached without considering the doomsday effect of Western involvement in the Pacific, beginning more than a century ago with the first missionaries and colonists and continuing even today given the ecological impacts.'[27] Decamous' example of the influence and presence of historical Western influences that pre-date the nuclear tests on the Pacific Islands, is a direct example of not just the enduring effects of the nuclear but also its hidden remnants, precursors, and imagined futures. It evidences how our understanding of the post-atomic is best approached in a non-linear, culturally- and historically-inclusive way. Where the post-atomic is a term that is usually understood as being representative of all that has existed or occurred after the advent of nuclear weapons, in the context of nuclear culture studies and this research, its definition can

[25] Sebeok and Weinberg proposed the 'atomic priesthood' as a select group of people from every generation, who would be equipped with the knowledge of the previous generations' nuclear actions. See, 'The Atomic Priesthood Project'. [n.d.]. *The Atomic Priesthood Project* http://www.theatomicpriesthoodproject.org/ [accessed 28 March 2024].
[26] See, 'Nuclear Culture'. [n.d.]. *Nuclear Culture* https://cecilemassart.com/statement [accessed 28 March 2024].
[27] Decamous, 'Invisible Colors', p. 54.

be further expanded to a timeline that includes the discovery of naturally occurring radiation, uranium mining, or pre-atomic western colonial actions.

In addition to revaluating the post-atomic in this way, I propose an expanded definition of atomicity, one that places emphasis on the cultural significance of the impact of the atomic on a multitude of things, from rocks to human bodies, energy production and climate. Where the post-atomic can represent the unfolding timelines and histories associated with atomic events and materials, my use of the term atomicity in this thesis is more direct and is representative of the physical, material realities of atomic encounters. Atomicity is a term used in chemistry to describe the number of atoms present in the molecule of a particular element, for example, the atomicity of Uranium-238 is 238. When radioactive isotopes decay, they do so by shedding their atomic weight through a process of alpha, beta, or gamma radiation, losing their energy to their surrounding environments, and breaking down over time into a variety of different elements, until they eventually reach a stable state.[28] The measurement we refer to as the half-life of a radioactive substance is representative of the time it takes for one half of its atomic weight to perform this act of transference.

The substances that we generate through our atomic interactions are 'transducers' – they exude energies, transmogrify, absorb, and adapt with their environments to return to a stable state. This process is also thermally active, and it is this side-effect that makes it possible for us to generate and harness radiation for energy production and adds to the devastating effects of thermonuclear detonations. This definition of atomicity as a state of transduction is considered in its aural potential through both my practice and Douglas Kahn's writing on the electromagnetic spectrum in the Second Chapter of this thesis. Through my analysis of the post-atomic and nuclear culture, I argue for a definition of atomicity or atomic-weight that can be equated to the many unfolding impacts of atomic events. Where atomicity is understood as a generative process of decay, is it possible to interrogate the half-life of the bombing of Nagasaki, to map a path through its cultural derivatives and how might this process proliferate in

[28] 'Isotope Basics'. [n.d.]. *Isotopes.gov* https://www.isotopes.gov/isotope-basics [accessed 11 June 2024].

the bodies, environments and cultures effected by the event? As I move forward into this thesis with these questions in mind, I wish for the reader to also understand my use of this word as a recognition of atomic burden that is rendered in the practice I present; in the citizen data projects, digital repositories, stories of nuclear veterans, and the streamed video of Fukushima's decommissioning.

0.4.2. – Neologisms: Documentation as Praxis & Noise-prints

Where some of the key terms in this research are reconfigurations of existing terminologies, such as sonic atmospheric attunements and my expanded definition of atomicity, there are in addition two new terms that I introduce as unique to this research - 'documentation as praxis' and 'noise-prints'. Documentation as praxis refers to practice that is derived from the documentation of the creative process, including observations of the workspace environment, its contents and occupants, and the interconnecting influences of both the space of making and its extended environment on the output work. Throughout my practice I use documentation as praxis in partnership with sonic atmospheric attunements as a combined methodology for revealing the auralities that emerge from the post-atomic. Sonic atmospheric attunements are an engagement of what Stewart describes as the 'ordinary' in art practice, and a method for observing and generating auralities that are attuned to the space, timelines, and intimacy of the site and act of practice.[29]

This practice-based research manifests as a communion of documentation, critical evaluation, and the act of making. Though these relationships are familiar to practitioners in all forms of art practice, through my methodology I introduce a practice-as-research approach that demands an attention not just to the outcome, art object, publication, or performance, but also to the shape of its origins, the consequences in its future, and both the aesthetics and conditions of its production. In this thesis I describe the methodological bases that I use as a toolset for the

[29] See, Kathleen Stewart. 2011. 'Atmospheric Attunements', *Environment and Planning. D, Society & Space*, 29.3: pp. 445–53 https://doi.org/10.1068/d9109.

performance of my practice, and how when combined they can discover new ways for sound arts practice to expose the myths and realities of the post-atomic.

Throughout this practice-based research I have listened and engaged with the sounds of my home-work space, the whirring of tape heads and film reels in archives, and the frequencies of digital radionuclides. It is in this act of attunement - listening, recording, and playback, that I have developed the 'noise-print' as a new concept for sound arts practice. The term 'noise-print' is derived from the process of noise reduction in audio-mastering techniques and is redefined within this thesis as a sonic marker. A noise-print provides an aural reference for sound arts practitioners that are unique to their point of capture – they can be recorded and translated between archives, text, film media, and audio recording devices. Noise-prints are aural evocations of the environments they communicate with, the atmospheres they share, and the cultures surrounding them, and it is this that makes them a suitable carrier for post-atomic cultural effects. Within this research noise-prints are located through sonic atmospheric attunement and documentation as praxis, and the practice that I present looks at how they can be captured, transported, and reactivated through the sharing or playback of the media and materials that contain them.

0.5 – Thesis Navigation

Within this thesis the boundary lines of document, practice, media, and material are frequently crossed. With this in mind, I include for your consideration a selection of materials, some of which would not usually find their way into a thesis of this variety. The practice that I present within this document exist in formats that include 35mm Polyester film slides, a VHS film tape, digital files, and links that all provide points of reference to the work that I describe. As I present to you each individual practice output, I will provide the following prompts to help you engage with the links and media that are representative of these works:

• Watch / Listen:

Where a link or item is prepended with ‘Watch’ or ‘Listen’ I wish for you to take that moment within your reading of the document to spend some time with a practice example that will form the basis of the next part of that chapter. Depending on the practice, I may direct you to a number of options for doing this, such as following a link or finding a media file.

• Action:

Where I provide the instruction ‘Action’, I intend for the reader to engage with the work in a more direct way. This could be by way of a reading of a written attunement while watching or listening to a piece of practice, or it could take the form of an interactive engagement with a piece of practice.

There is also a full copy of *The Nuclear Archive: Sound Map* bound to the back of this thesis. The thirty-page booklet includes sound recordings and field recordings from my time at the BFI, although the booklet contains instructions and links to these files, I have also included any directly referenced audio files as copies that are indexed on the digital media provided.

Chapter 1: Documentation as Praxis

1.1 - Introduction to Chapter

In this chapter I will describe a collection of artworks produced during the first two years of my research, these examples of practice are based around a series of experiments that helped to develop my documentation as praxis approach. I begin this chapter with a description of a multi-faceted exploration of my home-work environment, which is presented in a number of practice pieces that conduct an aural examination of this space of making. I also introduce a series of short films that document the workspace environment, and my experimentations with remote and live sensor data. Each of these works are aestheticized through the documentation of the site and act of making and combine with a long period of isolation during the early phases of my research. It is worth noting that although these works avoid any direct engagement with the subject or consequences of COVID-19 lockdowns and social distancing, they are a demonstration of the communicative potential of my methodology within the confines of a COVID defined working environment.

Evidence of the global pandemic that so impacted the lived experiences of those that encountered it, lingers in each of these works, it is though, a gently veiled presence that reveals itself more clearly in the captured 'noise-print' of everyday homelife; the spin-cycle of washing machines and the movement of pets and people caught-up within my practice. Throughout this thesis noise-prints are considered as correlations of documentation as praxis and sonic atmospheric attunement that make record of the unique auralities that emerge through my sound arts practice. This period of my research and the practice that I present in this chapter represents a process of 'tuning-in' to the atmospheric and energetic exchanges that are concurrent with the process and place of making and it is work that has helped me to formulate a practice that is suitable for interrogating sound in its post-atomic contexts. Throughout this chapter, written attunements accompany the works that I present and provide further insight into the conditions of the site of making. I consider these atmospheric attunements as

part of, and integral to the documentation as praxis approach that I will describe in the second half of this chapter.

1.2 - *Writing for Window Boxes*

Figure 1. 'Writing for Window Boxes' (film still).

Watch: *Writing for Window Boxes* (2020)

Link: https://vimeo.com/danbeck/wfwb

USB Media Location: Film > 1-Writing_for_Window_Boxes.mp4

Action: The following written attunement that accompanies this film can be read during or after watching, however, I recommend it is read out loud as you watch:

> *Writing For Window Boxes*
>
> *There are three varieties of chilli plant that appear in shot, there is one plant of each growing in the same rectangular tub running along the window ledge. Zimbabwe Black, Scotch Bonnet, and the threateningly titled, Demon Red. Growing chillies is one of several COVID lockdown pre-occupations I adopted as the months of isolation set in. The chillies are a sister project to home fermentation and a temporary pre-occupation creating increasingly volatile hot sauces. I kept them in sealed jars throughout the darker corners of the flat, which required daily 'burping' to save them from becoming saucy-glass-jarred-hand-grenades. The film opens on a snow-covered January day spent building a*

Geiger counter for my early experiments in sound and radioactivity. Footage from this day will later be used in another film…

… I'm watching this film back in my workspace, wearing open-backed studio headphones I can hear the creaking floorboards as though someone is here with me. Someone is tapping the keys on my desk; another is walking by outside my window. I squirm in my chair, and momentarily lose ownership of the sound of the wooden chair leg, that catches on the nail that tears a larger groove between it and the board that creaks the loudest.

The workshop is a modest sized room in a flat I share with my partner and dog. Before my dog and I arrived, this room housed a friend, a geriatric cat, and a small double bed. Cast among that loose hanging strand of guilt, there is a standing desk adorned with tools, a desk vice, and used electrical components. Further afield I can hear someone grinding coffee in the kitchen, an obsession that pre-dates any COVID enforced conditions.

All practice undertaken as a part of this research is considered in the contexts of its immediate atmospheric surroundings, which is vital to the methodology employed throughout my process of making. *Writing for Window Boxes* (2020) is a practice experiment that began my exploration of the site in which I work. The work is a 4k digital film of approximately five and a half minutes in length, it was shot using a Sony A7SII camera, with combined audio from a Sennheiser MKE-600 shotgun microphone. The piece was filmed over the course of a full year and documents the activeness and influence of the aural environments immediately connected to my workspace. The soundtrack along with the visual imagery articulates the influence of the changing seasons on the workshop environment, while the window, open in some shots and closed in others, dictates how accentuated that influence is within the captured sound-space.

The work consists of a fixed shot of the view from my workspace window, other than changes in focal length, the visual subject remains largely unchanged. The film observes the removal of a large tree stump from the grounds opposite, and the sprouting chilli plants in the window box just out of shot grow to obscure the view to the road and surrounding buildings. As the autumn sets in, their fruits can be seen more clearly, changing colour from green and black to red. The workspace remains hidden throughout the film and is only revealed gradually by the sounds of movements, keyboard strikes, creaking floorboards, and room acoustics. The presence

of the sounds of the workshop and the external noises are modulated by the window being open or closed. It is tempting to consider *Writing for Window Boxes* as an experiment or prototype for the works that I describe later within this thesis, but there is more to learn from this work than that temptation allows. It is an observation and experiment with the thermal environments of the workspace, where the weather outside and the window's open or closed state highlights the influence of temperature on the workshop's sounding environments throughout the film. The film's soundtrack elicits a sense of what Nicole Starosielski describes as 'thermoception'[30] - how we sense heat and cold, which is explored in its potential to reveal the atmospheric connections of the thermal and aural in the Second Chapter of this thesis.

Writing for Window Boxes represents the inception point for an experimental practice approach that reveals the act and site of making as generative to practice outcomes. In drawing attention to the shifting aurality of the environments of the workspace, where seasonal changes in temperature, plant growth, air quality and weather are combined with the sounding environment of the processes of writing for this research, the film also presents as an early demonstration of sonic atmospheric attunement. It is an example of how a combination of documentation and attunement can capture the act and space of making, or doing, in a state of flux. This inclusive method for capturing the environments surrounding my practice has contributed to the development of my concept of noise-prints, which I will expand upon in greater detail throughout this thesis. In the early experimental phase of this research, my workshop provided a space of audition from which I could begin to experiment with these methods and ideas. Throughout this thesis the influence of sound and environmental conditions on the site of practice is analysed further in the contexts of community knowledge and ownership, as well as the consequences of nuclear material half-lives. The purpose of this approach is to query the boundaries of nuclear and sonic practice and ask what ethical implications we should also consider when working with sound in irradiated sites and cultures. In the next part of this chapter, I will approach these queries

[30] Starosielski, Nicole. 2022. *Media Hot and Cold* (Durham, NC, USA: Duke University Press), p. xiii.

through an analysis of the methods and work of sound practitioners whose practice engages the post-atomic.

1.3 - An Enquiry of the Nuclear in Sound Studies

There is an expansive history and continued debate within sound studies that documents and explores the cultural transfigurations of sound and space. R Murray Schafer's *The Soundscape: Our Sonic Environment and the Tuning of the World* (1993) is considered a seminal sound research text that provides many interesting observations of the cultural impacts of sound specific to environments, locations, and communities. Schafer's writing calls for a more complete understanding of the variety and quality of sounding environments and establishes several methods for interacting with environmental sounds that remain integral to the common toolset of sound researchers and practitioners to this day. It is not my intention to offer an extensive critique on Schafer's influence, as there are already numerous focussed studies on this subject.[31] Instead, I introduce Schafer here as a point of reference for interrogating the complexities of sonic ethnography and the methods of sound practitioners working in irradiated landscapes.

Schafer's soundscapes are formulated from a musicological perspective and call for a sonic orchestration or 'tuning of the world' to be performed. His motivation for engaging with soundscapes, a term that Schafer popularised, is largely concerned with the aesthetic or cultural preservation of sounding environments, an attempt to counter the threat of loss or erasure of sounds linked to the identity of a place, its inhabitants, and environment. It is an approach that ascribes human responsibility for 'form and beauty' within a world soundscape that is being procedurally consumed by the noise of technology and industry.[32] It is therefore, despite its call for an expanded mode of listening to our environments, descriptive of a largely anthropocentric

[31] This includes those with direct links to the World Soundscape Project, such as, Barry Truax and Hildegard Westerkamp. See, *Sound, Media, Ecology*, ed. by Droumeva, Milena, and Randolph Jordan (Berlin, Germany: Springer, 2019).
[32] Murray Schafer, R. 1993. *The Soundscape: Our Sonic Environment and the Tuning of the World* (Destiny Books). p. 5.

practice activated by a process of elimination as much as the preservation of an environment of sounds deemed worthy of retaining.

The function of allocating value to sounds by way of composition or design has ethical implications that are long and complex in their unravelling, not least when you consider the power of influence that sound has on our mood, identity, behaviours, and cultures.[33] Schafer's approach and the work of the 'World Soundscape Project', the Canadian research unit founded by Schafer, has been rightly criticised for its focus on the sounds of Canada's settler-colonial past and its exclusion of indigenous communities.[34] It is a reminder that interpreting and reporting sound within any site contributes to the perception of that place and it is therefore important to question if sound capture, the presentation of it, and the interjections of sound practitioners in these environments can modify, or worse, erase some part of the identity of their aural environments? Within this chapter I will consider this question in the context of sound arts practitioners who have engaged with the nuclear in their practice and evaluate the impacts of their methods.

Sound practitioners working within environments that have been affected by nuclear activity are faced with a unique set of challenges. Access to irradiated landscapes is often limited, with strict controls on the activities that can take place during visits. As well as the practical challenges of monitoring and reducing the threat of exposure to radiation, nuclear sites such as Chernobyl and Fukushima continue to host

[33] Blesser and Salter (2009), describe the sensitivity of the relationship between space and sound in the context of what they term 'aural architecture'. 'Aural architecture can elevate or depress our affective responses - it bears directly on our sense of: privacy, intimacy, security, warmth, encapsulation, socialisation and territoriality.' Barry Blesser and Linda-Ruth Salter. 2009. *Spaces Speak, Are You Listening?: Experiencing Aural Architecture* (London: MIT Press). p. 18.

[34] Mitchell Akiyama provides an example of this in his evaluation of Schafer's project 'Soundscapes of Canada', a series for radio, which consisted of a collection of lectures, environmental recordings, and experimental tape pieces. 'The soundscapes they included in the broadcast overwhelmingly represented the nation's settler colonial past—simpler, quieter times they seemingly wished to restore. However, created at a time when Canada's immigrant populations were exploding, when indigenous activists were making important strides toward state recognition, Soundscapes of Canada was perhaps most notable for whom and what it left out.' Mitchell Akiyama, 'Nothing Connects us but Imagined Sound', in *Sound, Media, Ecology*, ed. by Droumeva, Milena, and Randolph Jordan (Berlin, Germany: Springer, 2019). pp. 113-29. (p. 115.).

communities and cultures whose identity and influence is coterminous with the atomicity of their respective nuclear events. In the introduction to this thesis, I describe 'atomicity' as a recognition of atomic burden that reaches beyond the immediate consequences of radiation. This chapter conducts an analysis of the impacts of sound practice that takes place within these sites and questions the ethics of a nuclear focussed sonic ethnography. Exposed to the effects of nuclear activities, communities such as those within the Chernobyl exclusion zone can provide vital witness accounts of post-atomic consequences. When considered in the context of sonic ethnography these aural accounts of post-atomic effects are an example of what Schafer terms an 'earwitness', 'one who testifies or can testify to what he or she has heard.'[35] Jacob Kirkegaard's piece *4 Rooms* (2006); a techno-mediated sonic intervention within the boundaries of the Chernobyl exclusion zone, and Peter Cusack's audio publication *Sounds from Dangerous Places* (2012), both utilise methods that are well established in sound arts practice and include field recording techniques, sonic ethnography, and site-based sonic intervention. Understanding the impacts of these methods is key to this research as I navigate them through my own practice in this thesis. In addition to an interrogation of these works, the limitations of Lendl Barcelos' 'nuclear sonic' and Cusack's 'sonic journalism' are considered in the context of this research and agitate for a more expansive definition of sound and the nuclear.

1.4 - Technology, Sonic Ethnography

Methods for performing sound studies have evolved over time to enable artists and sound practitioners to represent and attune to the sonic in increasingly expansive and comprehensive ways. Low-cost air travel and the proliferation of cheap, portable, and high-quality audio devices widened the scope and volume of sound practice throughout the late twentieth century. Aided by the portability and potential for unlimited storage in digital files and cloud-based servers, field recordings, soundwalks, sound maps, alternative modes of scoring, and aural histories are increasingly captured and distributed, collected in archives, and aestheticized in galleries and

[35] Schafer, 'The Soundscape', p. 272.

concert halls. It is with this in mind that we must consider the ethical implications of these practices, especially when sonic ethnographies connect to locations that are enmeshed with sensitive political, historical, or cultural legacies, such as those associated with irradiated landscapes. Peter Cusack's project titled *Sounds from Dangerous Places* is an example of a sound practitioner working within the conditions of nuclear sites. His expansive approach reaches out from a detailed aural study of the Chernobyl exclusion zone to the sheep farms of Snowdonia, where the consequences of Chernobyl's reactor meltdown in 1986 are still mitigated for in the measurement of radioactive hazards in the food chain, some 1,500 miles from their point of origin.

Cusack is a London and Berlin based sound artist and environmental recordist with a special interest in acoustic ecologies and the contribution sound can have on our 'sense of place'.[36] *Sounds from Dangerous Places* is a two-CD audio publication with an accompanying text containing descriptions of the audio recordings, transcriptions, and photographic evidence of the sites he surveyed. Through a process that Cusack terms 'sonic journalism'[37] the study investigates the aural make up of sites that Cusack highlights as having dangers, including the towns and villages of the exclusion zone surrounding the Chernobyl Nuclear Power Station; an area permanently adjusting to the consequences of a nuclear disaster that released enormous quantities of radiation upon the local environment, nature, and residents. Through a series of audio recordings taken during two visits to the Chernobyl exclusion zone, Cusack aims to provide an aural insight into the uniqueness of the locations he surveys. For Cusack, this journalistic approach allows for these sounds to 'be heard in their own right' and provides a focus on 'their original factual and emotional content.'[38] The result is a truly evocative collection of sounds that includes a variety of aural connections to the uniqueness of the site as a cultural, natural, damaged, reclaimed, and radioactive space. The scope of Cusack's recordings ranges from the iconic clicks of dosimeters to the songs and poems of local people and even the distant sounds of loud engineering

[36] Cusack, Peter. 2006. *Interpreting the Soundscape*, Leonardo Music Journal, 16: 68–70 https://doi.org/10.1162/lmj.2006.16.68.
[37] Cusack, Peter. 2012. *Sounds from Dangerous Places* (Surrey, UK: ReR Megacorp), p. 23.
[38] Ibid.

works being carried out on the 'sarcophagus', a huge concrete structure surrounding the Chernobyl plant's reactor core.

Cusack's project aims to question 'what can we learn by listening to the sounds of dangerous places?'[39] Although a simple question on the face of it, considering what quantifies as *we* and *listening* within the contexts of his sonic ethnography is a complex undertaking. Cusack's methods effectively place the 'listener' within the site, however the highly mediated approach to the recording process brings into question whether Cusack's recordings can have a realistic claim to being 'factual' or 'original' in their emotional content. An example of this mediation is noticeable in Cusack's positioning of his own presence within his recorded sounds. Cusack's descriptive titles such as '11. Walking on Books, Kindergarten' and '7. Walking on glass bottles, Kindergarten, Pripyat' acknowledge the influence of his presence as a recordist on his sound documentation, while the titles single this out as a focus of attention for the listener within the recorded material. Furthermore, there are several instances where Cusack suggests that the sounds of his own intervention provide the most definitive or 'essential' aural encounters within the sites he explores.[40]

Cusack's self-inclusive approach to his sound practice aligns with the direct or 'honest' representation of the sonic environments that he seeks but, at the very least, his approach presents complications for a sonic journalism based on minimal intervention. In addition to this, Cusack does not appear to challenge his methodology with this in mind, the project relies on the insertion of an external 'listener' (Cusack) within the confines and environments of an author-defined 'dangerous place', which brings up several challenges; our perception of danger is influenced significantly by our identity and experience, an experienced climber for example may feel in less danger hanging from a well tethered rope at a great height, than they might driving to their destination at the foot of a mountain. Likewise, a resident of the Chernobyl exclusion

[39] Ibid., p. VII.

[40] Cusack's description of track 5 'Kindergarten Footsteps, Pripyat' is one example of this 'The floors and corridors in the kindergarten are covered with two decades of debris, flaked plaster, broken concrete, brick pieces, dry leaves and, in one room, dozens of glass bottles. Every footstep creates a different crunch or snap that reverberates off the bare walls. Those steps, plus wind, are the essential sound of the building.' Ibid., p. 27.

zone may feel in greater danger from poverty, freezing weather, and more recently, invading forces than the possibilities of their exposure to radiation. It raises the question, to whom does Cusack's danger belong, whose danger are *we* listening to?

Although Cusack challenges some of these points in his written observations and the titles of the recordings he has made, there is a notable absence of an investigation into what his activeness within the site of his recordings means, and therefore the impact his presence as 'listener' may have on the recordings he has collected. To that extent, we must question whether Cusack's direct engagements of 'listening within' post-atomic landscapes can achieve the 'factual' and 'original' that his sonic journalism seeks. Despite this, there are several worthwhile connections to be made between *Sounds from Dangerous Places* and the practice undertaken as a part of my research. For Cusack, rather than his recordings acting as source content and material to be amended or adapted in the name of a sound arts practice, his method of 'sonic journalism' establishes the documented materials as the primary vital element of the work. It is a documentary approach that is focussed on a sonically inclusive practice that eschews any filtering of the sounding environment on the part of the recordist. 'Sonic journalism' is defined by Cusack as being 'based on the idea that all sound, including non-speech, gives information about places and events and that careful listening provides valuable insights different from, but complimentary to, visual images and language.'[41]

Although Cusack's 'careful listening' is not risk free, his approach is well aligned with my own practice - where documentation as praxis and sonic atmospheric attunements are enlisted in the discovery of post-atomic auralities. My definition of a 'noise-print', where a sonic capture can be directly traced to post-atomic events and their wider environmental and cultural effects also share similarities with Cusack's journalistic approach. Cusack's project is an inclusive acknowledgement of the post-atomic consequences of Chernobyl, which is especially effective where he documents the poems and songs of local people written following their relocation and the establishment of the exclusion zone around the Chernobyl plant. Paired with the

[41] Ibid., p.23.

sound recordings of the performance of these songs, these 'earwitness' accounts are formative of a nuclear sonic-ethnography that is carried out with sensitivity and recognition of the continuing cultural legacies of the event. It is a practice approach that this research can learn much from and has influenced my own approach to exploring the nuclear during my work at the BFI archive site, which is discussed in the fourth and fifth chapters of this thesis.

As well as providing a worthwhile example of an approach to sonic-ethnography within a nuclear focussed sound arts practice, Cusack's methods also provide interesting prerequisites for establishing a form of 'post-atomic listening'; or how paying attention to the atomicity of nuclear events can lead to a new understanding of sound in relation to nuclear culture. This is especially evidenced through the connections between Cusack's recordings of dosimeters, juxtaposing with the sounds of the natural environment and the emerging works within this practice-based research that document and utilise the making and adaptation of Geiger counters as sound emitting and modifying sensors.

1.5 - *Geiger Environs*

Figure 2. 'Geiger Environs' (film still).

Watch: *Geiger Environs* (2020)

Link: https://vimeo.com/danbeck/environs

USB Media Location: Film > 2-Geiger_Environs.mp4

Action: The following written attunement that accompanies this film can be read during or after watching, however, I recommend it is read out loud as you watch:

> *Geiger Environs*
>
> *The Geiger counter kit comes with numbered instructions for its assembly. A USB powered fan sucks solder smoke out and away from the helping hands, the base is clamped in a desk vice, surrounded by offcuts of sycamore, yew, oak, and horse chestnut. There is a light dusting of snow outside, and the road is quiet for this time of day, though it has been that way for a while… the low clouds and covered ground broadcast the world from under heavy blankets.*
>
> *People have stopped wearing masks in the street.*
> *I'm wearing a pair of adidas sliders and a beanie hat.*
> *I'm ignoring heart flutters.*
>
> *Slowing to construct a Geiger counter is an attempt to find time and space, my mind is long-lost somewhere in the insulation and boards between the flat*

above and the one below but there is an unconscious kind of excavation happening in the act of making.

I clamp the camera to a shelf above my workstation, the microphone pointing directly down towards my hands and poorly insulated feet. The completed device audibly clicks into operation and as I hook it up to a microcontroller, I can see numbers flashing up on screen, 19, 20, 19, 21…

Figure 3. Documenting the making of the Geiger counter.

Geiger Environs (2020) is an observation of the aural make-up of my workshop and its wider environment. The sounds of my workshop space, tools, fans, and occupants are presented in the context of their atmospheric conditions, the transit of cars on icy roads, the hum of heaters and fans, and sizzle of solder. The processes and

environments documented in the film are direct observations of the workspace and the atmospheric conditions present during the act of making. It is an example of a practice that is both a sonic atmospheric attunement and documentation as praxis, where the environment of my site of practice and the interconnecting influences of the space of making are included within the output work. *Geiger Environs* is an early example of practice within this research project that initialises a core argument for this study; that paying attention to, and engaging with these associations, can act as a vessel for understanding the significance of sound and atmospheric effects in the context of the post-atomic.

Geiger Environs is a documentation of the process of making a Geiger counter and an observation of the sonic environments of the workspace, in the contexts of Cusack's work this may seem mundane as there is little or no actual threat from radioactivity but there is a purpose to this process that reaches out to Chernobyl. Cusack describes the borrowed dosimeter that was carried throughout his visits and furthermore the broken, malfunctioning devices presented to his group by local people. He notes the indifferent reaction to the broken devices from the people he meets but does not appear to question the dosimeter or Geiger counter sound's meaning to the communities within the exclusion zone.

> During a lively evening great laughter was had at the expense of the dosimeters issued to everyone working in the zone. These are meant to indicate how much radiation each person receives over a specific time. With broken casing and missing components the ones we were happily shown obviously hadn't functioned in years, but served nicely as one of the zone's standing jokes.[42]

How might we consider this reaction to these broken devices, despite their ridicule, what is it that the dosimeter might represent to the people Cusack met? Perhaps a form of sonic erasure within the soundscape of the Chernobyl exclusion zone, or a political device whose unique sound-profile represents the enforced relocation and rezoning of displaced people and lands there? Reframing the dosimeter from a technology intrinsic to the exclusion zone, to one where dosimeter clicks are instead a technological interjection based on a projection or assumption of their belonging

[42] Cusack, 'Sounds from Dangerous Places', p. 17.

within that sound-space, can entirely change the meaning of that sound within its situated environment; these devices designed to offer protection perhaps instead intone an unwelcome aural intrusion of arhythmic breaks in the sonic field of Chernobyl.

The Otolith Group are an artist collective founded by Anjalika Sagar and Kodwo Eshun in London, 2002,[43] their film *The Radiant* (2012) offers a focussed look at the Geiger counter within areas affected by the fallout from the Fukushima Daiichi Nuclear Disaster. The film follows many of the conventions of art film and documentary practice combining archival footage, interviews, and long-duration shots of landscapes, with an audio track that includes elements of sound design, music, and location recordings. The artist collective describes *The Radiant* as 'a gathering together of different attempts to make sense of something insensible but which must be grasped, whether through visual, sonic or tactile means.'[44] The Otolith Group highlight their observations of Geiger counters within the film as key to this process, describing the device as 'a sonic guide' that 'can read the points where radiation connects.'[45] Within my practice, rather than utilising the Geiger counter as a sonic guide I look to its influence as a sound emitter - a sound generating device with its own enduring nuclear cultural effects.

Geiger Environs is not just an observation of the making of a Geiger counter but an acknowledgement of its ability to sonically invade a space, operating within my workspace its sonic influence far outweighs the impact of its background radiation measurements. It is from these observations that my documentation as praxis approach is developed and offers new insights into how post-atomic auralities can emerge from the site and act of practice. Rather than looking to where radiation connects with its surroundings, my approach instead conducts an examination of a device designed for post-atomic soundscapes, and a sound that is just as enmeshed with political, psychological, and cultural consequences in its absence as its presence

[43] The Otolith Group. 2021. *Xenogenesis* (Berlin, Germany: Archive Books). p. 8.
[44] 'The Radiant'. [n.d.]. *The Radiant → The Otolith Group* https://otolithgroup.org/work/the-radiant [accessed 21 May 2024].
[45] Ibid.

within the soundscape of the Chernobyl exclusion zone. It returns us to the query of Schafer's Canadian soundscapes and the exclusion, by methodological design, of what is already *not* present in the auralities of a culturally contested field of study. Although the intentions of Cusack's sonic journalism couldn't be further from Schafer's 'macrocosmic musical composition', perhaps the intervention of each of his dosimeter clicks brings *Sounds from Dangerous Places* closer to it. Cusack's project is an example of a sound practitioner operating within the nuclear landscape, but it also presents several ethical and practical challenges for his research, where the representation of effected communities, cultures, and environments, opens a query as to who has the right to access and expose sites with complex, local, colonial, and military histories, such as Chernobyl?

Jacob Kirkegaard's piece *4 Rooms* (2006), follows a similar trajectory to Cusack's fieldwork, inspired by Alvin Lucier's *I Am Sitting in a Room* (1970),[46] Kirkegaard attempts to extract the radioactive remnants of Chernobyl by recording the room tones of four abandoned spaces within the Chernobyl exclusion zone.[47] By playing the recordings back through loudspeakers in the same space and re-recording the results, Kirkegaard attempts to reveal the hidden post-atomic, radioactive voice or quality of the space through the production of layered drones and tones emerging from the aural architectures within the surrounding environment. Lendl Barcelos carries out a comparative study of Cusack and Kirkegaard's work in his essay 'The Nuclear Sonic: Listening to Millennial Matter' (2016).[48] Barcelos describes Kirkegaard's *4 Rooms* as a representation of the 'de-humanization' of the spaces of the exclusion zone, where aural architectures create feedback loops inflected with the radioactive. As we know through Cusack's documentation of people living within its locale, this understanding of the Chernobyl exclusion zone as devoid of life, human cultures and sounds is inaccurate in its presupposition and is representative of what Barcelos describes as a 'post-apocalyptic bias' within Kirkegaard's work that prematurely 'forecloses

[46] Composed in 1969 and first performed in 1970, Alvin Lucier's 'I Am Sitting in a Room' is a sound art piece that involves the repeated narration, recording, and playback of the same text until the words of the recorded text are obscured by the resonant frequencies of the room.
[47] '4 ROOMS'. [n.d.]. *Fonik.Dk* https://fonik.dk/works/4rooms.html [accessed 13 March 2024].
[48] Barcelos, Lendl, 'The Nuclear Sonic: Listening to Millennial Matter', in *Aesthetics After Finitude,* ed. by Brits, Baylee, Gibson, and Amy Ireland (Re. Press, 2016). pp. 71-87.

humankind's intervention' within the exclusion zone.[49] Compared to Cusack's use of dosimeters and recording devices within his fieldwork, Kirkegaard's is a far more deliberate technological interjection within the boundaries of the exclusion zone. His approach of deserting his equipment during the recordings, so as not to influence the outcome of the sounds he produces, also seems entirely tokenistic when the engaged method enacts an almost complete erasure of recognisable sound within his field of enquiry, a sort of techno-sonic flooding of the aural architectures of the spaces he surveys.

It is a method that operates on the condition that the nuclear histories of the sites he works within can be reactivated through an engagement with sound-based technologies; utilising speakers, microphones, and sound recording devices in an almost ritual aural exhumation of the nuclear. Sound art theorist, Seth Kim-Cohen (2009) describes Kirkegaard's work as an attempt to 'move back in time to engage an already written historical event.'[50] Throughout this research, this idea that the post-atomic can be reanimated, from a position of relic or remanent of past events is challenged in relation to the *always*-effects of nuclear events. In her essay 'Troubling Time/s and Ecologies of Nothingness' (2022), Karen Barad questions the understanding of nuclear timelines as a flat, linear series of events. For Barad, establishing the timeline of nuclear consequences by way of highlighting a single or series of events in their chronological 'pastness', is a misreading of the overlapping 'nowness' and interconnected influence of them.[51] Barcelos presents his idea of the 'nuclear sonic' as a mode of listening that challenges the sonic to engage with and along the 'millennial' timespans of nuclear material, asking, 'if our models of listening are circumscribed within the limits of an individual human being or even the human species as a whole, how is it they can become nuclear?'[52] This is a productive question to consider in the context of Barad's non-linear chronology of nuclear events. However, contrary to

[49] Barcelos, 'The Nuclear Sonic', p. 80.
[50] Kim-Cohen, Seth. 2009. *In the Blink of an Ear: Toward a Non-Cochlear Sonic Art* (Continuum International Publishing Group). p.132.
[51] Karen Barad, 'Troubling Time/s and Ecologies of Nothingness', in *Through Post-Atomic Eyes,* ed. by Lauzon, Claudette, and John O'Brian (Montréal, QC, Canada: McGill-Queen's University Press, 2022), pp. 306-29.
[52] Barcelos, 'The Nuclear Sonic', p. 86.

Barcelos, the question I approach in this research is not how it is that listening can 'become nuclear', but rather, how is it already?

1.6 - *Geiger Counter Compositions*

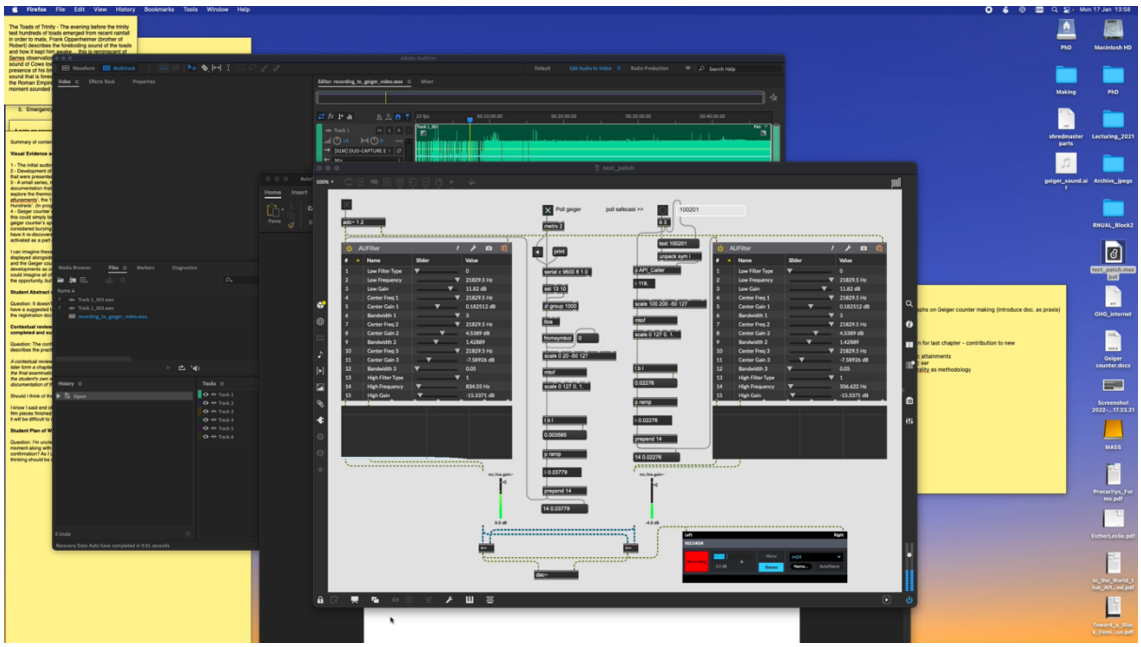

Figure 4. 'Geiger Counter Compositions – For Washing Machine' (film still).

Watch: *Geiger Counter Compositions* (2021)

Link 1: https://vimeo.com/danbeck/geigerforwashing

USB Media Location: Film > 3-Geiger_Composition-Washing_Machine.mp4

Link 2: https://vimeo.com/danbeck/lunchmaking

USB Media Location: Film > 4-Geiger_Composition-Lunch_Making.mp4

Geiger Counter Compositions (2021) are two short films that document the engagement of a Geiger counter as a sonic agent. The films represent an expansion of my workshop-based practice and are a record of an experimental approach that begins to blur the boundary between the site of my practice and the subject of my research, where radioactive data gathering, live audio manipulation, software design and documentation are activated as tools for modulating the aural environment of my space of making. The two films are a sonic examination of the Geiger counter device,

where both the audio output from the built-in line-out channel on the device and the audio output from the dosimeter speaker are modulated according to two independent streams of data.

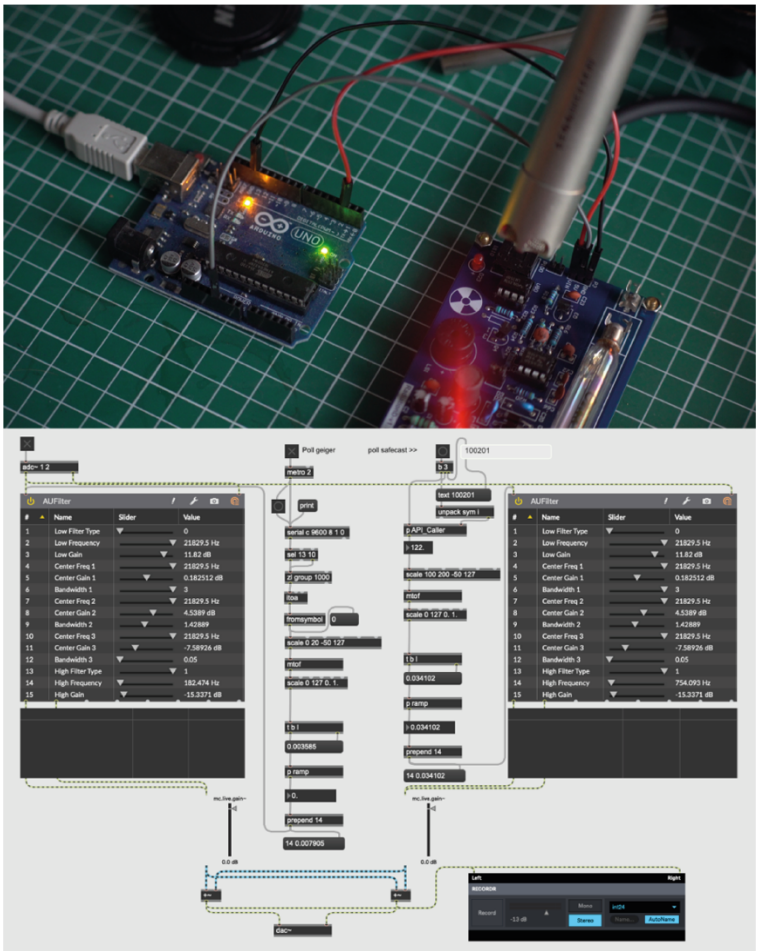

Figure 5. Geiger counter, Arduino microcontroller and microphone (top), Max patch showing the audio filters used to modulate the microphone and line-out audio channels of the Geiger counter (bottom).

The films consist of a screen recording of a desktop computer (Fig. 4) and the resynchronised audio recorded via a Max/MSP patch designed to filter the incoming audio signal.[53] The patch collates information from two live sources, the radiation reading from the Geiger counter and a remote reading of a dosimeter on the Safecast platform. Safecast is a global community data gathering project, where individuals, businesses and community-based organisations can utilise Geiger counters to measure radiation within their local surroundings. Safecast Geiger counters are linked to an

[53] Max/MSP is an audio-visual software design tool. See, 'What Is Max?' [n.d.]. *Cycling74.com* https://cycling74.com/products/max [accessed 14 March 2024].

online database on the website safecast.org, where information is stored and can be accessed through an API that reports the time, location, and radiation reading of each device in real-time.[54] A microphone, concentrated on the Geiger counter within my workspace, provides a live audio input source that is filtered according to the level of radiation reported. The same technique is applied to the output audio from the board, which predominantly consists of electronic noise and fuzz, using the incoming radiation data provided by the Safecast sensor.

Figure 6. Safecast API patch: Once a Safecast sensor is chosen in the main patch window, this subpatcher can report sensor data at an interval of once per minute. The complexity of the patch is mostly due to a requirement to correctly format a URL request with the correct date and time required to receive the most recent data back from the web API. The patch then filters and formats the returned data (which can be seen in the Max console to the right of the image) to individual data streams, which in this case is radiation (cpm), latitude and longitude.

I designed the patch as a sonic-radio*active* gating device, where radiation readings assume control of the content of the recorded audio. As the radiation measurements increase, the recorded audio's range of frequencies also increase, allowing more of the sounds of the workshop environment to be heard in the recording. When the Geiger counter readings reach above a set limit, the higher frequencies are accentuated by a high-pass filter, providing the Geiger clicks with a shrill sounding high frequency that is alarming to listen to. As well as filtering the sound of the Geiger counter clicks the

[54] Application Programming Interface (API): A set of protocols allowing for the communication of data between software and networked devices, the Safecast API is explained in more detail in my analysis of *37°N in* Chapter Two. See Section 2.4, '37°N (2021)'.

workshop's sounding environment is accentuated via the same process, creating an interplay between my space of practice and its mixed function as a shared living space. Visually the two films reach further into this now shared space of practice, offering a view of a desktop computer scattered with filenames, research notes, and storage devices. *Geiger Counter Compositions* and the other works that I have introduced within this chapter, are the result of a period of experimentation that helped to shape the methodological tools that I have outlined in the introduction to this chapter.

It is an approach that concentrates as much on the 'doing of' art as the outcome or practice, and it is through this concentration on the act and place of making that the timelines and consequences of the radioactive, atmospheric, and energetic can be attuned to the sound arts practice that I present throughout this research. This approach, which I have termed 'documentation as praxis' performs a displacement of the boundaries of nuclear practice, where the post-atomic auralities of Fukushima can merge through Safecast dosimeters, the background radiation readings of my home-workspace, and the rumble of washing machines. Where Cusack's sonic journalism includes the movements and sounds of the recordist within his sonic ethnography, documentation as praxis extends to the places that sound practitioners rarely draw attention to. The auditioning of audio files in open-backed headphones, the sounds of home-work, and the experimentation and selection of recording devices are all included and contribute to the practice of sonic atmospheric attunement that I carry throughout this research.

1.7 - Documentation as Praxis

> The senses sharpen on the surfaces of things taking form. They pick up texture and density as they move in and through bodies and spaces, rhythms and tempi, possibilities likely or not. They establish trajectories that shroud and punctuate the significance of sounds, textures, and movements.
>
> – Kathleen Stewart[55]

Documentation as praxis is a methodological tool for engaging in an art practice that includes within it the observation of the environment and the interconnecting influences of the site of practice on the artwork. Through my experimentations with Geiger counters, community data projects, sound, film, and documentary approaches, I have presented within this chapter a selection of works that begin to demonstrate these ideas within my practice. Borrowing from Stewart, it is a 'practice process that sharpens on the surfaces of things taking form', and a mode of practice that is sensitised to the significance of the space in which it is made. This chapter has questioned the impacts of the Geiger counter in Cusack's sonic ethnography, as well as discussing the ethical implications of Kirkegaard's technological interventions on site-based practice. My experimental works that I have described in this chapter are demonstrations of an expanded act of listening that interleaves the conditions of the site of making, the tools of my practice and their atmospheric encounters. Although conventional methods of art documentation such as, photography, sound recording, film, video, and text are utilised within this documentation as praxis approach, the purpose and function of these methods are equally generative of practice as they are representative of it. Through this reinterpretation, documentation as praxis performs an active attunement to the place, situation, and event of making, emulsifying the space and act of practice within my artwork. This relationship of documentation and art practice, however, is a definitively slippery one.

Art historian, Boris Groys argues that 'art documentation is by definition not art; it merely refers to art, and in precisely this way it makes it clear that art, in this case, is no

[55] Stewart, Kathleen. 2011. 'Atmospheric Attunements', *Environment and Planning. D, Society & Space*, 29.3: 445–53 https://doi.org/10.1068/d9109. p. 448.

longer present and immediately visible but rather absent and hidden.'[56] Groys' view of art documentation as a frozen representation of an artwork – perhaps a still from an art film, or a picture of a sculptor at work plastered on a gallery wall, is rooted in convention and the curatorial normative decision to include the documentation of artworks in place of, or among 'art objects' within a gallery setting. However, this view does not fully account for the fluid boundaries of documentation or its potential to be represented by less conventional means – in memory, handshake, or oral tradition, for example.[57] Groys' theory reflects on the common practice of art documentation exhibiting alongside or in place of an artist's work, however, insisting that the outcomes of this process 'cannot be art' is contestable before we begin to consider the many other interpretations and uses of documentation as a conduit for generating artwork that runs counter to this point of view. Groys might well refute this argument by insisting that the very moment that documentation 'is' the artwork then it is no longer documentation, but there are other statements from Groys that perhaps provide another end from which to untangle this complex knot.

In an interview with Siegfried Zielinski in 2014, Groys argues further that artwork 'itself cannot be inscribed into the archive, what is inscribed into the archive is documentation.'[58] The practice that I present in this research contests this suggestion as an undermining of the significance of documentation as a process, learned skill and medium. It could be argued that this contestation is also demonstrated in Cusack's *Sounds from Dangerous Places* and countless other sound art practices, where the process of observation is generative of a document that has impact and reveals itself as active within and generative of new events and consequences that are direct in the art they produce. When described in this way, the documentation as praxis approach that I undertake aligns more with Groys 'living art'[59] than that of the white cube

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[56] Boris, Groys. 2008. *Art Power* (MIT Press), p. 60.

[57] See van Saaze, Vivian. 2016. 'In the Absence of Documentation. Remembering Tino Sehgal's Constructed Situations', *Revista de História Da Arte: Performing Documentation in the Conservation of Contemporary Art*, 4: 55–88.

[58] European Graduate School Video Lectures. 2014. 'Siegfried Zielinski & Boris Groys. Thinking Media and the Man-Machine Relation. 2014' (YouTube) https://www.youtube.com/watch?v=6_9NA9ktorU [accessed 2 July 2022] at 23m-20s.

[59] Groys describes living art in the context of an artist's desire to work in the present, to be seen as active participants, engaged politically, and situated 'in social reality'. For Groys this

presentations of art documentation that might contribute to this view. There is also a question here of what it is that separates the archive from the art object? Is a painted canvas an archive or art object? It is certainly both artwork and the primary document of the 'doing of art'. The boundaries of what constitutes art, making, and documentation are further complicated by their format and their platform, whether the art in question is a performance or digital work, for example. Annet Dekker and Giannachi, G. (2022) argue that 'documentation is not only increasingly signifying art, becoming art, but also that the doing of it ought to be considered an art in itself.'[60] It is true that making record of the activeness or occurrence of art in-situ, does not automatically inscribe documentation 'as' an artwork, but as I progress through my own investigations of documenting practice, I will challenge Groys' theory that documentation is definably incapable of 'being art' or that in its archived state it is fixedly rendered as so. The works that I describe in the latter chapters of this thesis further challenge Groys assertion on the limits of archived artworks, where a compilation of practice pieces made during this research and in collaboration with the BFI National Film and Television Archive, are situated as practice that retains its status as an active art object within the archive.

In a space where the medium, data, atmosphere and site of practice are enmeshed, separating the artwork from the document can be a far more complex task than Groys' theory appears to allow, documentation as praxis is a unique methodology in this respect. The two films *Geiger Counter Compositions* that I have described in this chapter, are representative of this - how might one describe what quantifies documentation and practice in this work? It's possible the documentation could be considered the recording of the work, including the desktop screens and recorded audio, the data streams provided by the Safecast sensors and API platform that provides access to their records. It could also be argued that the primary document within this artwork is the edited film in its complete form. Through my application of a documentation as praxis approach, I will test some of the stricter definitions of where

derives from a desire of art and artists to bring 'art into life—beyond all historical constructions and considerations, beyond the opposition of old and new.' Groys, 'Art Power', pp. 23-24.

[60] Dekker, Annet, and Gabriella Giannachi (eds.). 2022. *Documentation as Art: Expanded Digital Practices* (London: Routledge). p.7.

the boundaries of documentation lie, asking, is there even any need for them and can they be probed and activated as artworks through an attunement to the site and act of work? It is in this process of actively listening to and testing these boundaries that a definition of praxis emerges that can engage with post-atomic auralities. Within this chapter, I will provide examples of artists whose work effectively crosses the boundaries of art and documentation, but first I wish to make clear my distinction of 'praxis' and 'practice' within this research.

1.7.1 - Praxis and Practice

Praxis and practice are often considered as interchangeable, concerned with output – they are born of the same breath; 'doing words' descriptive of action. Praxis is defined by the Cambridge Dictionary as 'the process of using a theory or something that you have learned in a practical way.'[61] However, modes of applying theory and learning differ vastly and it is therefore unsurprising that both practice and praxis are words attributed with a range of alternative definitions that are dependent on their use or context. Within the boundaries of the arts, the word practice can be used to define an art object, terminologically referring to the actualised result of a creative process, often described as a 'practice-piece'. It exists, it was created by methods mastered, and now it is presented as a solidification of one's mastery of an aesthetic discipline. It is also a word more commonly understood as descriptive of the process of learning; not just concerned with mastery but the action of becoming proficient. In law, medicine, psychology, and many other disciplines practice can define the daily 'doing of' a learned subject or technique, or even define the walls, employees, technologies, patients, or clients of 'a practice'; a placename entrusted with the understanding that those who operate within it are experts within their area of knowledge. Herein lies an issue of definition, many of these examples of practice also neatly meet the dictionary description of praxis, however the word itself does not fit comfortably with any of them; we do not praxis the piano.

[61] 'Praxis'. [n.d.]. *Cambridge.org* https://dictionary.cambridge.org/dictionary/english/praxis [accessed 22 February 2023].

In Aristotelian terms 'praxis' and 'poesis' are two modes of human activity that are conceptually distinct; praxis is concerned with the act of doing, poesis with the thing that is made. We can consider poesis therefore as being unavoidably wed to its outcome, a process where the action (making) is deferential to the outcome (the made). Oded Balaban (1990) describes this difference as a point of haecceity 'the decisive aspect of poesis is the result of the activity, whereas in praxis it is the activity itself that counts, and not the final result (i.e., its nature).'[62] In recent times poesis has undergone a repositioning of this definition within art criticism and theory, conflations of poesis such as autopoiesis (self-making), and Donna Haraway's 'sympoeisis', or, methodology for 'making with',[63] adopt poesis as a framework for an expanded mode, not just of making (or the made), but also a 'liveness of doing or being'. One whose outcomes are primarily conceptual and closer in definitive terms to the 'nature of doing' that Aristotelian praxis defines. Praxis has also undergone shifts in its interpretation over time, notably in Marx's socio-political 'revolutionary practice'[64] and Sylvia Wynter's weaving of the politics and economics of colonialism to a 'praxis of humanness'.[65] It is for this reason that I wish to pull at this definitive thread, to establish how documentation can not only 'be practice' but how activating documentation within the process of making can be considered a form of praxis, a doing not just of actions but actions of purpose.[66] Although definitively speaking this endeavour crosses the stricter boundaries of praxis and poesis as defined by Balaban, with Wynter and Haraway, I proceed in good company.

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[62] Balaban, O. 'Praxis and Poesis in Aristotle's practical philosophy' in *The Journal of Value Inquiry vol. 24*. 1990. Netherlands: Kluwer Academic Publishers. p. 190.

[63] Haraway, Donna J. 2016. *Staying with the Trouble: Making Kin in the Chthulucene* (Durham, NC, USA: Duke University Press), p. 98.

[64] 'For Marx, praxis consisted of theoretically informed and self-reflexive human action devoted to the emancipation of the working class from dominion by the capitalist class and the capitalist state.' Nonini, D. 'Praxis' in *Dialectical Anthropology, September 2016, Vol. 40, No. 3, The Fortieth Anniversary - Part Two* (2016), pp. 241-49. p. 242.

[65] 'Being human is a praxis of humanness that does not dwell on the static empiricism of the unfittest or the downtrodden and situate the most marginalised within the incarcerated colonial categorization of oppression; being human as praxis is, to borrow from Maturana and Varela, "the realization of the living."' McKittrick, Katherine (ed.). 2015. *Sylvia Wynter: On Being Human as Praxis* (Durham, NC, USA: Duke University Press), pp. 3-4.

[66] In the final chapter of this thesis, I describe my distribution and use of film materials at a Nuclear Energy Agency (NEA) conference as an engagement of 'praxis actions'. See Section 5.7, 'Tabloo'.

1.7.2 - The Document as Art Object

Documentation as praxis is concerned with the entanglements of the space, atmospheres, and procedures of art practice. Throughout this research I enlist methods for this investigation that include texts, recordings of various media, and other forms of document as a creative outlet for my practice. In the following pages I will provide examples of practice and theory that agitate for a reimagining of the relationship of the document's status and potential as an art object. Each of these examples enlist a different method for the transduction of document to artwork and in doing so offer a shift in coordinates for reaching the documentation as praxis approach that I have described.

Robert Smithson is an artist associated with the mid-twentieth century Land Art movement that coincided with the emergence of Minimalism and Conceptualism. The work of land artists including Smithson, are most commonly remembered for their large-scale sculptural engagements with remote locations. Smithson's *The Spiral Jetty* (1972), a 1,500-foot spiral of basalt rock and earth situated within the Rozel State Peninsula at Great Salt Lake, USA, and Michael Heizer's *Double Negative* (1969); where two long trenches of 50 feet in depth were cut into the Mormon Mesa in the Nevada Dessert are two examples of these grand-scale works of art. Smithson's legacy, however, is equally intriguing when considered in relation to his theories of 'site' and 'non-site', which are explored in more detail in the context of the accessibility of nuclear sites in the Second Chapter of this thesis. For Duncan White, Smithson's written observations and documented works present as artworks in their own right. In his essay 'Unnatural Fact: The Fictions of Robert Smithson' (2008), White describes Robert Smithson's documentation of *The Spiral Jetty* as being inseparable from any actual experience of it. White understands Smithson's approach to documentation as a form of 'reporting as seeing', where knowledge of the largely unvisited site is held both in the memory of those who have experience of it and in the extensive documentation of its permanently shifting relationship within its environment.[67]

[67] White, Duncan. 2008. 'Unnatural Fact: The Fictions of Robert Smithson', *Journal of Writing in Creative Practice*, 1.2: 161–75 https://doi.org/10.1386/jwcp.1.2.161_1. pp. 161 – 175. p. 161.

Considered in this way, Smithson's work is an example of how art documentation, including text-based works, can cross the boundary from art documentation to art object.

White provides further evidence for the consideration of documentary textual works as art objects by arguing that Smithson's extensive reportage demonstrates that 'the Spiral Jetty is a matter of writing'[68] and that Smithson's written accounts and documentation of his works should be considered as much a part of the artwork as the earthwork itself. White's evaluation of Smithson's written works as equal to the aesthetic formation of the rocks that constitute the site-based work, contradicts Groys' assertions on the limitations of documentation as artworks. Within this thesis there are repeated examples of text documents that are activated as practice outcomes, such as, in my written attunements to the site of practice that I include at the start of this chapter. For White, Smithson was an artist 'attempting to occupy the space between production and reception as a space which is not fixed but is instead a shifting representational process.'[69] This understanding of Smithson's work aligns with the intentions and methods of documentation as praxis, where paying attention to and making record of the atmospheric, procedural, and material entanglements of art practice emerges as a practice outcome. Identifying documentation as practice is a complex task to undertake, but there are further examples of artists working to this effect that offer a critical pre-requisite for this methodology, and backup White's argument for the boundaries of Smithson's *Spiral Jetty* to be expanded to the documentation of it.

Dekker, Giannanchi & van Saaze (2017)[70] provide one such example of this, with their detailed critical analysis of Lynn Hershman Leeson's *Roberta Breitmore* (1972-8). The following passage is a description of this work from the artist's website:

[68] Ibid.
[69] Ibid., p. 165.
[70] Dekker, A., Giannachi, G. and van Saaze, V. 'Expanding Documentation, and Making the Most of 'the Cracks in the Wall'' in Sant, T. (ed.). 2017. *Documenting Performance: The Context and Processes of Digital Curation and Archiving* (London: Methuen Drama), pp. 61-78.

In 1973, Hershman Leeson began a private performance as the fictional character, Roberta Breitmore. Breitmore's first act was to arrive by bus in San Francisco and check into the Dante Hotel. In the following years, she undertook real-life activities such as opening a bank account, obtaining credit cards, renting an apartment, seeing a psychiatrist, and becoming involved in trendy occupations, such as EST and Weight Watchers. Breitmore placed ads in local newspapers seeking a roommate. This action resulted in 43 responses. She pursued interactions with 27 of those individuals. Roberta had her own clothing, signature makeup, walk, gestures, speech mannerisms, and handwriting. Her activities were documented in 144 drawings and surveillance photographs, as well as other artifacts, including checks, credit cards, and a driver's license. During the fourth year of the performance, Breitmore multiplied into four other people appearing in her guise. The performance ended in 1978 at the Palazzo dei Diamanti in Ferrara, Italy in an exorcism ritual held in the crypt of Lucrezia Borgia, during which Breitmore was transformed through the elements of fire, water, air, and earth. Hershman Leeson collaborated with Spain Rodriguez, a Zap Comix artist, to document the escapades of Roberta Breitmore in a graphic novel.[71]

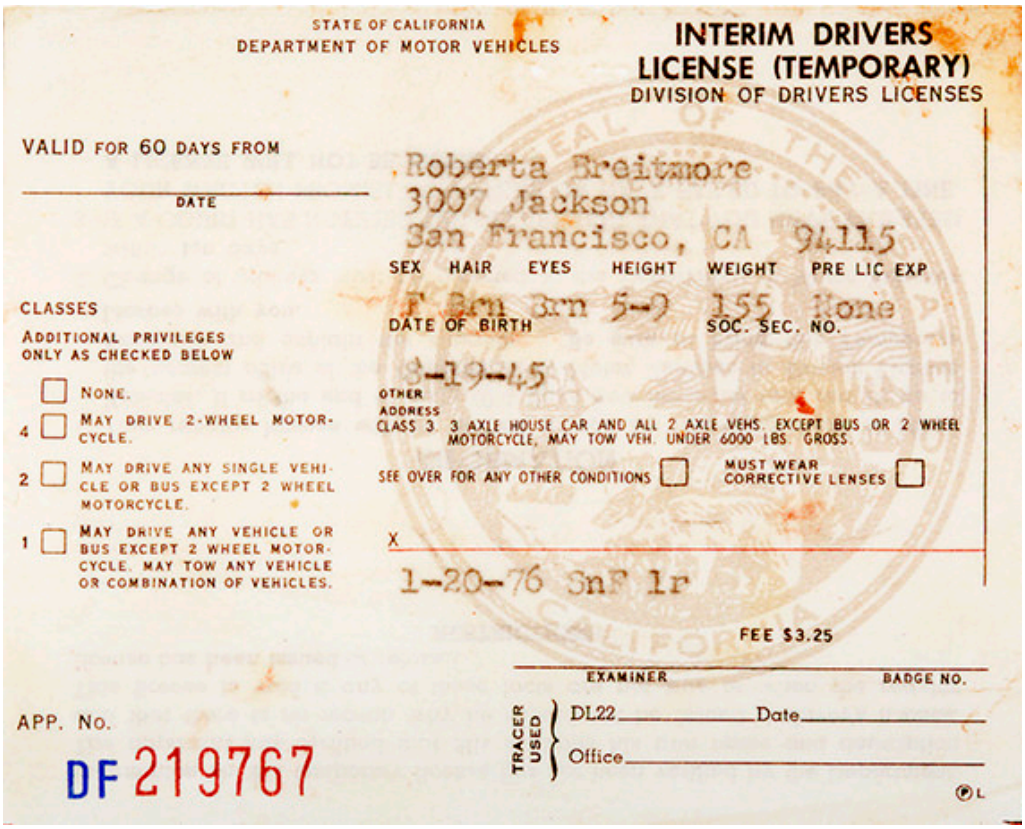

Figure 7. Roberta Breitmore's Interim Driver's License, issued January 20, 1976.[72]

[71] 'Roberta Breitmore'. 2016. *Lynn Hershman Leeson* https://www.lynnhershman.com/project/roberta-breitmore/ [accessed 23 February 2023].
[72] Image used with the permission of the artist. Leeson, Lynn Hershman. 2016. 'Roberta Breitmore - Interim Driver's License' (lynnhershman.com). https://www.lynnhershman.com/project/roberta-breitmore/ [accessed 23 February 2023].

For Dekker, Giannanchi and van Saaze, Hershman Leeson's collective work of performance is a demonstration of how documentation can cross the boundary of museological archive and documentary representation, to art object. The driver's license, paper cuttings and photographic evidence of *Roberta Breitmore* contribute to a multi-faceted art practice, where both the primary and secondary documentation of the work are formative of an environmental artistic-whole of *Roberta Breitmore.* 'Brought together, and seen as an inter-document, these documents do not so much construct a persona as an environment. Being part of this environment of the performance, both primary and secondary documents moved beyond being mere representations of a former activity to become part of it. Throughout this process, they also became autonomous artworks.'[73] Hershman Leeson's 'performing of documentation' and of *Roberta Breitmore* are a representation of how a praxis approach that concentrates on the observation of practice, can navigate between the boundaries of art documentation and creative output.

It is particularly noteworthy that Decker, Giannanchi and van Saaze describe this as a construction of the artwork as an 'environment', the creation of a kind of 'networked artwork' whose interrelating forms can present in their entirety as 'Roberta' or in the isolation and presentation of 'Roberta's' constituent parts. It is with great care that the work I present in this thesis, is considerate of the environment within which it is situated and the processes of sonic atmospheric attunement and documentation as praxis that I describe as key methodologies for this research are a conduit for this. Considering Dekker, Giannachi and van Saaze's evaluation of Hershman Leeson's work as a work 'of environment' provides an intriguing point of departure for the methodology that I am constructing here. There are several examples within this research where the output work could be considered the 'inter-document' that Dekker, Giannachi and van Saaze describe in Hershman Leeson's work, such as in the collected documentation and written presentation of the experimental practice I have already described. Rather than constructed around a 'persona', as with *Roberta Breitmore*, the 'networked-artwork' that Decker, Giannanchi and van Saaze describe is

[73] Dekker, Giannachi and van Saaze, 'Expanding Documentation' in *Documenting Performance*, p. 65.

demonstrated in my practice through the documentation, aural evocations, and sonic attunements that I have made within my site of practice.

Hershman Leeson's presentation of the written documents belonging to *Roberta Breitmore* as artworks are an example of where text-based documents can attain the status of art object. In Chapter Four of this thesis, I describe the making of a series of binary code translations of radionuclides to hand-bound textbooks and in the production of a printed sound mapping project I further introduce the textual document as an artwork within this research. The engagement of text-based documents as art practice requires a delicate act of balancing between what is critical, representative, or definitive within arts practice. Peter Cusack's project of 'sonic journalism' is an example of this, where his collected work of sound recordings, written observations and photographic images could very neatly be interpreted as the 'inter-document' or 'environment' that Dekker, Giannachi and van Saaze describe in Hershman Leeson's work. It is present also in Robert Smithson's textual works breaking down both the conceptual and actual borders of the site in which his sculptures are activated. White goes one step further in his description suggesting that 'to read Smithson's work is to be involved in an act of production. Openly drawing direct attention to the disparate array of sources it is possible to note the artificial arrangement, or stage setting, in Smithson's work.'[74] By encouraging you, the reader, to take part in 'Actions' where atmospheric attunements are read out loud during the reading of this thesis, I aim to draw the same attention to the presence of your space of doing, being, or making. It is in these tensions of site, documentation, and environment; be that the environment of the atmospheric, geologic or of the nature of the work itself, as Dekker, Giannachi and van Saaze introduce, that a praxis approach emerges. Documentation as praxis is a methodology where reading can be an 'act of production', or where, through an atmospherically attuned approach to documentation, the 'act of writing' can be captured in the context of its thermal environments.[75] It is from this realisation that we can begin to explore how this approach can open up new avenues for exploring the *always*-effects of nuclear events.

[74] White, 'Unnatural Fact', p. 163.
[75] See Section 1.2, 'Writing for Window Boxes'.

1.8 - Chapter Conclusion

In this chapter I introduce documentation as praxis as a methodology that I will explore throughout this practice-based research. I have considered the ethical implications of conducting sound practice within sites that have been impacted by nuclear events and describe how documentation as praxis and sonic atmospheric attunements can combine to find alternative ways for engaging in these nuclear cultural queries. I have outlined different critical interpretations of documentation in art and have highlighted Hersham Leeson's *Roberta Breitmore* and the textual representations of Smithson's land art as examples of where documentation can be transposed to artwork. Throughout this thesis I will provide practice examples of where my documentation as praxis approach has helped to uncover the post-atomic auralities that this research seeks out and extend this process to the development of my concept of noise-prints.

This chapter introduces the methodology that I will follow throughout my research, providing three examples of my early experimental practice, *Writing for Window Boxes*, *Geiger Environs*, and *Geiger Counter Compositions* that explore how sonic atmospheric attunements combine with documentary methods to reveal the post-atomic*.* Following a critical analysis of Peter Cusack's *Sounds from Dangerous Places* and Jacob Kirkegaard's *4 Rooms*, I have posed questions to the ethics of sonic ethnographies that have taken place within the boundaries of nuclear landscapes and events. In doing so, I have provided an analysis of how my own practice can learn from these examples. Within this early phase of my research, I have considered the conditions of my site of practice and establish a methodology that is inclusive of it, where the sounds of home-work are combined with the clicks of dosimeters and gathered data from remote sensor technologies. Throughout the remainder of this thesis, I will further challenge the limits of this methodology, engaging directly with the site, act, and atmospheres of art practice. In the next chapter of this thesis, I open the site of my enquiry to the decommissioning of the Fukushima Daiichi Nuclear Power Plant through a digital practice piece titled *37°N.* I will also explore how the electromagnetic connections between temperature (radiant heat) and nuclear

radiation can provide an example of how sound and atmospheric effects are communicated.

Chapter 2: Sound and Radiance

2.1 – Introduction to Chapter

Sound is an environmental effect. It influences, proliferates, and relies on the presence and movement of the co-energised and co-active elements that surround it. It is this environmental connectivity that permits sound to permeate and merge with environments, and bodies of many varieties - biological, geologic, oceanic, atmospheric. Sound's unique properties allow humans to map the deepest, invisible recesses of the oceans and for bats to locate prey mid-flight. It can seek out and destroy cancerous cells within bodies, and it can be weaponised and manipulated for the purposes of violence, coercion, and control.[76] Sound is forever an environmental phenomenon, it relies on and is influenced by the presence, density, movement, and excitement of particles and molecules that exist between emitter and receiver.

In this chapter, I will explore how environmental phenomena relate directly to the aural outcomes that proliferate from them. Sound's temporal nature, its short-time-curve of decay, requires a record of its existence for it to remain beyond its fleeting resonances. Many of these intrinsic traits are shared and multiplied through the addition, or in some cases, continuous presence, of other environmental effects such as temperature. This chapter will utilise the methodologies I have introduced in the First Chapter of this thesis to investigate where the atmospheric and energetic boundaries of sound, thermal influences, and radioactivity can be crossed. I introduce heat as one example of where the transference of energies between sound and atmospheric or environmental effects can open up a new mode of enquiry for my sound arts practice, exploring how sound and radiant heat can combine to reveal post-atomic auralities. It is with this purpose in mind that this chapter begins with a theoretical analysis of sound and thermal phenomena.

[76] See, Goodman, Steve. 2014. *Sonic Warfare: Sound, Affect, and the Ecology of Fear* (London: MIT Press) https://doi.org/10.7551/mitpress/7999.001.0001.

Following this analysis, I present *37°N* (2021), a web-based artwork that engages a series of live audio-visual interjections in the streamed footage from the decommissioning of the Fukushima Daiichi Nuclear Power Plant. The temporary online installation took place on the ten-year anniversary of the devastating earthquake, and the resulting tsunami that caused an explosion in one of the Fukushima plant's reactors in March 2011. As the work has now expired, it is represented in this thesis by the documentation I present later in this chapter as well as in the 'Remote Sensing Symposium'.[77] *37°N* is a practice engagement with weather systems, citizen data gathering projects, and radioactive monitoring stations that expands my field of research beyond the confines of my experimental workshop practice described in the previous chapter. Through this work, I will evaluate the ways in which listening or 'attuning' to the energetic exchanges between sound and environmental phenomena such as, weather, heat, and seismic events, can reveal new pathways for understanding the consequences of our post-atomic actions.

2.2 - The Sonic Incandescent

> The multiple is the sea of movements that do not stop, that vary like squalls; one might say it is a hot network of communications - ordered, disordered - whose heat also varies.
>
> - Michel Serres[78]

In this chapter I will look at the ways in which radiant heat (infrared) and nuclear radiation (alpha, beta, and gamma) interact with their sonic environments. Although radiant heat and nuclear radiation are both forms of electromagnetic radiation, their influence on the environments that they affect and how they are understood and experienced is distinct in many ways. This chapter listens to the shared properties of radiant heat and nuclear radiation to find a point of entry for the post-atomic auralities that my practice seeks out. Revealing the engagements, voids, and contact points of

[77] I have included my section of this publication in the appendix. See Appendix, 'Item 1'.
[78] Serres, Michel. 2015. *Rome: The First Book of Foundations*, trans. by Randolph Burks (London: Bloomsbury Academic). p. 111.

sound and heat, I consider the thermal, nuclear, and sonic as formative of what Serres describes as a 'hot network of communications'. This variation of interactions or 'multiple sea of movements' applies, but is not limited to scientific interpretations of waveforms, frequencies, and the vibrational forces associated with the energetic exchanges that occur between heat, sound, and other environmental and atmospheric effects.

Sound's vibrational interactions or 'vibes' are the subject of several detailed sound studies.[79] Although I wish to avoid dwelling on these well-established 'vibrational ontologies' within sound arts research, Marcus Boon's (2019) description of vibrations provides a worthwhile starting point for understanding the fundamental ways in which sound and waveforms of other varieties interact: 'In scientific terms, a wave or vibration is the product of an energy transfer: whether electro-magnetic, sonic through the vibration of air particles, or simply vibratory in the case of ocean waves or seismic phenomena such as earthquakes.'[80] Boon's definition considers the energies and vibrations of heat, sound, earthquakes, and airborne particles, as a coterminous product of energy transferences. The phenomena that Boon describes share common properties with the electromagnetic emissions of nuclear materials - gamma, alpha, and beta, and places the radiant (heat) within reach of the irradiated (atomic). Following Boon's definition and breakdown of this transference of energies, the associations of nuclear, thermal, and aural interactions can become clearer. In uncovering the aurality of thermal and nuclear effects, common atmospheric and environmental properties can be established that reveal their potential when connected through a practice of sound emission and listening. In this chapter I look to heat as a specific example of how these aural connections can be made. Although I will be focussing on heat, as Boon's quote suggests, the same approach can be applied to the energetic exchanges that occur between sound and weather systems, seismic events, or other environmental phenomena. These connections are revealed further into this chapter through my practice piece *37°N*, where the data from seismic events,

[79] Goodman, 'Sonic Warfare', pp. 81-84.
[80] Marcus Boon, 'A Place Where the Unknown Past and the Emergent Future Meet in a Vibrating Soundless Hum: Thoughts on Energy and the Contemporary', in *Energies in the Arts*, ed. by Kahn, D (USA: MIT Press, 2019) pp. 423–437. (p. 425).

airborne particulates, and weather systems are enmeshed with the data from radiation sensors and the live streaming of Fukushima's decommissioning programme.

The waveforms and movements of the earth, seas, sound, and heat are fundamentally similar, they generate together, move coactively, and exist on cotemporal timelines with varying rates of decay. It is the process of recollecting or recording elements of these events that allows a separation of these components from their cotemporal origins. Throughout this thesis I will describe how my sound arts practice has engaged with the processes of recording these connections through the documentation as praxis approach that I have described in the previous chapter. Observing these interactions has contributed to the development of my original concept of noise-prints, which I have outlined in the introduction to this thesis. Beyond their vibrational encounters, heat and sound communicate a wide variety of other influences, all of which are capable of generating outcomes that are culturally significant. Boon (2019) further describes the importance of defining energy not just in the context of physical, man-made and environmental exchanges but also as cultural 'transfigurations' of energy, 'from Aristotelian *energeia* to Chinese *qi* to classical Indian *prana* and *shakti.*'[81] Both Serres' 'hot network' of communications and Boon's '*energeiac* transfigurations', demonstrate that the theoretical groundwork for attuning to the cultural and energetic connections of sound and environmental effects is already well established. My exploration of the thermal and aural within this chapter is therefore not to argue or make a justification for this area of study, but rather to provide an entry point to this sonic-incandescent network of sound and thermal effects. Asking, how might a practice methodology that is malleable to the cultural and energetic consequences of the thermal, nuclear, and sonic be shaped?

The practice that I present in this research is an atmospherically attuned sound arts practice that could be considered as performative of what the American feminist theorist and author, Karen Barad (2019) describes as 'spacetimemattering' the 'dynamic ongoing reconfiguring of a field of relationalities among "moments," "places," and "things" (in their inseparability), where *scale is iteratively (re)made in*

[81] Ibid.

intra-action.'[82] Generating a method for post-atomic listening that takes influence from atmospheric phenomena such as heat and sound could be considered an example of an activation of Barad's 'intra-actions', where sound, heat, atmosphere, and radioactivity can 'speak to the complexity of the intra-active reconfiguring'[83] of environmental phenomena, and the timelines of radioactive events and materials. Barad's theories are engaged expansively within the field of nuclear cultural studies by both artists and theorists, but where other practitioners and theorists included later in this thesis, such as Susan Schuppli and Sasha Engelmann, connect more directly to Barad's 'deep-time' reconfigurations,[84] I will look instead to focus on a more direct mode of environmental practice that generates through a method of sonic atmospheric attunement. Barad's theory of 'spacetimemattering', however, is a productive place from which to begin this endeavour, as it allows us to consider the forces that act on and within space (heat, sound, radiation), matter (water, air, walls, bodies), and time (histories, events, recollections) as iterative, interacting participants of the same field - the same whole. Given the freedom to consider culture, data, story, sensing, history, and event, in material cohesion with, space, environment, landscape and atmosphere, we can begin to learn the significance of sound within the wider contexts of its atmospheric cohabitor - heat.

[82] Barad, Karen. 'No Small Matter: Mushroom Clouds, Ecologies of Nothingness, and Strange Topologies of Spacetimemattering', in Tsing, A. L. et al. (eds) (2017) *Arts of living on a damaged planet: Ghosts and monsters of the Anthropocene.* Minneapolis, MN, USA: University of Minnesota Press, pp. 103-120 (p. 111).
[83] Kleinman, Adam. 'Intra-actions', in *Special dOCUMENTA (13) Issue of Mousse Magazine* (Milan, Italy), Summer 2012, pp. 34 – 81. p. 77.
[84] See Section 3.4, 'Elemental memory'.

Figure 8. Film still from the 2011 documentary 'Peak', Dir. Hannes Lang.[85]

Consider as an example of this learning, the aural consequences and outcomes constructed by unexpected heavy snowfall or the unusual lack thereof, how sonically reflective may a mountain, freshly removed of its ice, become? The light that heats the ground, pulsing back, rock to air - a soft crunching snow turned to hard fizzing gravel. Earth emitter, to (other) receiver. The absent ice and snow drifts of our frostless mountain may threaten to withdraw the evolved usefulness of the snowshoe hare's winter coat,[86] briefly fattening the bellies of the hawks, eagles and mammalian carnivores that feed on them. This abundance quickly evaporating as the hare's numbers dwindle, moving or removing the food-source and therefore, the screeches of predatory birds, the roars and movements of bears and wild dogs; the mountain muting as the temperature rises. Winter tourism dwindles, ski lifts, chalets, towns, and ploughs lie dormant – hollowing human-aural cultures built over recent centuries. This leads to the production of new ones that fight the land for its 'usefulness', pumping fresh water from already limited reserves to huge machines that collect, freeze, and spray the mountainside white, with a ferocious mechanical din.[87] Here, sound is an active component not just of the 'soundscape', which as I have referred to in the First Chapter of this thesis, comes with its own challenges for sound practitioners, but also

[85] Image used with permission, courtesy of unafilm. Lang, Hannes. 2011. *Peak* (Germany: unafilm).

[86] See, Peers, Michael J. L. 2017. 'Predicting the Fitness Effects of Climate Change on Snowshoe Hares', *Arctic*, 70.4: 430 https://doi.org/10.14430/arctic4691.

[87] Hannes Lang's documentary film 'Peak' (2011) reveals the engineering process of artificially generating snow coverage within popular ski resorts and the implications of climate change within these communities. Lang, Hannes. 2011. *Peak* (Germany: unafilm)

as a manifestation of a Baradian *intra*-action; sound as a material, geologic, and living component of the mountain as patron to a *space*time that matters. Sound is always equally 'in' and 'of' its surroundings, it is a 'hot network' that leaks through steel and concrete walls, crashes in ocean waves, and hums in the vents and grills of freezer units. Within our bodies ultrasound technologies can supplant the eye's function of visualising new life – it is this inseparability from its surroundings that enables sound to tell such compelling stories of atmospheric and energetic encounters.

These links between sound and atmosphere are explored within this thesis through the development of a practice of sonic atmospheric attunement. A frostless mountain is an example of how attuning to these connections can unravel the communicative and coactive strands that enmesh sound with heat and other environmental effects. The influences of temperature are reflected in my practice in the changing seasons of *Writing for Window Boxes,* and the documentation of the natural surroundings of the BFI archive in the final chapter of this thesis. However, for the purposes of this research these outcomes are also present in the aftermath and consequences associated with post-atomic landscapes and events, the emissions of radioactive waste, and the unfolding disasters of human-induced climate change. As with areas irradiated by the remnants of nuclear activities, such as the fallout from nuclear weapons or the accidental release of radiation from energy production, thermal changes within a given ecosystem can lead to the erosion of natural environments, cultures, and such is the case with the snowshoe hare, can even lead to permanent and wide-reaching ecological changes.[88] Both radiant heat and nuclear radiation are generative of cultural and environmental effects that can be measured and recorded in a variety of different ways. Within my practice I incorporate documentation as praxis, and audio and visual media to highlight these effects. In the next part of this chapter, I will explore how the thermal and sonic are understood from the perspective of these media and how they might be enabled as a carrier for the post-atomic within this research.

[88] Sasha Engelmann (2021) highlights an example of this in the work of Cornelia Hess-Honegger; an artist who illustrates the 'malformed insects living in the shadow of the *Gösgen* nuclear power plant'. See, Engelmann, Sasha. 2021. 'Elemental Memory: The Solid Fluidity of the Elements in the Nuclear Era', *Theory, Culture & Society*: 026327642110390. p. 2.

2.3 - Thermal Media

In *Media Hot and Cold* (2022), Nicole Starosielski explores how thermal effects interact to generate 'thermocultures', which she describes as 'the cultural practices of temperature'.[89] Detailing the development of technologies such as the thermostat, air conditioning and infrared communications, Starosielski argues that 'temperature is neither a neutral or a natural environmental register: instead, it is thoroughly entailed with cultural practices and media technologies.'[90] The assertion is that heat and cold can be manipulated for social and political means, and that this engenders a form of 'thermopower' that is dependent on the conditions, frequency, and nature of our exposure to hot and cold influences and media.

Starosielski's 'hot and cold media' borrow from and expand Marshall McLuhan's initial categorisation of hot and cool media; where media formats and outputs including radio, television, cinema, and comics are all described as hot or cool depending on the level of active participation required to understand them. For McLuhan, the scale of these interactions is linked to the fidelity or 'resolution' of the medium in question 'a hot medium is one that extends one single sense in "high definition." High definition is the state of being well filled with data. A photograph is, visually, "high definition." A cartoon is "low definition," simply because very little visual information is provided.'[91] In contrast to Serres' immediately pliable 'hot networks of communication', McLuhan's categorisation of hot and cool media appears initially less receptive to the leaky nature of modern media cultures. As screens, sound, film, text, and other media are now shared in such varied ways, is it possible that the accessibility and adaptability of current media technologies can challenge the plausibility of categorising types of media as inherently 'hot' or another as 'cool'?

It could be argued that McLuhan's definitions of hot and cool media were unable to effectively predict or account for a 'mediascape'[92] where the ability to share, and

[89] Starosielski, 'Media Hot and Cold', p.204.
[90] Ibid., p. xiv.
[91] McLuhan, Marshall. 2012. *Understanding Media*, 2nd edn (London: Routledge), p. 24.
[92] I use the term mediascape in relation to the boundaries of a media format, the contexts of its situational use, technological delivery, and atmospheric encounters. See Appadurai, Arjun.

transmogrify cultural outputs exists in the (hot) pockets and hands of its observers, which are then disseminated by the 'hottest' network of them all - the internet. With this in mind, McLuhan's categorisation is perhaps better understood in the contexts of a sliding scale of heat, one that is dependent not only on the source media and mode of delivery but also the conditions of its site and its 'liveness' in respect of its 'shareability' or potential for adaptation. This sliding scale aligns with McLuhan and Fiori's (2008) assertion that 'our electronically-configured world has forced us to move from the habit of data classification to the mode of pattern recognition',[93] where the instantaneous nature of electronic communication means that both environment and experience are able to 'co-exist in a state of active interplay.'[94] This interplay is demonstrated most clearly in the morphology of interactive and social media, where community and social interactions blend, adapt, and contort produced media to new meanings though online interaction, meme generation, the algorithmic sorting of search engines and artificial intelligence.

In the final two chapters of this thesis my practice makes a transition from a web-based work to film media and explores the complex nature of physical media formats in the context of their cultures, the atmospheric conditions of their capture, and distribution in archives. Starosielski describes the thermal influence of film as both hot and cold to varying degrees - cold in respect of the complex thermal relationship between movie theatres and movie goers, with their highly controlled airconditioned spaces, or the content of film media itself such as in the 'Coldsploitation' genre, where films are produced with the intention of bringing the feeling of freezing environments to cinema audiences. Starosielski also highlights 'thermoception' in cinemas through the communication and transference of heat from the playback of film materials in projection booths, sensed through the bodies of projectionists working long hours in sparsely ventilated rooms. For Starosielski, these associations are examples of how thermoception and thermopower are entwined, where cultural consequences are an inevitable by-product of the conditions, design, and material of media. This is

1996. *Modernity at Large: Cultural Dimensions of Globalization* (Minneapolis, MN, USA: University of Minnesota Press), p.35.

[93] McLuhan, Marshall, and Quentin Fiore. 2008. *The Medium Is the Massage* (London: Penguin Classics), p. 63.

[94] Ibid.

demonstrated in her linking of the female body to the development, advertisement, and design of thermostatic control systems,[95] and in connecting colonial narratives to the emergence of airconditioned cinemas 'cold, clean air, like the colonial fantasies of Arctic exploration, promised a blank sensory environment free from the heat and contamination of non-white or immigrant others.'[96]

There are many parallels between Starosielski's assertions and those associated with irradiated and damaged territories – the stories of invisible environmental effects such as radiation, climate, and toxified air are often penned with the purposes of cultural, political, economic, and scientific advancements in mind. Their actual and potential impacts on land, community, flora, ocean, or critter are commonly disguised and de-prioritised in consideration of these aims. Understanding the interaction of data, community knowledge, and media cultures is a vital ethical consideration within this thesis, which expands outwards from my web-based practice to an understanding of 'cultural atmospherics' and the development of a 'nuclear archive'. The next part of this chapter presents *37°N* (2021), a live-streamed installation and remote activation of the conditions and sites surrounding the Fukushima Daiichi Nuclear Power Plant. This piece is a development of the compositional Geiger counter device works described in Chapter One and explores the potential for a praxis approach to emerge through engagements with atmospheric sensor technologies and the data sets they produce.

[95] Starosielski, 'Media Hot and Cold', p. 34.
[96] Ibid., p. 96.

2.4 - *37°N*

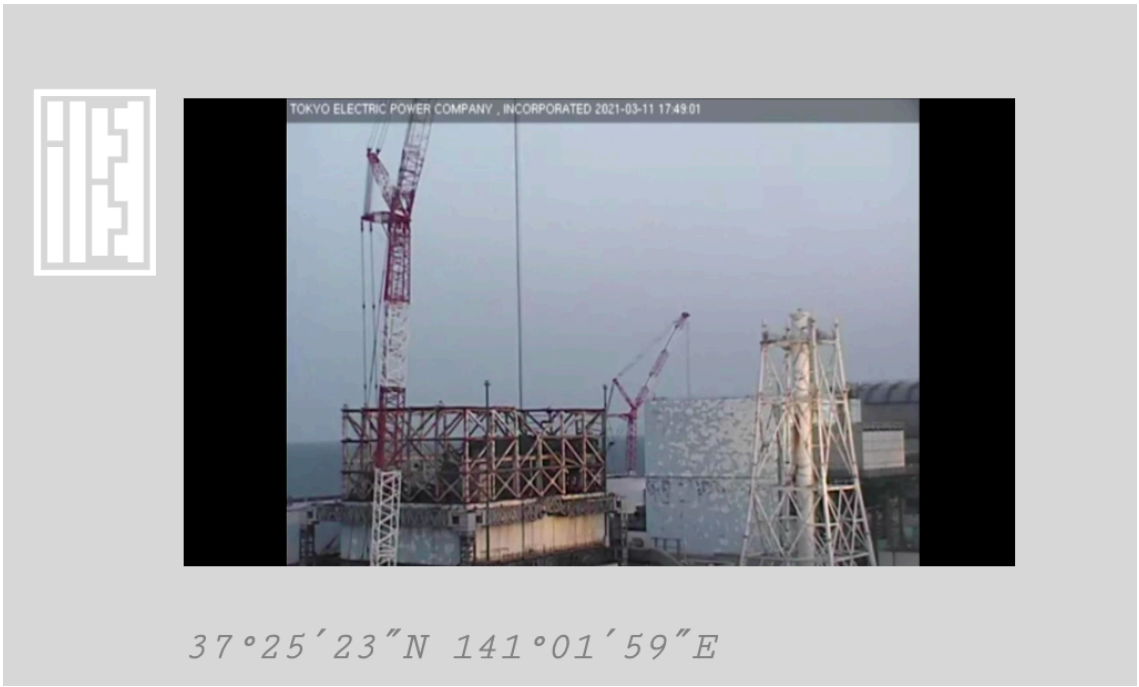

Figure 9. A screenshot of the website showing the embedded video, taken during the live streamed event '37°N' (2021).

Watch/Listen: I invite you to watch this short clip before reading further:

Link: https://vimeo.com/danbeck/37n-night

USB Media Location: Film > 5-37degsN_night.mp4

Action: The following written attunement accompanies this clip and is intended to be read while watching:

> *The clip you are watching now is from a point in the stream not long after dusk. Due to the time difference, the dark skies, and slow distant lights of passing ships is the image I've become accustomed to most. The stillness of the image of the plant is always striking, it's something I continue to feel uneasy interrupting, but I've handed that responsibility over to the sensors. At this time of night, the pollution levels are low, so some of the audible distortions have taken on a more subtle quality, while the quakes still burn brightly into the image, as they strike with varying degrees of magnitude.*
>
> *The plant is floodlit, all night long – the stream burns briefly bright with white light at each quake, awash with coded data, tangible data, community knowledge.*

> *I'm thinking back to the video archives that formed much of the focus of my initial research, the faked film-sound of mushroom clouds added at later dates for dramatic effect, contrasting with the reports of observers of the early nuclear tests – a blinding flash before pulsing wave of sound and heat. Here the crunching of digital video data, slower and more ponderous than the accompanying audio turns this relationship on its head.*
>
> *The sound interjecting first, like the Toads of Trinity, like the cattle lowing Hercules toward Cacus' cave, protruding outward, with the invisible.*

37°N was a live streamed event and online installation that took place on the ten-year anniversary of the Tōhoku quake in March 2021, between the hours of 2.46pm and 5am local time - the same length of time between the earthquake hitting and a national disaster being declared in Japan on the day these tragic events unfolded. The piece combines archive audio, which is a sound recording from an operating nuclear reactor at the Ringhals nuclear power plant in Sweden[97] and the real-time, live streamed footage from the Fukushima Daiichi Nuclear Power Plant. The stream is from a webpage belonging to the Tokyo Electric Power Company (TEPCO), the owners of the Fukushima plant have been live streaming the decommissioning of Fukushima on their website since January 2014.

The audible and visual fluctuations in the live footage and audio were triggered by time accurate, actual instances of earthquakes that struck the Japanese mainland on the day of the quake. This seismic data was gathered from a website managed by the US Geological Survey that records and tracks seismic events across the world.[98] From this website I was able to find every seismic event that occurred on the day of the disaster. I also had a wealth of information on each event such as the magnitude, depth, and the exact geographical coordinates that each earthquake struck. This meant that as well as matching the timings of the historic seismic data to trigger events within the stream throughout the day, I could also adjust the intensity of events based on a selection of other data sets. Interruptions to the stream lasted no more than a second or two, however each one was unique with varying changes to elements such as the distortion

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[97] Johansson, Fredrik. [n.d.]. *Generator Noise- Nuclear Power Plant - Sounds Of Changes*, soundsofchanges.eu https://www.soundsofchanges.eu/sound/generator-noise-nuclear-power-plant/ [accessed 12 November 2021].
[98] See, [N.d.]. *Usgs.gov* https://www.usgs.gov/programs/earthquake-hazards/earthquakes [accessed 28 March 2024].

and amplitude of the audio and the colour, the arrangement of pixels and brightness of the video.

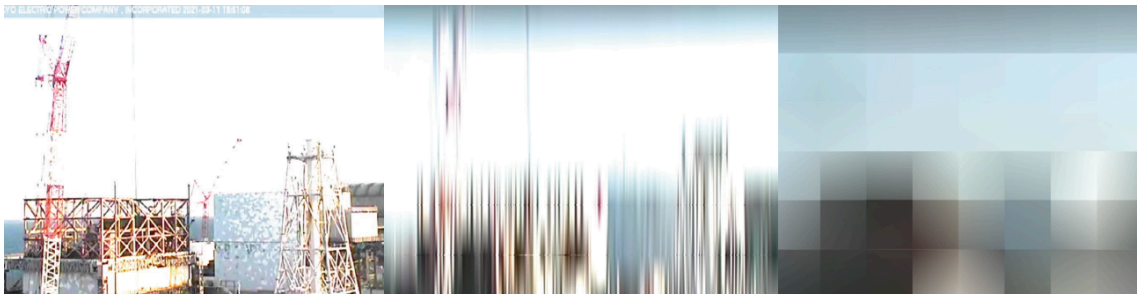

Figure 10. Screenshots of some of the visual interruptions that occurred during the 37°N live stream.

The image (Fig. 10) is a composite of three screenshots taken at different points in the live stream that demonstrate the visual displacements that took place during different seismic occurrences that impacted the stream throughout the day. In addition to the historical seismic archive data, the installation also takes live data from a number of different sensors, including radiation sensor data provided by the Safecast API[99] and air pollution sensors from the World Air Quality Index (WAQI).[100] This information was collected in real-time through a complex interface that I designed to communicate with the website APIs and a Max/MSP patch. The purpose of this audiovisual software patch is to index and gather the information, and then use it to distort and modulate both the audio and video streams throughout the day. As well as outputting the streamed audio and video, the Max/MSP patch acts as a complex data handling device, designed as a bespoke tool that allows for cross communication between incoming data from Safecast and WAQI. The APIs within the project provide an open, uncopyrighted data set that can be used communicatively within the audio-visual elements of the streamed video. The patch can poll for existing indexed data, receive live or 'real-time' information by way of active sensors, or generate data of its own and communicate this back in the opposite direction. Although the process of polling for data occurred

[99] An API (Application Programming Interface) provides a set of definitions that allows for the transference and interaction of data between applications. In the instance of Safecast, an API provides real-time access and logging of data from radiation sensors around the world. See, 'Safecast'. [n.d.]. *Safecast.org* https://safecast.org/ [accessed 14 March 2024].
[100] See, The World Air Quality Index project. [n.d.]. 'World's Air Pollution: Real-Time Air Quality Index', *Waqi.Info* https://waqi.info/ [accessed 14 March 2024].

each second that the stream was active, interruptions to the stream were only triggered when the historical seismic data from the day of the quake recalled an event.

2.4.1 – Programming and Development

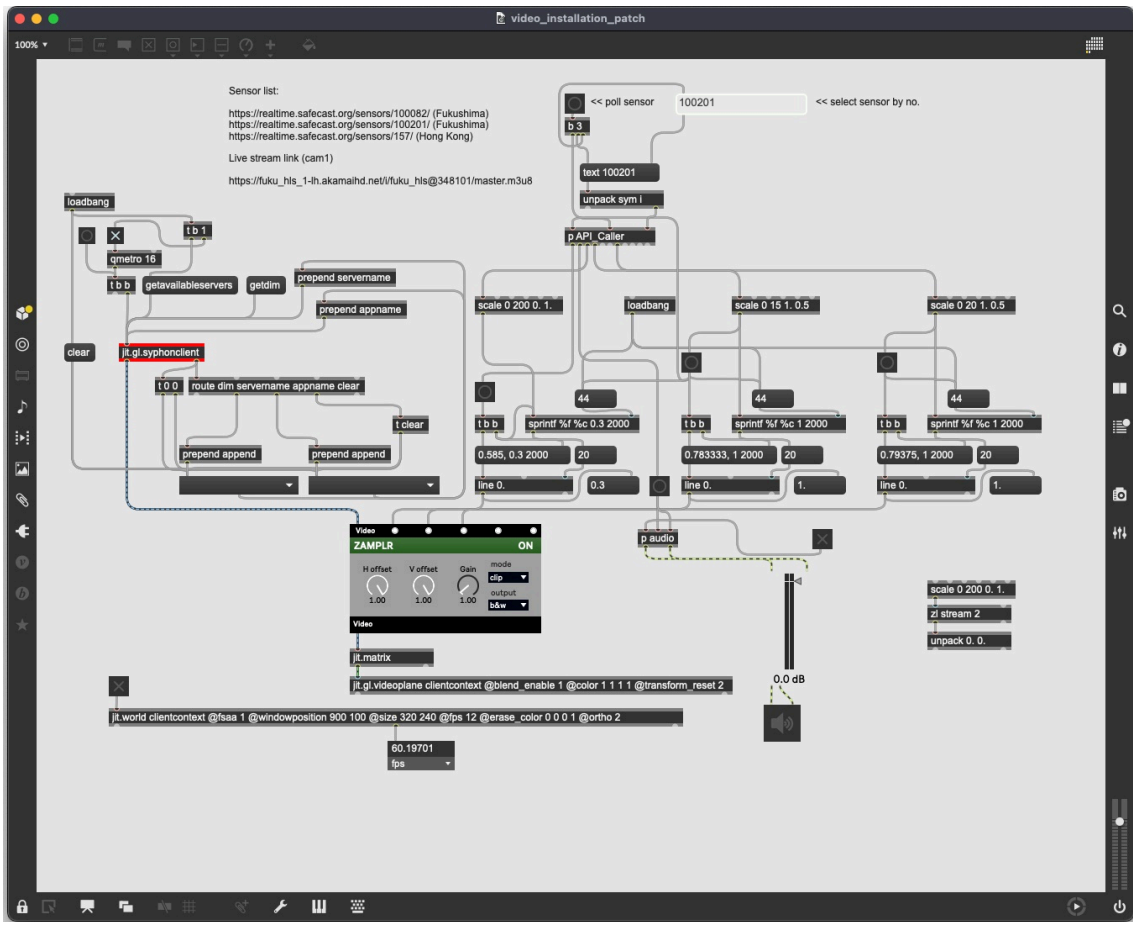

Figure 11. Image showing the main patch window including the Syphon server integration, Jitter interface and data streams for the visual interruptions in the stream.

The above image (Fig. 11) is the main patch window I designed and utilised for the live streamed event. It is important to note that the changes that were made to the live streamed video were not enacted directly on TEPCO's streaming webpages, which would have presented a number of ethical and technical challenges. Instead, an embeddable link to the video stream was obtained from the site and opened in the VLC media player on a local computer. This allowed for the video stream to be shared to the patches I had designed in real-time via an application called 'Syphon', which enables the instant sharing of video frames between computer applications. The video

from the operating patch was then routed from Max/MSP to an 'OBS' streaming client, which was connected to a live-streamed YouTube video embedded on a dedicated page that was accessible on my website iless.eu throughout the period of the installation.[101] Although all of the API and data handling functions of the patch designed for this installation are still operating normally and could be used again to repeat the installation, recent changes to the function of TEPCO's streamed videos mean that it is now not possible to obtain the video link required to embed the videos on other sites and therefore the installation cannot be repeated or exhibited in other contexts as I had planned.

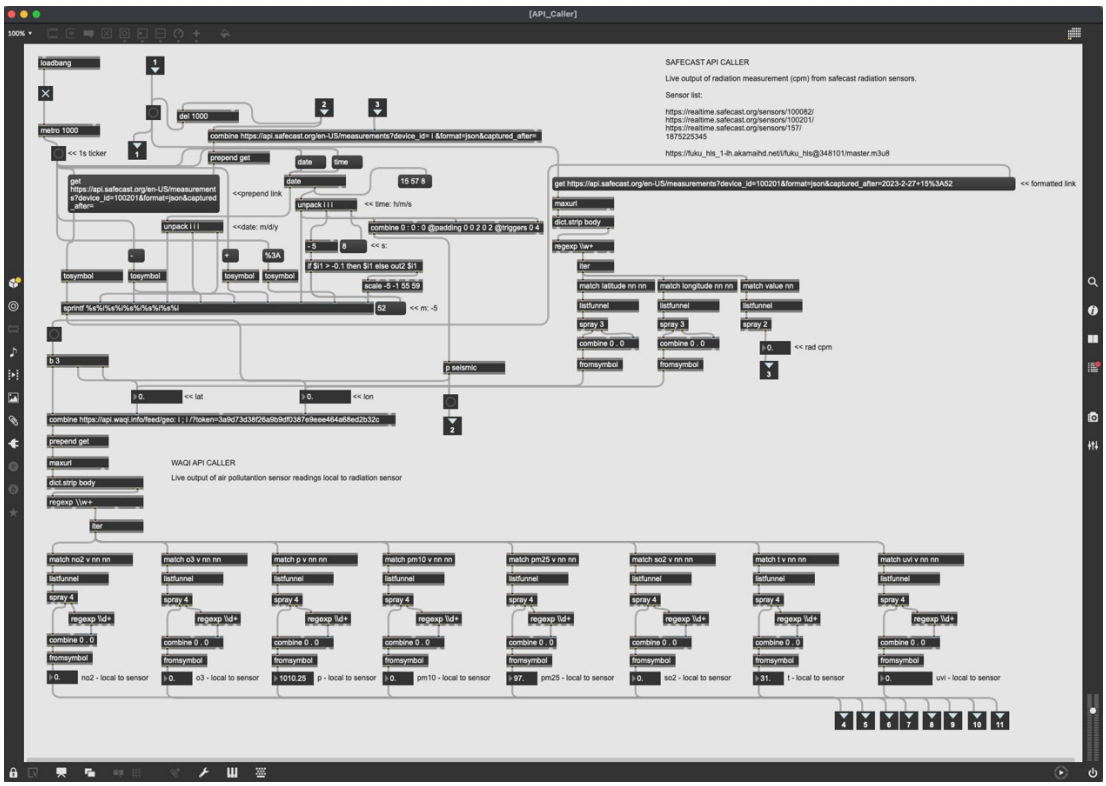

Figure 12. Screenshot of the API data handling subpatcher.

[101] OBS is an opensource video streaming platform that allows the sharing of video and audio from a computer to sites that provide streaming services such as Facebook and YouTube. See, 'Open Broadcaster Software'. [n.d.]. *Obsproject.com* https://obsproject.com/ [accessed 14 March 2024].

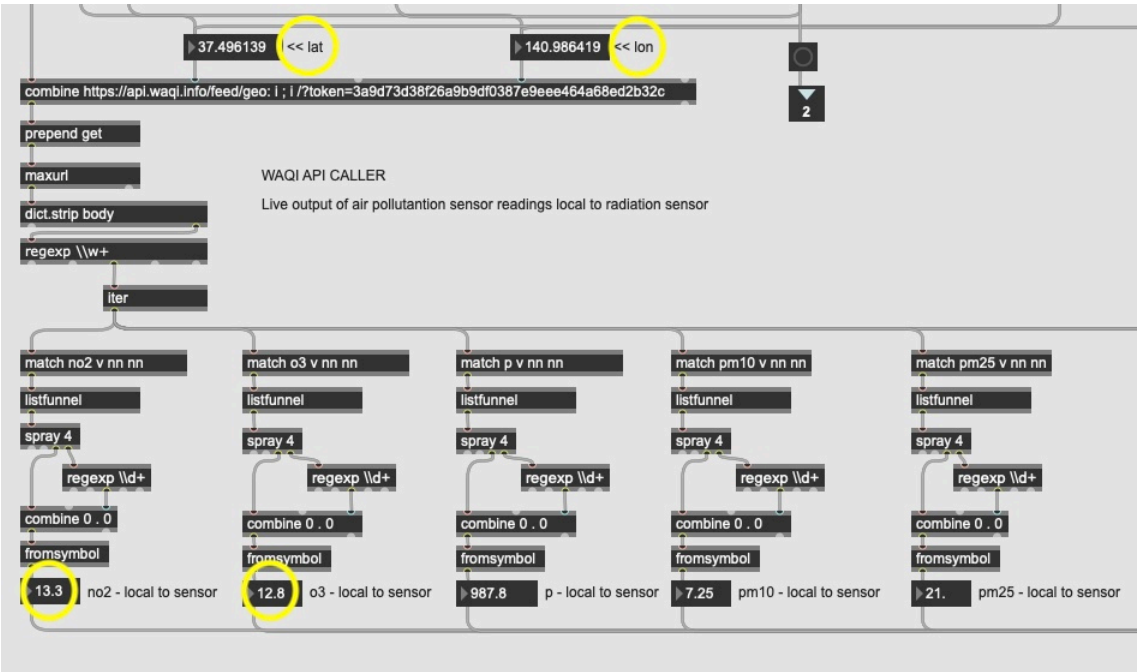

Figure 13. Screenshot showing the latitude and longitude of the Safecast sensor, and the output environmental data generated by WAQI.

There are three main sources of data utilised in the patch, the live radiation data from the selected Safecast sensor, real-time atmospheric pollution data from the World Air Quality Index (WAQI) API, and finally the historical seismic data that activates the patch in accordance with the incidence of seismic activity on the day of the disaster. The Safecast function is the same as the patch that I created for my practice *Geiger Counter Compositions* described in Chapter One of this thesis. The patch polled the Safecast API for radiation data from a sensor close to the Fukushima plant. Details of the latitude and longitude of this sensor was then used to make a further request to the WAQI API to provide live atmospheric data readings from the sensor closest to the coordinates of the Safecast data source. The image (Fig. 13) highlights this part of the process, where the yellow circles at the top indicate the latitude and longitude information, and the bottom two circles show the readings of the pollutants local to the sensor.

37°N is an expansion of the experimental work that I have conducted with Geiger counter devices in the First Chapter of this thesis. With the inclusion of remote sensors and historic seismic data from the day of the Fukushima quake, the piece opens up new sites and modes of translating atmospheric weather events, airborne particulates, and radiation, to audio-visual practice. It is an example of how my digital practice can

translate and communicate the atomicity of the event through the data and documentation that it uses and generates. In the next part of this chapter, I will explore these outcomes further through an analysis of *37°N* as an example of 'remote sensing', where community data sets act as 'transducers' for the political, cultural, and environmental consequences of nuclear events.

2.4.2 - Remote Sensing

Figure 14. Screenshot of one of the unique webpages for a Safecast sensor in Fukushima. In most cases Safecast pages do not provide much information on the owners of the devices, but it is notable that several of the sensors in areas effected by radioactive events are populated with images and information of the owners of the sensors.

37°N was presented at the 'Remote Sensing Symposium' and in the event's accompanying publication, in April 2021.[102] The presentation I made at the event argued that remote sensor data can enable a form of digital fieldwork and practice that is considerate of the environmental and ethical implications of sonic ethnographic

[102] *Remote Sensing 2021*. [n.d.]. Remote--Sensing.Co.Uk http://remote--sensing.co.uk/publications/remote-sensing-2021/ [accessed 20 January 2022]. A copy of this document is included in the USB Media Location: Reference Documents > Remote_Sensing-publication.pdf

practice. It also called for a questioning of how community generated archives, mapping, and data collection, can activate new ways of placing arts practice within the reach of post-atomic consequences. For the purposes of this research, the documentation and generation of works, manifests as exhibitable practice that represents the conditions in which they are made. This is evidenced in the use of sensor technologies and historic seismic data in the example of *37°N*. In addition to this, a new understanding of digital space, material, data, and connectivity was revealed from the community data sets, web-based durational works and atmospheric readings represented within this research.

37°N attends to the impact we have as participants in remote spaces, developing a 'remote sense' that enables and protects the digital space as a platform for sharing, preserving, and engaging in what Olga Kuchinskaya describes as collective 'social memory'.[103] In her book *The Politics of Invisibility: Public Knowledge about Radiation Health Effects after Chernobyl* (2014), Kuchinskaya documents the cultural, political, and local effects of the Chernobyl Nuclear Disaster, describing the various conditions that impact public knowledge of the disaster, while documenting local attitudes toward the threat of radiation in the local populations. For Kuchinskaya, adequate infrastructure and data collection when dealing with the invisible threat of radiation is key. 'We do not always need much public visibility of a hazard, in the sense of a rampant public discussion about it, as long as its visibility, the recognition of the hazard, is built into infrastructures of radiation protection and there are adequate mechanisms for research and decision making.'[104]

APIs such as Safecast are reliable, open platforms for people to contribute their information, they make visible the reality of the lived environments of communities, and in doing so, they de-mythologise the 'invisible threat' of radiation. In the case of Chernobyl, Kuchinskaya's community focussed study makes clear how the relative imperceptibility of the threats of radiation can be used as a tool to help manipulate, mis-inform, and cover up the effects of nuclear disasters. *37°N's* various sensors, data,

[103] Kuchinskaya, Olga. 2014. *The Politics of Invisibility: Public Knowledge about Radiation Health Effects after Chernobyl.* (London: MIT Press), p. 9.
[104] Ibid.

community information, accessible APIs and digital archives are just one example of what is often described as a form of 'remote sensing'. Remote sensing is commonly defined as 'the acquiring of information from a distance',[105] which is coincidentally a curiously acceptable definition of listening. Whether confined to a format of hard data or manifest as a listening practice, the accessibility of data on platforms such as Safecast provides us with a rich and important well of information that can connect us to both our own and the environments, histories, and communities of others. In the next chapter of this thesis, I will introduce another work of remote sensing, Sasha Engelmann and Sophie Dyer's *open-weather* project, where remote sensing and satellite technology, combine in a feminist listening practice. The gathering of data, such as on the Safecast and WAQI platforms, performs a collective act of sensitivity; it is in itself a techno-mediated form of listening where our attunement to it can reveal the realities of radiation or atmospheric pollution within our environments. However, as Kuchinskaya's study demonstrates these data sets can also help us to connect the strands between nuclear events and the communities and environments whose ability to bear witness to them is often jeopardised by their political sensitivities.

Within my written attunement to *37°N* I describe each quake as 'awash with coded data, tangible data, community knowledge'. Within this research acts of listening, remote sensing, and archival research combine in my concept of noise-prints. It is a practice that utilises data, documentation, and recording techniques to capture an aural representation of nuclear events. While this is emphasised in the practice I present in the final stages of my research, *37°N* is perhaps the most direct translation of data sets to audio-visual media within my practice, where audible modulations (sound effects), are translated from data to a unique noise-print of the Fukushima plant. *37°N* in its live engagement with readings from active sensor technologies, is an investigation of the potential for a remote sensing practice that crosses the energetic boundaries of seismic event, heat, radioactivity, atmospheric conditions, and audio-visual materials. It is in consideration of these transferences between sound, digital data storage, and energetic effects that I conclude this chapter.

[105] Hall, Cynthia. 2019. 'What Is Remote Sensing?', *Earthdata* https://www.earthdata.nasa.gov/learn/backgrounders/remote-sensing [accessed 25 March 2024].

2.5 – The Remote Site: Digital Nuclear Repositories

Throughout nuclear cultural history the accessibility of information, places, data, and power have been highly controlled. National and financial interests, local and global politics, scientific advancements, and geologic resources, have all contributed to the development of a culture of secrecy and violence. This can be traced from the early advancement of nuclear technologies to the Cold War and the current reality of an escalating climate emergency.[106] Throughout the post-atomic era, artists and theorists have found novel ways of engaging with emerging technologies, materials, and data, and it is the outcomes of these engagements that form the basis of what can be defined as 'nuclear culture'. However, as this research highlights, the 'site' of the post-atomic is expansive and can be understood to include much more than the material or land in which it is borne out.

This research engages with the contortions of the meaning and definition of site-based practice, considering in equal significance the 'site' as digital repository, energy exchange, archive and field of research. This is evidenced and explored through my practice in the use of platforms such as Safecast and WAQI in *37°N* and *Geiger Counter Compositions.* These digital repositories are openly accessible and built around a basic set of functions (provided by the structure of an API), they offer opportunities for people to take control of the information that is recorded in their surroundings. In his essay 'Big Data? No thanks' (2022), James Bridle challenges the role of data within the context of nuclear sites and history.[107] The essay traces the history of the development of computers used as measuring instruments throughout the establishment of the US nuclear programme. Bridle highlights the Electronic Numerical Integrator Computer (ENIAC), which was built at the University of Pennsylvania between 1941 and 1946 and used extensively in the early development stages of the hydrogen bomb. He also describes the enormity of the Utah Data Centre; a US government-controlled

[106] See, Wellerstein, Alex. 2021. *Restricted Data: The History of Nuclear Secrecy in the United States* (Chicago, IL, USA: University of Chicago Press).
[107] James Bridle, 'Big Data? No thanks', in *Through Post-Atomic Eyes* ed. by Lauzon, Claudette, and John O'Brian (Montréal, QC, Canada: McGill-Queen's University Press, 2022), pp. 136-148.

supercomputer and data capture device capable of storing, filtering and categorising billions of pieces of citizen information every day.

For Bridle, the supercomputer is 'as much a part of the battlefield as a tank or gun: it is a war machine, but it looks identical to a computer stack.'[108] Bridle argues that surveillance systems and an excess of real-time data is a part of an information system that causes confusion, that befuddles and provides a place for information to be hidden in plain sight. Bridle's work titled *citizen-x* (2015), a web-app that provides an 'algorithmic citizenship' that is based on the geographic source of the websites an individual visits, appears to address this.[109] However, within the contexts of Bridle's digital space of suspicion, darkness and covert motives, the artist's frequent use of personal data, CCTV and drone images within his own artworks is strangely contradictory. More importantly, Bridle's observations on 'big data' do not provide an expansive view of the contrasting value of the development of digital data sets that can be initiated and recorded by local communities, this is demonstrated within this chapter through Olga Kuchinskaya's study on Chernobyl and my digital installation practice piece *37°N*.

Information in the form of big data can expose, endanger, and censor a population, but it can also provide a platform for the development of robust, representational sets of data that belong to, and proliferate within and from communities. Applied with this purpose in mind, large collections of data can document and bear witness to events that may otherwise remain hidden and in some instances, can even form the basis for the layperson's ability to record and demonstrate the impacts of post-atomic consequences.[110] While it is understandable to be suspicious of mass surveillance by states, media, military and corporations, it is the variety and application of data collection systems that set their value, their threat level, and usefulness, not their size. Self-initiated digital surveillance within communities can generate vital stores of representational material that can act as an 'accessible witness' to real-life

[108] Ibid., p. 143.
[109] *Citizen Ex*. [n.d.]. Jamesbridle.Com https://jamesbridle.com/works/citizen-ex [accessed 20 January 2022]
[110] This is evidenced through online community data projects such as safecast.org.

consequences through open and irrefutable data sets. The issue with big data is therefore perhaps not as binary as Bridle's evaluation suggests. The BFI archive practice that I present in the final two chapters of this thesis, bring to focus a question of the suitability and ethics of digitally storing our post-atomic heritage, as well as the suitability and accessibility of media and materials that are capable of the transduction of this atomicity to our media repositories. It is within the scope of the transduction of media to atomicity that I close this chapter with an evaluation of Douglas Kahn's writing on energies in the arts and the energetic transferences that can be observed between Fukushima's deadly quake and *37°N.*

2.6 - Transduction

37°N performs an energetic transduction that begins with the earthquake that caused the tsunami, and in turn resulted in the breakdown of the Fukushima nuclear reactor. At each stage, rippling outwards, countless atmospheric, environmental, and cultural interactions and consequences proliferate, during which sound and heat have an interchangeably useful role. Consider the seismograph from the ocean floor, as the first instance of an energetic exchange in this chain of events, as it converts the physical vibrations of the earth's movements to electronic signal (cause: geologic heat, effect: seismic event, outputs: sound, heat, wave, data). The event, relative to the distance of the seismograph from the point of origin, already codified into recorded information contains two energy transferences of immediate significance. The first is the recorded and transmitted data, the second, the ocean wave, and lastly the by-product, which is largely thermal and sonic; it is worth noting that these environmental effects are not entirely by-products, as such – the sound or underwater heat from the quake may well have been sensed or experienced by surrounding aquatic life, damaging ecosystems on the surrounding ocean beds, interrupting the communications of underwater animals, or warning passing ships of a seismic event under the water. However, the immediacy and remoteness of this thermal and sonic event means there's little that bears direct witness to this.

The heat and sound from the quake dissipate quickly across the vastness of the Pacific Ocean, while the wave caused by the huge positional shift of the earth emanates outward, seeking obstacles that can absorb the forces that have set it on its path. Moments later, monitoring stations across the world, receive information that a 9.1 magnitude earthquake has hit in a deep-sea region, off the coast of Japan. This transference of electronic data generates heat in the form of activity on computers and data servers, which is then returned to the ocean along the tentacular miles and 'hot network' of underwater infrared, fibre optic cables. Sound beginning with small beeps to alert one user proliferates - becoming warning systems, sirens and alarms that are triggered to warn people of the danger of a possible tsunami or earthquake in the region. This is an example of Serres' multiple 'sea of movements' in action, but it also marks the inception point of a multitude of thermo-cultural events – energy exchanges are always thermally and sonically active, but it is only the perceived usefulness of their consequences that provide them with significance. Attuning to the emanating network of sonic-atmospheric consequences that proliferate from Fukushima highlights the post-atomic aurality of the event. Take for example, the 'appearance' of sound as a direct output of this seismic event, initially it seems to serve little purpose, a by-product at source - but then it reappears, carried along the co-temporal strands of related, emanating, effects, morphing from sensory by-product to siren, warning system, evacuator – becoming a vital signifier and sensory emitter. Engaging in a sound art practice that functions within the boundaries of energetic exchange and atmospheric influence requires a working definition of how energetic transferences take place. Within this chapter I highlight temperature as just one example of this, however, in the wider scope of my research, it is also important to establish the connections of sound and atmosphere to other energy transferences, such as the electromagnetic emissions of nuclear radiation.

In his text *Earth Sound Earth Signal: Energies and Earth Magnitude in the Arts* (2013) Douglas Kahn sets out to rethink 'cultural engagements with electromagnetism',[111] prompted by the works of Alvin Lucier and Joyce Hinterding, Kahn posits a theory that

[111] Kahn, Douglas. 2013. *Earth Sound Earth Signal: Energies and Earth Magnitude in the Arts* (Berkeley, CA, USA: University of California Press), p.4.

places sound, nature, technology, and culture in a permanently unfolding state of electromagnetic transduction, definable by the transference of energies from one energetic effect to another. Kahn argues that it wasn't until the sixties that electromagnetism began to be explored as 'artistic raw material' and not until after 'the air had been primed with decades of radio broadcasting, with threatening atmospheres of gamma, broadcast television, global telemetry of satellites, and with the mobility of transistor radios.'[112] The components that Kahn associates with electromagnetism in the arts, all have significant post-atomic legacies – such as, the geologic impact of radioactive isotopes, the employment of heat sensitive satellite technologies, and the broadcast of Cold War era propaganda.[113] For Kahn, the process of transferring sound from, to and with other energies, is reliant only on the need for a transducer. By way of this exchange of energies, sound can move beyond the constraints of its atmospheric interactions, allowing for a wide gamut of transferable and interchangeable interactions and outcomes between energetic forces. Kahn's theory argues that the differences between the exchanges of sound as mechanical force and other energies in the form of electromagnetism can be explained by defining transduction in two different ways '*transduction-in-degree (t-in-d)* and *transduction-in-kind (t-in-k)*'.[114] This definition of the transference of energies within the electromagnetic spectrum and how they can be activated within the contexts of sound studies and cultures, provides a theoretical basis for exploring these connections further and returns us to the sonic and thermal environmental consequences of the earthquake that triggered the events in Fukushima that I have previously described.

To apply Kahn's theory clearly, it is important to clarify what denotes a 'kind' or 'degree' of energetic exchange. As is demonstrated through Boon's definition at the beginning of this chapter, sound, and heat both rely on the same mechanical process, the transference of energy between molecules, as in water or air. Any direct exchange between sound and heat, therefore, represents a transduction in degree; or as Kahn describes an energetic exchange within the same 'class' of energy. The excitement of

[112] Ibid.
[113] See, Starosielski, Nicole. 2016. 'Thermocultures of Geological Media' in, *Cultural Politics an International Journal*, 12.3: 293–309.
[114] Kahn, 'Earth Sound Earth Signal', p.4.

these molecules can be initiated by any transducer that has the ability to enact this effect within the environment in which it is situated, underwater lava flows, seismic activity, a kettle whistle. Confined to the scope of the definitions within Kahn's text, a transference of sound from, for example, a plucked string to an ear would denote a *transduction-in-degree*, whereas the transference of a sound from musical instrument to radio wave, would denote a form of *transduction-in-kind* or transference from one class of energy to another: mechanical-soundwave to electromagnetic-radio wave. The practice that I have presented in the First Chapter of this thesis is a study of these exchanges, where my documentation as praxis approach makes record of the outputs of Geiger counter devices and presents them within the atmospheres and conditions of the site of my practice.

For the purposes of this research, Kahn's definition of *t-in-k* and *t-in-d* can be expanded to include energy exchanges between sound, environment, and culture. In the case of *Geiger Counter Compositions* there are several layers of transduction taking place; the creation of ion pairs as radiation enters and passes through the gas filled Geiger tube, generates a measurable pulse of current between two electrodes *(t-in-k)*, the output of the Geiger tube produces heat in the exchange of energies through the circuitry of the board *(t-in-d),* until the electrical signal is output as audible clicks *(t-in-k)*. This, however, is not the limit of the possible transductions occurring within this interaction. Kahn's theories on transduction can also be applied to the many interlinked energetic effects that unfold in the build-up, immediate wake, and legacies of nuclear events. This is demonstrated by the example of the 9.1 magnitude earthquake that struck off the coast of Fukushima in 2011, where the immediate conversion of seismic activity to heat, sound and ocean wave forms an initial energetic *transduction-in-degree.* Kahn's second definition of transduction or *transduction-in-kind* is also observed through the conversion of seismic motion, to electrical signal and digital data via seismograph. A process that witnesses a shift in the type of energy exchange that exceeds the boundaries of the initial energetic encounter, or what Kahn would describe as a change to a 'larger class' of energy. This may seem a stretch of Kahn's definition, but he later makes clear the fluidity of these changes in class of energy – 'The temperature of the ocean is an important measurement in the study of global warming; therefore, long sounds are situated in the channel from Cold War to

Warm War.'[115] In this quote, Kahn pushes the boundaries of the transduction of energies between heat, water and sound to the cultural implications of post-atomic events and global heating. It is the concern of this research to explore further how sound, in particular, can perform these transductions between culture, atmosphere, and atomicity.

2.7 – Chapter Conclusion

37°N utilises my practice methodology to reimagine the connections between remote data sets and their ability to communicate post-atomic auralities. In this chapter I have described how this artwork is considerate of the interconnected nature of sound, heat and environmental conditions. Nicole Starosielski's 'thermoception' (the sense of temperature), is introduced as an example of how environmental effects are complicated by their cultural connections and sets up an enquiry into the nature of the atmospheric interactions of sound, heat and other forms of electromagnetic radiation. Sound and temperature are explored in this chapter as one example of how aural cultures are generated and maintained through the atmospheric interactions that they share. I have investigated how cultures are communicated through thermal and aural interactions and how my practice of sonic atmospheric attunement can provide access to them.

In observing the effects of infrared radiation, which we perceive as heat, this chapter draws attention to the enduring effects of other forms of electromagnetic radiation, such as the alpha, gamma, and beta emissions of nuclear materials. Douglas Kahn's theory of 'transduction' describes how sound arts practitioners can access this network of electromagnetic effects. In the final two chapters of this thesis, I apply this process of transduction to my sound arts practice and describe how it has influenced the development of my concept of noise-prints. Where the relationships of temperature, remote sensing, data, and nuclear events forms the basis of this chapter, this thesis continues with an exploration of the boundaries and definition of

[115] Ibid., p. 165.

atmosphere within this research. This includes a detailed critical analysis of the research in relation to atmospheric and airborne effects. Accompanied by an analysis of Susan Schuppli's writing on 'material witness' and Sasha Engelmann's 'elemental lures'. My practice piece *Radionuclide Websites* expands my practice from *37°N* to further challenge the role of the digital artwork as a conduit for a nuclear focussed practice and looks to answer the question of how post-atomic legacies and the site of the nuclear can be revealed through the development of novel digital radionuclide materials.

Chapter 3: Atmosphere

3.1 – Introduction to Chapter

Within this research my methodology of sonic atmospheric attunement combines with documentation as praxis to generate artworks that are sensitized to the site and act of making. This process is inclusive of atmospheric and environmental effects, such as the thermal influences that I have focused on in the previous chapter. Uncovering the connections between atmosphere and sound art practice calls for a better understanding of where aural cultures might fit within the many intriguing distinctions of atmosphere and how they can be communicated differently according to our understanding of that which is 'of the air' and 'in the air'. To approach this subject this chapter presents my practice *Radionuclide Websites* (2022 - present), which is contextualised through an analysis of arts practice that engages with the elements of the air.

This research argues for an expanded understanding of the effects of air, atmosphere, and radiation within the context of sound arts practice, and digital and audiovisual media. Sasha Engelmann's concept of 'elemental lures', where the air is explored as a cultural and political space of engagement for the humanities provides a pre-requisite for this subject. I will explore how Engelmann raises challenges to the influence of the geologic within arts practice and agitates for a more-than-elemental view of what is in the air. In addition, Susan Schuppli's 'material witness' and a further concept of Engelmann's, 'elemental memory', open an enquiry to the significance of geology within nuclear cultural practice and pose questions to the connections of the elemental/material and the airborne/atmospheric within this research.

In addition to this I will ask if a digital artwork can be atmospheric. With *Radionuclide Websites* I present a series of long-duration digital artworks that reveal the potential for online spaces to represent the material half-lives of radioactive isotopes. Following Kyle Devine's 'political ecology' and Gustav Metzger's manifestos on auto-destructive and auto-creative art, I will interrogate the language, materiality, and atmospheres of

digital media. In doing so, I present my practice as performative of a 'transmissional relay', a method that Susan Schuppli describes as 'a provocation for thinking materiality differently.'[116] These web-based works are vital to the development of the practice I have undertaken at the BFI archive site in Gaydon, Warwickshire, which is described in detail in chapters four and five and contributes to a larger artwork of media transductions that considers both the material realities of nuclear events and the timelines of their ever-unfolding consequences.

3.2 – Art, Air, and Atmosphere

'Atmosphere', the subject of this chapter, can accurately be described as the mass networked and interacting whole of gasses that surrounds the earth and other planetary bodies capable of supporting one. However, in the context of my workspace and the practice that I have presented in the first two chapters of this thesis, atmosphere is also considered in its more localised definition, descriptive of an 'air of the senses'; an affective element, where thermal modulation, the effects of weather systems, room acoustics and the presence and influence of sound's traversal through it are explored. The definition of atmosphere can also be ascribed to the aesthetics of a work of art, it can be used as a description of feeling and mood or an 'atmosphere' of emotional or political effect, it can also be quantified as a unit of measurement in atmospheric pressure. A practice of atmospheric attunement, such as the one I have undertaken in this research, should consider all of these definitions of atmosphere as descriptive of the same thing, only varying in the influence of their atmospheric effects. For example, 'the atmosphere in a room' can concurrently and plausibly be described as 'composed of mostly hydrogen and oxygen atoms', 'filled with tension', '1,040 millibars of mercury' and 'thick with smoke'. Understanding atmosphere in this way evokes Michel Serres' descriptions of 'the multiple' that I have referenced in Chapter Two of this thesis, where the air around us can be understood as a flowing 'sea of movements that do not stop', or a container of elements that cannot be

[116] Susan Schuppli, 'Atmospheric Correction', in *On the Verge of Photography: Imaging Beyond Representation*, ed. by Rubinstein, Golding and Miller (Birmingham: Birmingham Article Press, 2013), pp. 17-33. (p. 27).

separated from their cultural and political effects.[117] There are, however, ethical concerns that need to be addressed when this space of complex interrelations is intercepted and interpreted through our practical engagements with it.

Kathleen Stewart warns us that 'there are uncertainties (to say the least) in the links between human action and complex systems. Notions of truth and expertise gain purchase in the gap, but sketchy connections also proliferate in the very effort to solidify some kind of order.'[118] Atmosphere is the 'stuff' of the air and an example of one such 'complex system' that Stewart describes, it is elementally and sensorially linked to the propagation of effects that inform our methods for knowledge gathering. This includes sound, heat, weather, what we perceive as light and all other electromagnetic forms of radiation. As I have analysed throughout this research, it is also capable of a change in the type of energy it communicates, or a transduction-in-kind,[119] to the emotional, political, and cultural. If we are to accept atmosphere in this way; a polyglottal communicator and carrier of that which is 'of the air', how then might the relationship of sound and atmosphere shift when we consider sound as airborne, not just 'of' but also 'in' the air, and what implications does this have for a practice that includes in this the radioactivity of nuclear material half-lives?

Sasha Engelmann is an author and member of the GeoHumanities Forum based at Royal Holloway University, London.[120] Engelmann's writing establishes the notion of 'elemental lures' which she describes as 'the "pull" of aerial, atmospheric and meteorological phenomena'.[121] In doing so, she argues for an expansion of our understanding of air and its interfacing elements to include the 'social, cultural and

[117] Serres, 'Rome', p. 111.
[118] Stewart, Kathleen. 2007. *Ordinary Affects* (Durham, NC, USA: Duke University Press). pp. 90-91.
[119] See, Kahn, 'Earth Sound Earth Signal', p. 54.
[120] 'GeoHumanities is an umbrella term that has emerged internationally over the last 2 – 3 years to signal the growing interdisciplinary engagement between Geography and arts and humanities scholarship and practice […], the term indicates how scholarship on key geographical concerns such as space, place, landscape and environment is advanced across arts and humanities disciplines.' 'About'. [n.d.]. *Geohumanitiesforum.org* https://geohumanitiesforum.org/about/ [accessed 15 May 2023].
[121] Engelmann, Sasha. 2022. *Sensing Art in the Atmosphere: Elemental Lures and Aerosolar Practices* (London: Routledge), p. xvii.

political forces suspended in it.'[122] The elemental lure that Engelmann describes is an attempt to re-animate a sense of atmospheric awareness, one that can enter cloud formations, the wind, sun, and weather systems into open dialogue with the consequences of colonial or environmental violence, for example. Elemental lures are introduced by Engelmann through a critical exploration of art practice, in particular the 'aerosolar arts'; a movement prompted by the art house Studio Tomás Saraceno in Berlin, of which the author is a former collaborator and researcher in residence. For Engelmann, elemental lures 'are feelings of push, pull and attraction'[123] that allow the atmospheric and airborne to orient us alongside their political and cultural tethers.

Projects such as 'Aerocene' a series of atmospheric engagements focussing on the distribution and implementation of airborne sculptures across a variety of locations across the world, are analysed by Engelmann as atmospheric artistic endeavours that serve as conduits or 'lures' that can connect local and global communities. For Engelmann, this airborne creative practice also provides a platform for engaging in a political and environmental activism that is in communication with the movements of air and atmosphere. 'Aerosolar artworks amplify an elemental politics of location by foregrounding personal histories, corporeal capacities, and by acting as wayfinding instruments in the heavy weather of the present.'[124] By focussing on 'air' Engelmann takes under her wing a container, an 'element of elements'[125] that in its many varying interactions and associations presents as a carrier for an arts practice that aligns with the atmospheric and in turn can reveal its influence and cultural significance, stating that 'to be lured to the wind and weather [...] is to apprehend the social, cultural and political forces suspended in air.'[126] One example of these aero-centric works is the Studio Tomás Saraceno piece *Sounding The Air* (2018), which is an example of an artwork that proposes an interaction with the air in the way that Engelmann describes, while also acknowledging the atmospheric significance of sound. Exhibited at the Palais de Tokyo, Paris in 2018, the work consisted of an installation of an 'aeolian

[122] Ibid.
[123] Ibid., p. 2.
[124] Ibid.
[125] By which I mean air as both planetary element (fire, air, earth, water), as well as host to its many constituent parts, or the 'elements' that it contains.
[126] Engelmann, 'Sensing Art in the Atmosphere', p. 74.

instrument'. Video sensors concentrated on the airborne fluctuations of five silk spider threads were used to generate audible tones and patterns, which in turn created shifts in the audible and visual experience of the gallery setting. The artist describes *Sounding The Air* as:

> Improvised by an ensemble of forces and bodies: the radiant heat of human bodies, or the flurries and tremors created by the flux and breath of visitors but also the endless intra-actions of different aerial elements — dust, silk, heat, wind, spider, electrostatic force.[127]

The measurable impact of the 'intra-actions' the artist describes is difficult to quantify, but it is worth noting that the influence of breath and the presence of bodies in the gallery setting is likely fractional compared to the natural circulation of air through the installation space, or the designed effect of ventilation systems, dehumidifiers, and air conditioning, which, as discussed in the second chapter of this thesis, have significant cultural implications of their own.[128] *Sounding The* Air is an effective example of a practice of transduction, where spider silk, digital audible tone generators, and video technology are engaged directly with the atmosphere of the gallery space. However, there is a question as to whether *Sounding The Air* performs the purpose of its title as effectively as the artist collective's assessment suggests, this is most notable when considering the artist's description of the work as an aeolian instrument 'sounding the air'. Considering that the conversion of spider silk movements is an engagement that is primarily visual in the nature of its encounter: the silk's movement tracked by video technology, the installation's 'sounding' could be considered as largely performative by design, rather than a transduction of sound, air, and atmosphere. As a spectral representation of the movement of silk strands in the air, the 'aeolian' element of the work is present only in the replication of the tonal quality of an aeolian instrument via its synthesis within a digital technological device. The aeolian within Saraceno's work, therefore, is an 'idea' of what air sounds like, in practice it is sound designed to emulate the air. In the context of our initial question, *Sounding The Air* is perhaps best

[127] 'Sounding the Air · STUDIO TOMÁS SARACENO'. 2019. *STUDIO TOMÁS SARACENO* https://studiotomassaraceno.org/sounding-the-air/ [accessed 15 May 2023]
[128] See, Starosielski's writing on thermopower and thermoception, which describes the cultural impacts of climate control systems, heat and cold. Starosielski, 'Media Hot and Cold', p. 7.

described as an example of a sounding 'in the air' rather than a sounding 'of the air' as the title and artist's evaluation suggests. In *Sounding The Air,* sound is activated as an agent of interjection rather than a sonic atmospheric attunement, which also places the installation in conflict with its aeolian description. The work of Studio Tomás Saraceno is, for Engelmann, an art that 'amplifies the lures of aerial media, whether these are the shapes of clouds, uncanny rays of light, corridors of wind, or changes in the weather.'[129] However, contained within the gallery setting, Saraceno's methods of atmospheric amplification in *Sounding The Air,* encounter some of the same troubles as Kirkegaard's *4 Rooms*, where the outcome of the artist's interaction threatens an atmospheric erasure of the 'realness' of a culturally and politically contested nuclear-sonic space.[130] There is a wider question that arises here, which is concerned, in-part, with who has the right to insert 'culturalness' to atmosphere and what are the ethical implications for these kinds of cultural atmospheric engagement?

[129] Engelmann, 'Sensing Art in the Atmosphere', p. 142.
[130] See Section 1.5, 'Geiger Environs'.

Figure 15. Engelmann & Dyer's open-weather project, image shows participants at a DIY Satellite Ground Station Workshop at Wagenhallen Kunstverein, Stuttgart in September 2020.[131]

Engelmann and collaborator, Sophie Dyer, take up this concern in their piece titled *open-weather* (2020 - present), described by the artists as 'a feminist experiment in imaging and imagining the Earth and its weather systems using DIY community tools.'[132] *Open-weather* consists of a series of workshops, a web-based mapping project, and toolset for intercepting and sharing information gathered from meteorological satellite technology. Using readily available, inexpensive technologies, Engelmann and Dyer conducted workshops where participants could be trained to intercept transmissions from passing weather satellites (Fig. 15). Presented via an online 'nowcast' during the COP26 meeting of nations on the 21st of October 2021, Engelmann and Dyer call on this network of participants with 'DIY satellite ground

[131] 'Open-weather' (Image: photograph). Source: http://www.sashaengelmann.com/amateur-radio. Shared under a CC BY 4.0 Deed Attribution 4.0 International license - https://creativecommons.org/licenses/by/4.0/.
[132] 'Open Weather —'. [n.d.]. *Sasha Engelmann* http://www.sashaengelmann.com/amateur-radio [accessed 5 December 2023].

stations'[133] to gather and submit imagery to the platform throughout the first day of the conference. A similar act of remote sensing, and gathering of citizen data, is reflected in this research with the practice piece *37°N* described in the previous chapter. *37°N* engaged historical data from seismic events and real-time data in respect of streamed video, radiation and air pollution readings to draw attention to the *always*-effects of nuclear events. For Engelmann and Dyer, *open-weather's* data gathering conducts a citizen-lead experiment for reimagining the planet in the context of 'climate crisis' enacting 'an imaginary of climate change that is situated, temporally bounded and inseparable from the ontological realities, or fractals, that compose it.'[134]

Open-weather demonstrates the massive network of elements that form our understanding of what atmosphere is; where the traversal of data through electromagnetic frequency transmission, digital images, the weather, and an act of 'foregrounding positionality' through the process of gathering and notating the event are all concurrent.[135] For Engelmann and Dyer, their approach targets a 'feminist and fractal' imaging of the planet that 'centres the body as a sensing technology.'[136] Although sound is notably absent within the documentation of *open-weather*, the artists insist that it is vital to this process of embodying a feminist-atmospheric mode of sensing, 'when we raise our antennas and hear a burst of sound in a sea of static, we are participating in a séance. We are listening to, and meeting with, the bodies of womxn who heard a signal in the noise.'[137] In contrast to Studio Saraceno's *Sounding The Air, open-weather* is a far more complete demonstration of a sounding 'of the air', despite its apparent silence, and one that is well attuned with the cultural dynamics of atmosphere that she describes. Returning to my earlier question of ethics, 'who has the right to insert 'culturalness' to atmosphere and what are the ethical implications

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[133] Ibid.
[134] Engelmann, Sasha, Sophie Dyer, Lizzie Malcolm, and Daniel Powers. 2022. 'Open-Weather: Speculative-Feminist Propositions for Planetary Images in an Era of Climate Crisis', *Geoforum; Journal of Physical, Human, and Regional Geosciences*, 137: 237–47 https://doi.org/10.1016/j.geoforum.2022.09.004. p. 243.
[135] Engelmann, Dyer, Malcolm and Powers, describe *open-weather* as a foregrounding of 'positionality through meta-textual elements like field notes and noise.' Engelmann, Dyer, Malcolm and Powers, 'Open-Weather: Speculative-Feminist Propositions', p. 244.
[136] 'ALMANAC'. [n.d.]. *Almanacprojects.com* https://almanacprojects.com/public-programme/open-weather-feminist-handbook [accessed 8 December 2023].
[137] Ibid.

for these cultural atmospheric engagements?' Engelmann and Dyer's *open-weather* is a demonstration of an approach which is sensitive to the air and the cultural effects that are 'tethered' to it. It is an atmospherically attuned sonic practice that demonstrates that where sound can allow for quiet, an act of listening or a sounding *of* the air can be as powerful as a siren or shout.

With *open-weather,* Engelmann and Dyer engage their practice in a form of what media theorist Lisa Parks describes as 'cultural atmospherics',[138] conducting an open traversal of the cultural elements exposed by an aerial network of interactions and airborne media. For the artists, this practice of transducing the atmospheric to a digital space of images, notes, and noise generates an 'imaginary that not only makes explicit its means of production, but also expresses its emergence from diverse weather worlds, radiophonic spaces and the bodies that live in them.'[139] *Open-weather* is a demonstration of the definition of praxis that I have introduced in the First Chapter, where an art practice that is sensitised to the atmospheric can be engaged through the documentation of practice of actions. It is an example of where creative practice and data gathering can be enlisted in the wider cause of climate change awareness. Both *open-weather,* and my own practice, *37°N,* are practice actions; live interventions that expose cultural atmospherics via citizen data gathering, accessible technologies, sound, and a space of digital documentation. They are both examples of how an attunement to the atmospheric and cultural connections that surround practice can reveal new insights into their influences and effects. It is within this scope that the following practice piece is situated, and asks, if a practice of cultural atmospherics can 'write bodies and experiences into remotely sensed imagery',[140] can a nuclear cultural

[138] 'The concept of *cultural atmospherics* is invoked in a literal and figurative sense, literally to account for the way that cultural practices such as audiovisual communication move through (or beyond) the atmosphere in the process of their production, distribution and/or, reception, and figuratively, to account for the potential of such process to generate affects and sensations, modulate moods, reorder lifeworlds, and alter everyday spaces.' Parks, Lisa. 2018. *Rethinking Media Coverage: Vertical Mediation and the War on Terror* (London: Routledge). p. 14.

[139] Engelmann, Dyer, Malcolm and Powers, 'Open-Weather: Speculative-Feminist Propositions', p. 243.

[140] Ibid., p. 245.

digital device be similarly encoded, both sonically and visually, to the *always*-effects of nuclear material half-lives?

3.3 – *Radionuclide Websites*

Figure 16. Screenshot of 'Radionuclide Website – Pu240' (2022 - 8583).

Links: Curium-244, Krypton-85, Plutonium-238, Plutonium-240, Plutonium-242, Strontium-90, Caesium-134, Caesium-137

Action: The Radionuclide Websites (2022 - present) can be accessed on the links above, up until the date of their individual expiries. Caesium-134, with its half-life of 2.0652 years is the only website that has expired at the time of writing. I encourage you to spend some time with them now – they can be accessed individually but I suggest that you open each website in any order one by one. Experiment with the audible frequencies of the sites together by switching the sound on and off using the audio toggle in the top-left corner of the page.

Radionuclide Websites (2022 - present) is a digital artwork that consists of eight webpages. Each one is designed to represent a specific nuclear material that is generated by human activities, such as in the production of nuclear fission-based energy and nuclear bomb explosions. The websites are code-based sound and image

generators that consist of an audible sinewave generator, waveform visualisation, and colour modulator. The programmed function of these websites is to cycle through each colour within the RGB colour spectrum and every frequency within the human range of hearing (20 – 20,000Hz), over the course of the half-life of their associated nuclear material. Once a website has completed its cycle, it deletes itself.

The webpages are a digital artwork and artefact that merge the half-lives of radioactive materials with digital media technologies, their languages, and material infrastructures. *37°N* explores the potential for the digital space to conjoin nuclear events with the atmospheric effects of weather and pollution, and radioactivity data gathering. *Radionuclide Websites* takes a further step, attempting a realisation of the nuclear in the form of digital-material. As you would expect of any interaction with radioactive materials, the production of these websites was undertaken with great care as to their handling, impacts, and futures. This caution, however, is not purely performative, as one might expect, given the absence of the immediate threat of radiation from these digital radioisotopes. The digital space can be understood as a material network of personal devices, fibre-optic cables, and servers, each with their own requirements in respect of their power consumption, precious metals, silicon, plastics, and glass. This material dependency exposes the digital artefact to the political ecology of an infrastructure that is simultaneously generative of the nuclear materials they represent. This is also demonstrated by the digital space's dependence on nuclear energy generation,[141] the atmospheric-climactic effects of fossil fuels, and the geologic and cultural impacts of the mining of materials that support it.

In his comparative study of the impacts of music media and their related technologies, music theorist Kyle Devine, points out that the political ecologies of 'material' media formats are not so different from their digital equivalents.

[141] Although some data centres are supplemented by local renewable energy sources, the majority are still powered by the electricity grids of their respective countries. According to the International Energy Agency (IEA), around 10% of global power generation comes from nuclear energy production. See, Wanner, Brent, and Ryota Taniguchi. [n.d.]. 'Nuclear', *IEA* https://www.iea.org/energy-system/electricity/nuclear-power [accessed 27 May 2024].

> Emerging research, in cultural studies as much as industrial ecology, confirms that online consumption is not only resolutely material but also significantly dependent on various forms of energy, resources, and laborers. Indeed, in highlighting parallel instances of these factors in relation to other forms of online consumption - reading, gaming, viewing - it becomes apparent that no form of digital consumption can be thought of as immaterial.[142]

It is within this material network that the *Radionuclide Websites* can be considered as not just digital representations of nuclear materials but also direct activations of them. The colours, tones, and shapes generated by the websites visualise and make audible the alpha, beta, or gamma emissions of the byproducts of their own source of power. The digital space links *Radionuclide Websites* with the global power requirements of data centres and narrows the gap between the web-based artwork and their nuclear material subject. The *Radionuclide Websites* are an example of my expanded use of the term 'atomicity' in this thesis – where the atomic weight and decay of radioactive materials can act as a 'recognition of atomic burden in the practice I present.'[143]

Radionuclide Websites exhibit atomicity in a number of ways, primarily by their pre-programmed durations; once set in motion they are fixed to an outcome of expiry. The lack of any repetition in the sequence as they cycle through each RGB colour and audible frequency, paired with their specific half-lives, generates a unique combination of audio and visual effects for each moment in the sequence. *Radionuclide Websites* is an artwork that is automatic, continually generative, and ultimately self-destructive. There are prerequisites to this approach within sound arts practice, where an auto-generative work is paired with a long-timescale expiry, such as Jem Finer's *Longplayer* (1999 - 2999), a one-thousand-year composition set to play without repetition throughout a series of digital and site-based locations.[144] The origin of artworks with auto-generative properties can be traced back to Gustav Metzger, an artist and political activist whose manifestos described an approach to art that is aligned with this method of making. Metzger initiated an 'auto-destructive' and 'auto-creative' approach to the making of art, in addition, his work was consistently anti-nuclear and

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[142] Devine, Kyle. 2019. *Decomposed: The Political Ecology of Music* (London: MIT Press). p. 133.
[143] See Section 1.3, 'An Enquiry of the Nuclear in Sound Studies'.
[144] 'Overview of Longplayer'. [n.d.]. *Longplayer.org* https://longplayer.org/about/overview/ [accessed 25 January 2024].

'aimed at triggering specific responses in the viewer concerning particular issues to do with, for instance, nuclear weapons and nuclear power, pollution and the capitalist system.'[145]

Where Finer's *Longplayer* and *Radionuclide Websites* diverges from Metzger's manifestos, is in his consistent calls for an art of expiry that could last for no longer than twenty years. In his second manifesto he states that 'auto-destructive art is art which contains within itself an agent that automatically leads to its destruction within a period of time not to exceed twenty years.'[146] This twenty-year limitation seems at odds with an artwork concerned with the nuclear, but where the long timescales and slow fade of radiation's effects now dominate the discourse on atomicity, at the time that Metzger was writing his manifestos, there was a far more immediate concern that the real threat of the atomic era would come from the escalating tensions of the Cold War and a sudden global-nuclear-annihilation. The web-based radionuclide is a medium for the self-generation and self-destruction of a digitally rendered nuclear-element. Codified with a nuclear half-life, the digital artefact of the *Radionuclide Website* assumes the form of an 'elemental medium', acting as contact point and carrier of atmospheric and post-atomic consequences. Despite its divergence from Metzger's prescribed timescales for auto-destructive art, *Radionuclide Websites* acknowledges Metzger's call for an auto-creative 'art form of the immediate future'[147] as well as an auto-destructive art that 'aims at the creation of works of art that diminish in volume until they cease to exist.'[148]

John Durham Peters describes the digital space as 'resolutely material', where networked computation and the infrastructures that support it are inseparable.[149] Understanding long-duration digital artworks such as *Radionuclide Websites* in this

[145] Wilson, Andrew. 2008. 'Gustav Metzger's Auto-Destructive/Auto-Creative Art', *Third Text*, 22.2: 177–94, p. 178.
[146] Excerpt from Gustav Metzger's second manifesto on auto-destructive art. Metzger, Gustav. 2019. *Gustav Metzger: Writings 1953-2016*, ed. by Matthieu Copeland (Zürich, Switzerland: JRP Ringier). p. 66.
[147] Metzger, 'Gustav Metzger: Writings', p. 84.
[148] Ibid., p. 85.
[149] Peters, John Durham. 2016. *The Marvelous Clouds: Toward a Philosophy of Elemental Media* (Chicago, IL, USA: University of Chicago Press), pp. 48-49.

way extends an ethical concern toward the ecological impacts of situating these projects within networked digital spaces, as Devine states:

> A single server farm […] can consume thousands of megawatts of electricity (enough to power millions of homes). It is for these reasons crucial to counter the 'big white fluffy' connotations of cloud computing by stressing 'the cold hard physicality of warehouses, servers, generators, and climate control devices.'[150]

It is with this in mind that the *Radionuclide Websites* have been designed to have as small a footprint as possible with respect to their energy use, minimising the real-world impact of their 'atomicity'. With the help of two coders, Apoorv Khandelwal and Mathew Davies, the websites' audiovisual effects are entirely code-based, this means there is no requirement for audio and video streaming from remote servers. This auto-generative design results in a total file size of 20KB for each site, which can be equated to less than 0.04% of one minute of high-definition video streamed once from a web server. Accepting that there is some variation according to the content of the video and audio played back, one minute of streamed high-definition video on the world's most popular video platform, YouTube, would require roughly 50MB of data to stream.[151] It should be noted though that the real data cost of this process would be multiplied by each streaming event, which could count in the thousands or millions of streams, and also does not include the energy requirements of the server space required to store the film for playback.

[150] Devine, 'Decomposed', p.138.

[151] Although accurate at the time of writing, this figure may change as video compression technologies improve. Jayasekara, Gimhana, and Winces Solutions. [n.d.]. 'YouTube Data Cost Calculator', *Web.App* https://online-calculator-yt.web.app/ [accessed 13 December 2023].

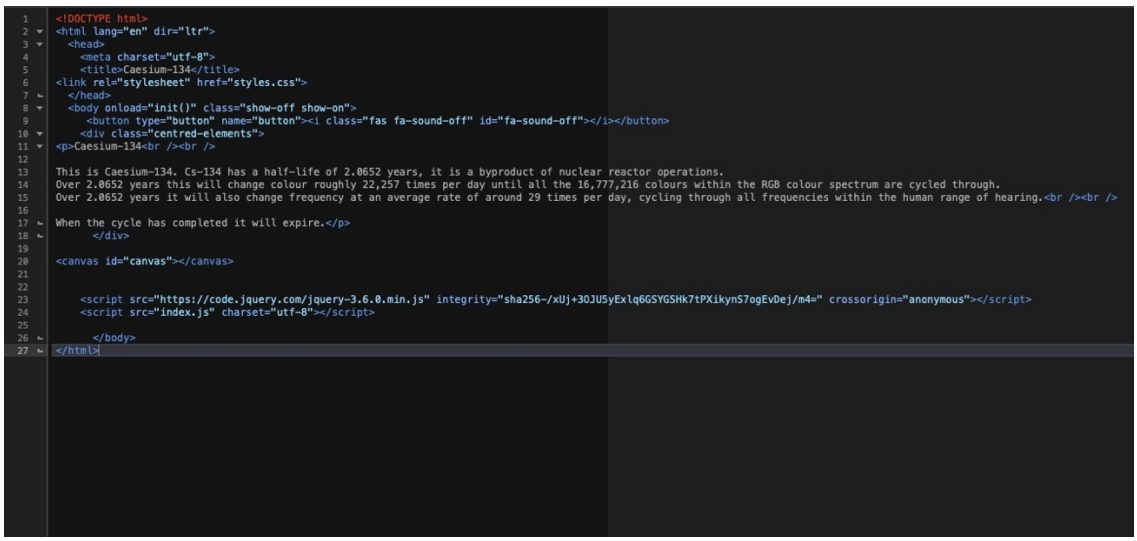

Figure 17. Screenshot of the html code for the 'Radionuclide Website – Cs-134' (2022 - 2024), at less than 30 lines of code, the webpage's front-end has a file size of just 1,145 bytes.

In addition to the files hosted within my personal webspace, the site's more complex functions, such as the oscillator and waveform drawing function are provided by the code library 'jquery-3.6.0'. jQuery is a widely adopted and open-source JavaScript project that provides a library of tools that web-designers and coders can use to perform a large variety of website functions, without the need for users to host extensive coding libraries of their own. Although jQuery is a fairly large code database its size is still comparatively small in the context of most other file types.[152] The decision to use jQuery was based on the cumulative effect of a single hosted code library being far smaller in comparison to multiple millions of users and sites each requiring their own hosted JavaScript files, which although may be smaller in size, are performing the same functions as each other. From this perspective, the use of jQuery is understandable, it does however represent a threat to the *Radionuclide Websites* longevity through the sites' exposure to the cycle of updates, removal of features, and changes in language that are very likely to occur before many of the longer timescales within their programmed functions are reached. Furthermore, there is a likelihood that other new languages within the digital space will overtake JavaScript, HTML, and CSS entirely, long before most of them can complete their radioactive cycles.

[152] The file size of the most recent jQuery library is less than 300KB in size. For information on the most recent versions. See, OpenJS Foundation-openjsf.org. [n.d.]. 'Download jQuery', *Jquery.com* https://jquery.com/download/ [accessed 13 December 2023].

Igor Štromajer's project *Expunction* (2011) highlights this temporal challenge faced by net-based artworks.

> Between 11 May and 16 June 2011 […] Štromajer ritually deleted a number of his net art works produced between 1996 and 2007. He expunged one net art project per day, permanently deleting it from his online server, so that the projects are no longer available at the Intima Virtual Base. He deleted 37 net art works altogether, amounting to 3,288 files or 101.72 MB.[153]

Štromajer's erasure of these works is an attempt by the artist to free them from the inevitable distortion and alterations that have occurred as after-effects of their deteriorating dependent technologies. For Štromajer, the process of erasure is both generative 'the deleted works or their remaining fragments, […] tell us much more about the originals (original works) than the originals themselves'[154] and performative of a practice of 'purification' that 'makes space for something new to come.'[155]

Although I have hopes for the continuation of *Radionuclide Websites* far into the future, I do not share Štromajer's concerns of the negative effects of deterioration on these artworks or his motivation to remove them. This is partly due to their pre-programmed expiry, but also, I understand that over time the radionuclide webpages may break down slowly, losing their functions one-by-one as each element of their production is replaced or made defunct by new developments, or that they may disappear completely and suddenly, for example, in the event of a catastrophic failure of one of the global systems keeping them in place. Rather than viewing this as a negative potential outcome, it is precisely this threat that adds to the inherent atomicity of the digital radionuclide, as Peters states, 'old media rarely die; they just recede into the background and become more ontological.'[156] Rather than extraneous to this work, the 'receding media' and its timeline of decay is a vital function that is also reflective of the process of decay and the volatility of the nuclear materials that they represent.

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[153] Robert Sakrowski and Igor Štromajer, 'EXPUNCTION Deleting www.intima.org Net Art Works A Conversation', in *Lost and Living (in) Archives: Collectively Shaping New Memories*, ed. by Dekker, Annet (Amsterdam, Netherlands: Valiz, 2017), pp. 160-73. (p. 160).
[154] Ibid., pp. 160-161.
[155] Ibid., p. 169.
[156] Peters, 'The Marvelous Clouds', p. 23.

I will explore this relationship of media and decay further in the practice I present in the final chapter of this thesis, where the *Radionuclide Websites* are re-animated and preserved outside of the fragile infrastructures of the digital space, within archives, documentation, nuclear bunkers, and the materials of audiovisual media. Firstly, Štromajer's *Expunction* opens up one further area to explore, which is concerned with the position and role of memory within this research. Štromajer considers his deteriorating net art as a 'deceitful memory' no longer truly representative of his intentions as the artist, which means that they can be 'erased without qualms, for it does not offer an authentic image of the past of which it speaks.'[157] Where *Radionuclide Websites* inherit the millennial timelines of radioactive isotopes this idea of an 'honesty of erasure' gains little purchase, when an 'authentic memory' of them cannot register as anything more than a microscopic glitch within the noise-print of a near-endless signal. I return to this idea of a noise-print emerging from the *Radionuclide Websites* in the final chapter of this thesis, where I perform a transduction of the websites to physical film materials and investigate how these materials can be enlisted as devices for communicating post-atomic auralities.

3.4 - Elemental Memory

In the context of the timelines of our interactions with nuclear materials, the *Radionuclide Websites* deposit themselves as a digital-site of radioactive effects. As I have discussed, this digital space consists of a complex system of elements that are reliant on their atmospheric and energetic interactions. Their survival within this space, however, is highly dependent on their ability to be found, accessed, and remembered into the future. These issues of access and memory within the digital space are shared with the *always*-effects and millennial timelines of nuclear materials. Engelmann expands her concept of 'elemental lures' toward the nuclear in her paper 'Elemental Memory: The Solid Fluidity of the Elements in the Nuclear Era' (2022),

[157] 'Expunction – Deleting Net Art Works'. [n.d.]. *Intima.org* https://www.intima.org/expunction/www.html [accessed 6 February 2024].

where she argues for an 'elemental memory' where the site and function of memorialisation is separated from the 'recall of individual persons' or the 'social process of remembrance'.[158] For Engelmann, an elemental memory instead resides in the 'auto-relation'[159] of elements that can present as 'ontological categories of matter, molecular units, environmental milieus or media.'[160] Within nuclear culture research this 'pull' of the material from which Engelmann's 'elemental memory' is drawn, has underwritten the geological as key to our understanding of nuclear effects, where the half-lives of radioactive materials are engaged as totemic in our understanding of the post-atomic. Although it is within this expanded definition of memory that the work that I describe in this chapter could be compared, where the molecular matter of radioactive substances performs a transduction of the digital, archival, technological, and environmental, there are benefits and risks in accepting this form of geologic 'auto-relation' as a pivotal point of departure for understanding the post-atomic.

Engelmann's detailed descriptions of the content and dispersal of trinitite rock that formed in the area of the Trinity Test Site following the successful detonation of the first nuclear explosion on July 16th 1945, conducts a forensic investigation of the origin and influence of the unique post-atomic glass-like substance. She describes trinitite as 'not "history encased in glass", as if the trinitite bead were a transparent vitrine through which we can gaze at a "solid" presentation of events; it is a memory of solid fluidity that tells a story of rapid transformation and process.'[161] For Engelmann, trinitite's formation during nuclear tests in the Arizona desert and its composition of radionuclides, bedrock, molten metals, and sand are communicative of the elemental memory that she describes, a material continuum of post-atomic effects that are 'unfolding events […] that continue to perform their memories and nuclearity in the wake of atomic violence' rather than 'snow-globes of the past'.[162] It is a proposition that appears to place greater emphasis on the radioactivity of trinitite as a defining

[158] See, Engelmann, 'Elemental Memory', p. 2.
[159] For Engelmann, elemental memory is a description of how 'rocks can contain fossilised, melted, dissolved or sedimented substances that auto-relate the medium to (past) processes and events.' Ibid., p. 5.
[160] Ibid., p.2.
[161] Ibid., p. 9.
[162] Ibid., p. 12.

factor of our understanding of it, as though it were the radioactivity of the material itself that empowers it with a *super*-endurance that reaches into and beyond the recollection or memory of the event.[163] In Engelmann's description of the 'black glass beads' of trinitite rock, I am reminded of the recollections of the author and survivor of the bombing of Nagasaki, Kyoko Hayashi. The following extract is from her book *From Trinity to Trinity* (2010):

> The officer pointed to one stone that had no shine, and started to explain: 'This small stone was made when the atomic bomb explosion blew up the earth's sand and soil, which danced together in the air, mingled, melted in the high heat, and got jammed together into a ball shape. We call this small stone a pearl,' he said. The stone was a perfectly shaped sphere. […] Did the people who were melted in the high heat also become small stones and dance in the air? Someone told me the bones of young people shine pink. I wished the bones of my dead friends would at least become lovely pink pearls.[164]

By concentrating on the half-lives, material content, and structure of radioactive elements within trinitite rock, is it possible that the significance of recollections, such as Hayashi's, can be reduced or overwritten? What happens when rock-hard geology enters the record alongside the more pliable 'soft-tissues' of memory? In her description of *Aerocene* (2015), a work by Studio Tomas Saraceno, where a large 'aerosolar' device is launched in the air above the White Sands, New Mexico, USA, Engelmann goes as far to suggest that Hayashi's writing is an example of how 'the sands of New Mexico remember other stories.'[165] It is pertinent to consider the impacts of this academic reification of geologic memory, especially when it is contextualised through the lived experiences and consequences of our interactions with radioactive materials. Furthermore, it poses difficult questions to Engelmann's 'elemental memory' that calls for the separation of 'individual recall' from the material realities they reflect. I will explore this relationship further in the Fourth Chapter of this thesis, where I present a sound mapping project that combines the recollections of

[163] Trevor Paglen's 'Trinity Cube' (2015 – present) is another example of an artist looking to transfer the atomicity of trinitite to exhibitable artwork. The artist utilises an irradiated block of trinitite which he has encased in a glass cube for the *Don't Follow The Wind* exhibition. See, 'Trinity Cube'. [n.d.]. *Paglen.Studio* https://paglen.studio/2020/01/21/trinity-cube/ [accessed 3 June 2024].
[164] Hayashi, Kyoko. 2010. *From Trinity to Trinity*, trans. by Eiko Otake (Barrytown). p. 54.
[165] Engelmann, 'Sensing Art in the Atmosphere', p. 125.

a nuclear veteran within a wider sonic exploration of a former UK Ministry of Defence nuclear weapons storage site.

Engelmann's 'elemental memory' draws a neat line between Karen Barad's 'spacetimemattering' and other theories that explore the inter-relations of time-as-material and the very well-established theories of 'deep time' that Engelmann includes in her essay as influential in the development of her theory. Often referenced in seminal texts on the subject of nuclear materiality within the humanities, Barad's contribution to, and influence on nuclear cultural studies is wide-reaching. However, it is also important to consider if such a focus on the long tail of nuclear time and materiality can be counterproductive to our understanding of the post-atomic in the arts, or even perform an erasure of the nowness of post-atomic effects that Barad, Engelmann, Schuppli and numerous other nuclear culture theorists espouse? In his essay 'Geology Without Geologists' (2016) Douglas Kahn agitates on the dangers of the emergence of such reifications of 'geologic imagination' stating that:

> Theorists, academics, and artists who could have cared less in the past are now raising the rubble and unleashing a virtual avalanche of the inert. They have found a touchstone in geology, a bedrock of materiality, and want to ride it as a rocky life raft into a world of rising sea levels.[166]

Kahn argues that the field of geology is inseparable from the geologist and rightly points at the contradiction of its emergence within theories of eco-politics and aesthetics, when considering its responsibility, in-part, for every one of the major global concerns surrounding it, resource extraction, climate disaster, energy systems, and agriculture. In *A Billion Black Anthropocenes or None* (2018), Kathryn Yusoff argues further that establishing the nuclear Anthropocene by marking a Golden Spike in the geologic record provides a reference point for the nuclear that is 'lodged in the event of the atomic bomb and its technological achievements rather than the effects on the peoples and ecologies of the Pacific and the more widespread nuclear colonialism and its ongoing presents in nuclear waste.'[167] For Yusoff, this geologic marker silences the

[166] Douglas Kahn, 'Geology Without Geologists', in *Aesthetics After Finitude*, ed. by Brits, Baylee, Prudence Gibson and Amy Ireland (Re. Press, 2016). pp. 89.96. (p. 89).
[167] Yusoff, Kathryn. 2018. *A Billion Black Anthropocenes or None* (Minneapolis, MN, USA: University of Minnesota Press). p. 48.

voices of those exploited and enslaved in its making, stating that 'the origins of the Anthropocene continue to erasure and dissimulate violent histories of encounter, dispossession, and death. In the geographical imagination.'[168] In her book *Infrastructures of Apocalypse: American Literature and the Nuclear Complex* (2020) Jessica Hurley approaches the subject of the imagined futures of the nuclear complex that Yusoff refers to. Hurley plots a route through the post-atomic in the context of an expanded understanding of apocalyptic thought in American literature, arguing that 'by radically changing the imagined future, apocalypse allows for different realities to become imaginable in the present.'[169] For Hurley, the imagined threat of nuclear apocalypse is 'embodied' within imaginaries of mushroom clouds reaching out across the world in a spontaneous act of destruction, an image of the 'nuclear sublime'[170] that is 'designed to reduce the capacity for critical thought and induce habits of submission to the nuclear complex for which the mushroom cloud serves as metonym and disguise.'[171]

In my introduction to this thesis, I pose the question 'is it possible to interrogate the half-life of the bombing of Nagasaki, to map a path through its cultural derivatives and how does this process proliferate in the bodies, environments and cultures effected by the event?' In Hurley's understanding, the atomicity of the event of the bombing of Nagasaki is also measurable in its ability to maintain the infrastructures of a nuclear military complex whose existence relies on the acceptance of the inevitable presence of the *always*-effects of our post-atomic world and is simultaneously responsible for them. Hurley's research demonstrates an 'atomicity of myth', which is driven by a narrative of fear. This is demonstrated in the concept of 'mutually assured destruction' (MAD); where the nuclear military complex attaches itself like a parasite, proliferating through a narrative of destruction and the globalised psychological effect of the fear of its capacity to destroy itself and everyone with it. Hurley's focussed study on the literature of the post-atomic is an example of how our cultural outputs are influenced

[168] Ibid., p. 101.
[169] Hurley, Jessica. 2020. *Infrastructures of Apocalypse: American Literature and the Nuclear Complex* (Minneapolis, MN, USA: University of Minnesota Press). p. 4.
[170] See, Ferguson, Frances. 1984. 'The Nuclear Sublime', *Diacritics*, 14.2: 4 https://doi.org/10.2307/464754.
[171] Hurley, 'Infrastructures of Apocalypse', p. 9.

by the political and social fallout of atomic events, and how our methods of memorialisation can be compromised and corrupted by this.

Where forgetting and emotion adapt and change the retelling of tales, Plutonium sheds its atomic weight to an inevitable, barely perceptible point of neutral mass, expanded over enormous timescales. Elongated over millennial timescales the 'imagined-future' of these materials becomes a fluid conception, which is more accessible to us when interpreted through the fallible timescales of past events and our memories of them. For Hurley, the 'sketchy connection' of the nuclear military complex resides in the cultural outputs of American post-atomic literature, which has 'responded to the atom bomb not only as an unthinkable paradox or a future threat but also as a new national infrastructure that has determined the flow of resources and risks across the twentieth and twenty-first centuries.'[172] Returning to Stewart, both Hurley and Engelmann's understanding of the post-atomic demonstrates how our 'notions of truth and expertise gain purchase in the gap', while they both also highlight the difficulties of defining what best represents an effective witness to nuclear events.

3.5 – The Sonic Witness

For Susan Schuppli 'evidence for nuclear events secretes itself in matter as a dangerous latency that only emerges under certain conditions.'[173] In her essay titled 'Trace Evidence: A Nuclear Trilogy' (2016), Schuppli highlights an example of this by detailing the various conditions that saw the detection and emergence of radioactive materials from Chernobyl at a nuclear power station in Sweden, before the announcement of the disaster in Chernobyl's neighbouring town of Pripyat. [174] For Schuppli, the emergence of this radioactive material in Sweden is a 'material witness that would first come to testify publicly to the accident of Chernobyl.'[175] What Schuppli

[172] Ibid., p. 3.
[173] Susan Schuppli, 'Gamma Camera', in *The Nuclear Culture Source Book,* ed. by Carpenter, Ele (London: Black Dog Publishing, 2016), p. 179.
[174] Susan Schuppli, 'Trace Evidence: A Nuclear Trilogy', in *The Nuclear Culture Source Book,* ed. by Carpenter, Ele (London: Black Dog Publishing, 2016), pp. 37-42.
[175] Ibid., p. 40.

describes here is multi-faceted – it is 'in the simplest interpretation', the first recorded material manifestation of the event that irrefutably evidences it. In addition to bearing witness to the event, for Schuppli, these materials are also representative of the time-delayed announcement of the disaster. The discovered material is a witness to many proliferating outcomes (or transductions) – such as the decisions of politicians and officials not to inform the public of the immediate danger to their environment and health. It is through the various engagements with sound and atmospheric encounters within the practice I present, that nuclear materiality can expand to include the consequences of the decisions of governments and 'make visible' the disastrous consequences of atomic era events. Furthermore, I ask how focussing on sound and atmosphere as an unfolding outcome of them could contribute to a better understanding of nuclear cultures and the post-atomic?

> **Listen:** Track 1 - The Toads of Trinity (Acoustic Atlas: Jeff Rice)
> **Link:** https://www.iless.eu/phd_audio.html
> **USB Media Location:** Audio > Track1-The_Toads_of_Trinity.wav
>
> Date: 2017-08-01
> Time: 11:50PM
> Creator: Rice, Jeff [176]

The 'frogs' that Frank Oppenheimer describes keeping him awake on the night before the Trinity Test were (among several other probable species) the calls of the Western Green Toad.[177] These small amphibians, native to the Southern states of the US, can remain concealed beneath the ground for several years and emerge to mate when the heavy rains come, usually in the early weeks of July.[178] Later, in an interview in 1973, Oppenheimer ascribes the emergence of this cacophonous natural event in proximity

[176] Source: 'Acoustic Atlas Trinity Recordings - MSU Library'. [n.d.]. *Montana.edu* https://www.lib.montana.edu/acoustic-atlas/acoustic-atlas-blog/posts/acoustic-atlas-features-trinity-recordings.html [accessed 2 April 2024]. Audio file copyright Jeff Rice and Montana State University. Shared under a Creative Commons Attribution-Noncommercial-No Derivative Works 3.0 United States License; http://creativecommons.org/licenses/by-nc-nd/3.0/us/.

[177] Frank Oppenheimer was the brother of J. Robert Oppenheimer. Director of the Los Alamos Laboratory during World War II, J. Robert Oppenheimer was a leading physicist involved in developing the first nuclear bomb.

[178] See, 'AmphibiaWeb - Anaxyrus Debilis'. [n.d.]. *Amphibiaweb.org* https://amphibiaweb.org/cgi/amphib_query?where-genus=Anaxyrus&where-species=debilis [accessed 2 April 2024].

to the Trinity Test as having 'a kind of funny significance. The only living thing around there, coming together. I mean, everything was full of import.'[179] Jeff Rice, program director at 'The Acoustic Atlas', at Montana State University describes this event as the 'Toads of Trinity',[180] and on August 1st, 2017, having had news that the rains had fallen in the area of the Trinity Base Camp, he travelled to the deserts to capture the sounds of the toads emerging to mate around the newly formed pools of water surrounding the site.

The recordings are evocative in several ways – they connect us not just to the sounds of the living environment around the Trinity site but also to the memories of those who experienced them at the time of the test. For the hundreds of press, scientists, military officials and observers anxiously anticipating the events of July, 1945, the toads mating songs might have heralded the oncoming consequences of a post-atomic world. However, for Rice and 'The Acoustic Atlas' the urgency in collecting these sounds comes from the fear of a different threat; that increasing temperatures and changing weather systems brought on by the climate crisis might destroy the species' responsible for this unique historical soundscape and the aural history they carry with them. Listening to these recordings, the events of 1945 are brought back to life and although the toads of 2017 face very different threats to those of 1945, their ancestral connections to this key moment in the timeline of the atomic adds weight to their current plight. Rice's recordings also demonstrate how sound can connect us not just to the immediate audible resonance of places and events but also to their legacies and our memories of them. The 'Toads of Trinity' are a record of a unique example of how the aural can reveal post-atomic effects, within my research these effects are captured and reanimated in creative practice. It is this process that is generative of what I describe as 'noise-prints', where post-atomic effects can be traced through the

[179] It is worth noting that the toads are and would not have been 'the only living thing around', and this is perhaps revealing of the attitudes and lack of consideration for the unique and complex ecosystems, native human populations and environments that were violently occupied and poisoned as a result of the nuclear tests.
[180] Rice, Jeff. 2018. 'The Toads of Trinity: Witnesses to the Atomic Age', WBUR https://www.wbur.org/hereandnow/2018/07/16/trinity-nuclear-test-toads [accessed 26 February 2024].

recording of their aural connections and through a sound arts practice that is attuned to them.

Within the field of sound studies, the type of aural evocation demonstrated by the 'Toads of Trinity' is well described as a form of Anamnesis. Augoyard & Torgue (2006) describe anamnesis as 'an effect of reminiscence. […] Anamnesis, a semiotic effect, is the often involuntary revival of memory caused by listening and the evocative power of sounds.'[181] In addition to this they state that this effect 'can span very different periods of time while retaining its intrinsic nature.'[182] In respect of the trinity toads the timespan of the anamnestic effect can be extrapolated both between Rice's recordings and Oppenheimer's recollection of the 'frog' calls,[183] and the historical and immediate threat of nuclear explosion and climate change. The recordings are a representation of the Trinity site in 1945 that exists in the memory of the bodies and songs of these toads, in the same way that just a few short miles away the surrounding terrain and trinitite rocks of ground-zero still retain, leak, and countdown the radioactive effects of the first day of the atomic era. In listening to these recordings, it is possible to understand more clearly Barad's 'sense of temporality' and it is a worthwhile demonstration of how sound can reveal itself as a conduit for 1945 to 'live inside' 2017 within the context of the timeline of the atomic era.

On August 9th, 1945, a matter of weeks after the successful explosion of 'The Gadget'; the codename given to the device triggered at the Trinity Test site, a bomb of the same design was detonated over the city of Nagasaki. Kyoko Hayashi was a survivor of the attack and has written extensively on her experiences and life as a 'hibakusha'.[184] In *From Trinity to Trinity*, Hayashi describes her visit to the Trinity test site in later life and offers an imagined witness account of the destructive power of the first nuclear test:

> The flash of light of the atomic bomb ran all directions in the desert. I heard, on the day of the experiment, it had been raining hard since morning, unusual in

[181] Augoyard, Jean-Francois, and Henri Torgue. 2006. *Sonic Experience: A Guide to Everyday Sounds* (McGill-Queen's University Press), p. 21.
[182] Ibid.
[183] See Section 0.1, 'Research Question'.
[184] Hibakusha is a word used in Japan to describe the victims of the attacks on Hiroshima and Nagasaki.

> New Mexico. The experiment was carried out in the heavy rain. The flash of light boiled the downpour and, with that white froth, ruined the fields, burned the helpless mountains, and shot up to the sky. And then silence. Without time to defend and fight back, the wilderness was forced to silence.[185]

Although, as we know from Oppenheimer's recollection, that it is true there had been heavy rains around the time of the Trinity Test, the rains in fact led to a delay in the detonation of the bomb and it is not the case that it was raining at the time of the explosion. Nonetheless, for Eiko Atake, the translator of Hayashi's text, this does not in any way invalidate her statements. 'Hayashi's imagination was surely fuelled by her memory of August 9: the blackened sky, the violent gusts of wind created by the explosion, the commotion and cries, the black rain after the explosion that fell on burned trees, animals and human skin.'[186]

Earlier in this chapter I asked, 'what happens when rock-hard geology enters the record alongside the more pliable 'soft-tissues' of memory?' While there is room for and value in exploring the 'material as witness' and 'the elemental as memory', there is a danger that lurks in thinking too rigidly, or in reifying the matter of memory over what matters in memory. It is without doubt that it would be an error to call into question Hayashi's recollection of Trinity for its interpretive fallibility, as her message and memory is bound in realities unimaginable to those outside of her direct witness to the bombing of Nagasaki. In her visiting and subsequent imagining of the violence inflicted on the lands, animals, and environments of New Mexico, Hayashi, precisely because of her role as witness to the events in Nagasaki, narrows the time and space between the bomb's test and the devastating effects of its eventual use. In doing so, Hayashi bonds the silence of the bodies of hibakusha with the muted croaks of the toads of trinity – it is a powerful representation of post-atomic witness, whose accuracy lies not in any 'false' recollection of the effect of rain on the test itself, but in the immediacy of her memory and experience as a direct witness of the consequences of the events in 1945.

[185] Hayashi, 'From Trinity', p. 49-50.
[186] Ibid., p.60.

Radionuclide Websites began their countdown with the invasion of Russian forces on the grounds of Chernobyl on the 25th of February 2022, a conflict which has seen the loss of many lives within the borders of the independent nation of Ukraine. At the time of writing this conflict has yet to resolve in any peaceful solution. With each passing moment the websites continue their act of generative decay, transposed to the events of Chernobyl, they highlight the continued threat of nuclear military actions that Metzger's 'auto-destructive' art, and Hayashi's witness accounts draw attention to. The *Radionuclide Websites* extend the digital space to the proliferating effects of human nuclear actions. They inherit their atomicity both from their connections to the timelines of the half-lives of their respective radioactive materials and their date of inception. In the final two chapters of this thesis, the inherited atomicity of *Radionuclide Websites* is extended to the aural architectures of nuclear bunkers and media materials that further expand their potential as witness to these events.

3.6 - Chapter Conclusion

Within this chapter I have explored how duration and time are an ever-present point of debate and observation within the context of the atomic era and nuclear culture. The radioactive legacies of nuclear weapons testing, like those carried out in the deserts of New Mexico, are commonly cited as heralding the onset of the Anthropocene or 'human epoch' and the Trinity Test is often mooted as a 'Golden Spike'; a term given to the defining moment within any given epoch. Beyond this, the examples of Hayashi and the Toads of Trinity evidence that each of these moments in the timeline of the post-atomic trigger a fluid and complex network of related and interacting effects that are bound not just in their historicity but to the enduring legacies, memory, environment, and cultures that they produce. It is in paying-attention-to and understanding these interactions through an understanding of sound's role within them, that I argue for a mode of listening that reveals these as post-atomic auralities.

This chapter takes up this endeavour by exploring how sound interacts among a milieu of airborne and atmospheric elements, following an evaluation of Engelmann's

‘elemental lures’ I have initiated a mapping of the elements of atmosphere to nuclear cultural practices, that highlight the ethical and conceptual significance of engaging in a practice of ‘cultural atmospherics’. This thesis explores the consequences of sound practice within the landscapes and communities of those effected by atomic events, the enduring effects of radioactivity, nuclear waste, and their cultural and atmospheric connections. It is through a sound focussed, atmospherically attuned practice that this study of the post-atomic offers an alternative mode of listening to this contested space of material and cultural effects.

Engelmann’s ‘elemental memory’ demonstrates how our understanding of materials is complicated by their origins, whether drawn up from the earth's core, deposited by way of planetary or extra-planetary events, or by their geographical location. In addition to this, it is an example of how materials are codified by the shape of their encounters and interventions. This can include those of human, animal, plant life or weathering on their appearance, tacticity, scale, elemental state (fluid, solid or gas), and as is the case with human-made nuclear materials such as trinitite, their molecular structure and capacity to communicate energy to their surrounding environments. The work of artists such as Studio Tomas Saraceno and Engelmann and Dyer’s *open-weather* project, reveal the complex relationships that are exposed when art practice reaches out to become airborne and how an understanding of what is ‘in’ and ‘of’ the air, can lead to an expanded field of atmospheric effects. It is a practice approach that not only includes atmosphere but can perform a ‘transmissional relay’ of it to a digital site of practice. *Radionuclide Websites* presents as an example of practice that expands the field of atmospheric attunement to the digital space. Armed with this digital-elemental-practice, I come to the final two chapters of this thesis, where my focus is on an archival study that takes place within a unique location of media and nuclear cultural heritage and futures.

Chapter 4: British Film Institute Fieldwork

4.1 - Introduction to chapter

Each of the previous chapters have focussed on the potential for sound to communicate with and through atmospheric and radioactive encounters. During the first two years of my research, I have tested the boundaries of these interactions through an experimental art practice that includes, community data projects, digital fieldwork, and sonic ethnography. In doing so, I have established an approach to sound arts practice that includes documentation, the site and act of practice, and sonic atmospheric attunements within the practice outcomes. This approach, however, is not limited to sound-based practice outcomes. It is an adaptable methodology that calls for a re-sensitisation to atmospheric encounters and their consequences. It is my intention for this research, however, to demonstrate sound as a worthwhile conduit for these purposes, and to interrogate its potential through my art practice.

The following chapter describes a body of work that activates this intention, produced primarily during the third year of my research, the work is the result of a partnership with the provider of my funding for this research, Techne (AHRC), and the British Film Institute (BFI). The fieldwork centres on a study of the BFI archive that combines site-based fieldwork, nuclear cultural heritage, sound mapping, documentation, audio-visual media, and nuclear material futures. A booklet titled *The Nuclear Archive: Sound Map* is included within this thesis and acts both as companion document to this chapter and a practice outcome. I invite you, the reader, to follow this praxis document as I navigate through the various bunkers, technologies and learnings that are uncovered along the way.

It was during a discussion with Frank Horn, the then Head of Sustainability and Risk Management at the British Film Institute in February 2021, that I learned of the nuclear history of a largely unexplored site of British nuclear heritage. Now housing one of the world's largest collections of film and televisual media, the BFI Master Film Store is situated within a Cold War era UK Ministry of Defence (MOD) site that has

remained in private hands since its decommissioning as a nuclear storage facility in the mid-seventies. The BFI archive presented as ideal for the site of an extensive fieldwork within this research, meeting all of the following key requirements:

1. Presents a nuclear history or serves a current nuclear purpose.
2. Largely unexplored – a contribution to new knowledge.
3. Accessible and suitable for developing a site-based practice.
4. Historical or actual presence and use of nuclear materials.
5. Sonic potential – is sound a suitable medium for exploring this place?
6. Serving or situated within communities and environments that welcome my practice.

As a film and sound practitioner, the potential for exploring a media archive with such a rich and unexplored nuclear history was immediately compelling, especially in respect of the practice methodology I was developing at the time through documentation as praxis. The next part of this thesis describes the site, its nuclear history, and its current use as a film archive. I will also profile the project proposals, planning, and methods undertaken during my on-site fieldwork, which took place primarily in the winter of 2021 and 2022. The chapter presents the site in the context of my practice piece titled *The Nuclear Archive: Sound Map* (2022); a sound mapping project that includes interviews, field recordings, photography, and written attunements to the various bunkers, modern buildings and earthworks that constitute the BFI archive site.

4.2 - The BFI Film Archive

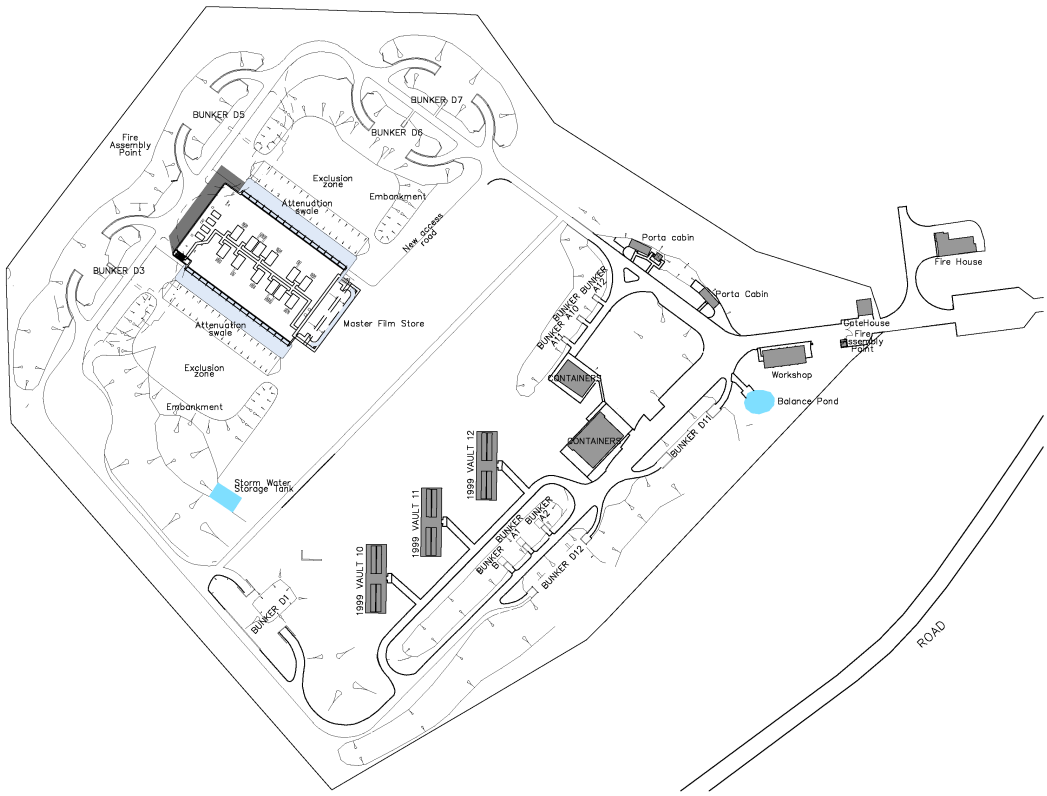

Figure 18. A map indicating each structure and point of interest at the BFI Master Film Store site in Gaydon, Warwickshire. The map details each of the remaining MOD buildings as well as the temporary and permanent structures put in place by the BFI.[187]

The British Film Institute is the UKs leading organisation concerned with the preservation, promotion, and production of moving image media in the UK, it is also custodian to the British National Film and Television Archive. As a part of this custodianship the BFI are tasked with storing, preserving, and providing access to millions of hours of film and televisual media. It is a task that is complicated by the wide variety of film technologies, media formats and the skills and knowledge that are required to maintain this cultural history. The Master Film Store located at the BFI facility in Gaydon is an archive building designed to keep the most sensitive and volatile of these materials in stasis. While the long-term futures of this cultural content can be further preserved through digitisation, duplication, and transference to other film media, the preservation of film material - acetate, polyester, cellulose nitrate

[187] 'BFI Gaydon - Map' (Image: map). Courtesy of The British Film Institute.

substrates and their audio tracks, are also considered vital to the archivists and technologists that work on the collection. In addition to the modern cultural-material-archive that sits at the centre of this eight-hectare site, the BFI utilise and maintain a series of vaults, bunkers, workshops, and outbuildings that are buried beneath mature trees, mosses, and bramble throughout the grounds. These structures, with their curved entrances and thick concrete walls are the remnants of a former MOD nuclear storage facility known as a 'clutch'; a Cold War era munitions depository that provided services and weaponry for V-Force era RAF Airbases, such as RAF Gaydon, which was situated two kilometres from the BFI site before its closure as a military airfield in 1974.[188] The practice described in this chapter questions if applying archival knowledge and techniques to a sound-based fieldwork can expose post-atomic legacies and cultures. As a repository of both film media and nuclear cultural heritage, the BFI site provides a unique platform for this.

Following my initial discussion with Frank Horn in February 2021, I asked if he could share with me any information about the site that may provide an insight into the nuclear history of the BFI archive. One piece of information he was able to provide was a radiation report that took place on the 17th of May 1990 (Fig. 19), which details the areas of the site that were tested for the presence of radiation owing to its former use as a nuclear storage facility. Although the report showed no activity that would fall outside of the normal parameters expected, I was intrigued to find that not all areas of the site were surveyed directly, also the report contains several caveats that warn of the potential for as yet undiscovered sources of radiation.

[188] The V-Force aircraft were Cold War era nuclear capable jets. See Section 0.3, 'The Academic Field: Nuclear Culture & Sound Arts Research'.

SITE SURVEY REPORT

Site: National Film Archive, Gaydon.

Date: 17th May 1990

Contact: Mr R.H. Belgrove
Head of Conservation
National Film Archive
John Paul Ghetti Jnr. Conservation Centre
Kings Hall Way
Berkhamsted, Herts HP4 3TP

Purpose of the Survey.

To confirm the absence of a radiological hazard on the site due to the previous usage for atomic weapon storage and maintenance.

Scope of the Survey.

The radioactive materials associated with this type of weapon are enriched Uranium, and more commonly Plutonium-239. The floors, walls and concrete work benches were monitored for alpha activity with a Mini/AP3 monitor. In addition, measurements of the external gamma absorbed dose were made using a calibrated Mini 6-80 monitor, to detect an external gamma radiation hazard from areas contaminated with enriched Uranium.

Limitations of the Survey.

The short range of alpha particles imposes limitations on our survey. Areas contaminated with Plutonium-239 which have been painted over, to avoid any re-suspension of active material, would not be detected and would not be a hazard unless construction work unearthed the contaminated areas. Such areas are commonly painted in a bright colour to indicate the presence of a contaminated area during future refurbishment.

The alpha measurements made apply only to the surfaces surveyed; any localized contamination away from the areas monitored would not be detected.

The survey is limited to the 4 bunkers indicated in the report, which were identified by the site manager as the areas where maintenance and storage of the weapons occurred.

Figure 19. An extract from the radiation survey report conducted at BFI Gaydon in 1990. This report took place in the development phase of the '1999 Vaults', the site's first purpose built, temperature-controlled archive buildings, that are still in use today.[189]

It is unsurprising to find that the buildings, at least on the surface, contain no alpha emitting radioactive substances, as you would expect this to have been surveyed in detail in the 1970s, but the buildings, their design and positioning around the site are directly representative of the materials and devices that were stored and maintained there. The physical presence of radioactive materials is an obvious point of interest when investigating sites with nuclear history, however, it is not a requirement for their continued communication of them. With this thought in mind, I proceeded to explore the direct history of the site as an MOD nuclear base of operations. Aside from a few references in texts, such as Steve Carvell's *Twentieth-Century Defences in Warwickshire* (2007)[190] and a handful of reports and surveys made public during the

[189] 'BFI Gaydon - Radiation Report' (Image: letter). Courtesy of The British Film Institute.
[190] See, Carvell, Steve. 2007. *Twentieth-Century Defences in Warwickshire* (London: History Press).

BFI's custodianship of the site since the 1970s, there is very little information available on the actions and purposes of the buildings, structures and their remaining fixtures and fittings. In addition to this, much of the information that the BFI hold on the site's history is limited to the building's surveys and any other information the MOD had provided at the point of sale, more than fifty years prior. The site, therefore, presented as safe, unexplored, and culturally rich. Its modern function as a cultural archive offered a fascinating correlation to its former use as a safe storge site for nuclear materials and opened many avenues for generating practice within this research.

Having established the suitability of the site for a potential fieldwork, I constructed a proposal for a residency at the archive, which was to be a mix of fieldwork and conventional archival research. I planned to spend up to a month on site, visiting regularly to explore the grounds and buildings, and document my discoveries. This initial proposal advocated for an archival research project that included the content, media, buildings, grounds, and history of the archive in a practice-led outcome and included a review of any nuclear related film materials that are stored at the archive. The first proposal was submitted on the 2nd of July 2021, and after a long wait, was rejected in September of the same year. The reason given by the BFI was a lack of resource, but there also appeared to be some uncertainty about the suitability of a research project built around a residency at the site. A re-written proposal that instead of a residency, requested an undefined number of visits to the site, was eventually approved a month later and the project could go ahead.

[BFI Project Timeline: Key Dates and Tasks]

TASK NAME	START DATE	END DATE	DURATION in days
Initial Planning Meeting	01/11/21	01/11/21	1
Research and Development	01/11/21	17/11/21	17
First Visit to Gaydon	17/11/21	17/11/21	1
Compiling audio and visual materials	17/11/21	01/12/21	15
Second Visit to Gaydon	01/12/21	01/12/21	1
Editing and arranging recordings and images	01/01/22	01/03/22	60
Development of film media project	15/02/22	01/05/22	76
Practice proposal and approval of final site visits	20/05/22	16/08/22	89
Websites converted to 35mm Film Reel	02/08/22	09/09/22	39
BFI Berkhamsted visit for VHS transfer	20/09/22	20/09/22	1
Editing of footage from Berhamsted	21/09/22	26/09/22	6
Third Visit to Gaydon	29/09/22	30/09/22	2
Production of final works - sound map, vhs archive film, 35mm film cut, and books	01/10/22	20/11/22	51
Presentation of work at Tabloo - Dessel, Belgium	22/11/22	24/11/22	3

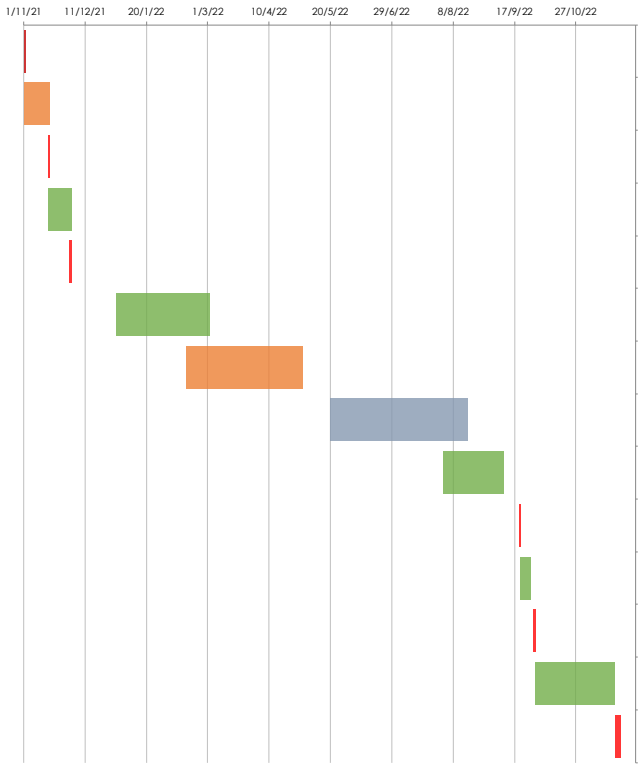

Figure 20. A chart detailing the timeline of key events for the BFI practice. Key dates and events are marked in red, research and development in orange, and practice in green.

Access to the site was initially restricted to two visits, I was permitted to record still images and audio on site, but video recording of the grounds and buildings was prohibited.[191] Working with these limitations in mind, I began to formalise a plan for the visits taking place in November and December 2021. The two visits would be an information gathering exercise, at the time, it was not clear if any further access would be granted beyond this, so it was vital to return from them with as much information, recorded audio, and images as possible. Taking the map of the site (Fig. 18) that had been provided to me by the archivists at the BFI, I planned to record audio of each of the points of interest that are visible on the map. As well as these field recordings, I wanted to capture my movements around the site, while taking in interviews with the archivists and technicians working there.

[191] These limitations did not extend to the filming of my activities with the technologies at Gaydon or my visits to other BFI sites that feature in the final chapter of this thesis.

As is demonstrated on the timeline for the archival research and the subsequent practice outcomes (Fig. 20), following my first two visits to Gaydon, there was a break of almost a year before revisiting the site. During this time an exhaustive process of editing and organising the material from my visits in 2021 resulted in a pitch to the BFI for further access, which was granted in August 2022. In Chapter Five, my investigation of the site is extended to a series of film and video-based works that explore the site in the context of its role as a media archive and former nuclear material depository. It would not have been possible to produce these later works without the act of listening and information gathering that the sound mapping project described in this chapter conducts.

4.3 – *The Nuclear Archive: Sound Map*

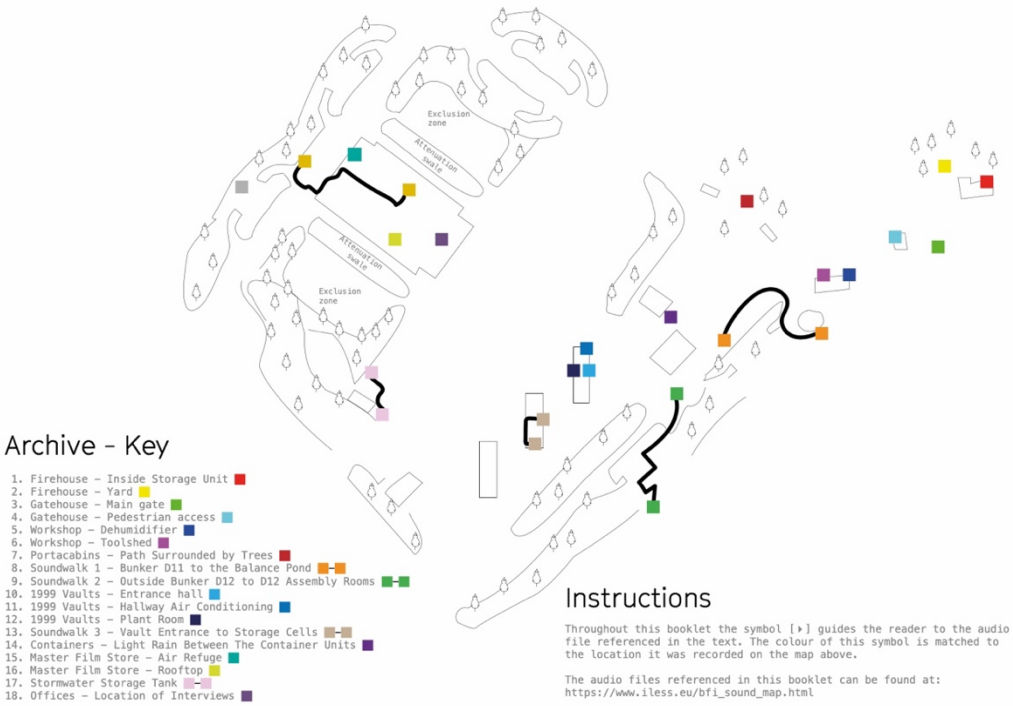

Figure 21. A double page spread from the booklet containing the map and locations of each of the areas visited during my research.

The Nuclear Archive: Sound Map is compiled from the audio recordings and images gathered during my initial visits to the BFI archive. It also features interviews collected in 2022 with Pete Sharp, a veteran Cold War armourer and Charles Fairall, who is a BFI Technologist. The work is presented as an audio booklet containing a weblink to a selection of edited audio clips, tracing a route through the sonic environments of the surrounding land and aural architectures of the buildings contained within the BFI archive site. When navigating this sound practice, I encourage you to think and listen beyond the immediate recorded encounter, to attune to the presence of the nuclear in these recordings it is important to understand the contents of the listening platform that I provide and to activate through listening, the methodology that I have described in the previous chapters. The booklet is included in this thesis in a pocket of the back-cover of this document, a digital copy can also be found on the USB Media in a folder titled 'Sound Map'.

Action: Please turn to the pages titled 'The Firehouse' in the booklet and listen to each of the six tracks that are referenced on these pages.

Listen: https://www.iless.eu/bfi_sound_map.html

USB Media Location: Sound Map > Audio Referenced in Thesis

> *[A1] The Firehouse is situated near a small, wooded area just outside of the main gate leading to the BFI archive, the redbrick building is an original structure that stands slightly elevated from the access road that forks away to the left as you enter the site. Inside there is a double height room with a mezzanine floor and staircase added at some later date by the BFI. Rows of storage shelves stretch out across the full length of both floors and the walls are covered in a peculiar wooden panelling the purpose of which neither the archivists nor Pete can explain. A large chrome-silver dehumidifier sits near the entrance, emanating a sound like white noise - the audible funnelling of air pervades the whole space.*

The mapping of this location begins with a field recording of the inside of the firehouse building and a short observational piece of writing that offers a descriptive sonic atmospheric attunement to the space and the audio that I have captured. Field recordings within the booklet are commonly accompanied by this style of descriptive writing, which is a technique that I have developed through my attunements to my workshop practice in the first two chapters of this thesis. However, there are examples

of locations throughout the sound map where this approach is not used. 'The Portacabins' and 'Containers' pages within the booklet are both examples where the page itself carries no descriptive text, instead I have chosen to include some of Pete's more personal recollections of his time as a nuclear armourer. It is my intention that the field recordings in these examples become conduits for these memories to intermingle and return to the site of their origin, as an activation of sound as anamnestic effect.

Figure 22. A double page spread from the booklet on the page 'Containers'. Listen: Audio 1 - Field Recording: Light Rain Between Container Units and Audio 2 - Pete: Nobody Ever Mentioned QRA at https://www.iless.eu/bfi_sound_map.html.

Each page could be described as a 'noise-print' - a sound capture of a unique part of the site that reveals the *always*-effects of their nuclear associations as well as their function within the modern media archive. The transcription below returns us to the Firehouse, where the connection between the site's nuclear history and archival use is made clear in the written descriptions that accompany Helen and Pete's interviews on the subject of this out-building.

[A2] During an interview at the BFI offices, Helen describes the importance of the neutral temperatures provided by the Firehouse for archival storage, the presence of dehumidifiers throughout the site is a common element of the sonic environment within both the MOD era buildings and the structures built by the BFI. For the BFI modifying the humidity of these older structures allows them to become effective temporary storage facilities, or transitional spaces for media and materials that are entering the archives.

[A3] Pete is in his mid-eighties and a veteran armourer with direct experience handling the same Cold War era nuclear devices that were stored and assembled at Lighthorne Rough. He is wearing a cap and faux-leather jacket that crackles and squeaks as we talk and move around the site. For Pete, the presence of an extremely large iron girder brings into question the documented original use of the building as a firehouse – instead, he suggests that the building may have been used to transfer heavy weapons from convoys entering the site to trolleys for transportation inside the secure area, a functional purpose that isn't far removed from the archival usage that Helen mentions. This is the first of many correlations between the archive's use of the buildings and their nuclear history, where the protective remit of the archive is enmeshed with the high-security design features of the bunkers and MOD buildings that populate the grounds.

[A4] Pete's enthusiasm and knowledge of the V-bomber era of British nuclear military history is abundantly clear but it takes just a few minutes before memories of the fear and uncertainty of this era of nuclear military history also enters the discussion.

[A5] Pete shares with us the story of how he came to be an armourer for the MOD. It is interesting to hear that Pete initially intended to apply for a position as a military photographer, this hadn't come up in our previous discussions. Had he persevered with this ambition it is entirely possible that his work with film could have found its way into the Master Film Store here at Lighthorne Rough.

It is through the linking of Pete's personal recollections of the Cold War period and his research and knowledge of each of these buildings, that a post-atomic aurality begins to emerge. The recordings, images, and interviews, although consigned to historical document are codified as praxis; in their documentary form they remain an activation of recollection and knowledge. *The Nuclear Archive: Sound Map* is an engagement of the fragility of time-based media, where the preservation of recorded sound, film and video are the focus of an archival future for these materials. It is an active querying of the site as a base of nuclear operations that is uncovered through Pete and the archivists' discovery of it. The associations between time-based media and nuclear and archival futures forms the basis for the works described in Chapter Five and further

develop the potential for post-atomic auralities to emerge from this type of sonic ethnography.

The archivists at the BFI consider these associations in the context of film preservation, where the archiving of film material to digital formats is a risky undertaking reserved for the purposes of improving access to the material within the archive or for the retention of film and televisual content that is received into the archive on media that is at greater risk of damage or deterioration, such as magnetic tape formats. These issues of suitability, access to site, and preservation are comingled with concerns around atomic landscapes and are taken up within this research in the examples of practice that I will explore in the next chapter of this thesis. Dealing with these complex interactions initiates a line of questioning around how the site of practice is established within a landscape and space of the post-atomic. In my introduction to this thesis, I described this research as a challenge of the post-atomic in respect of its timelines and the realities of its material futures. *The Nuclear Archive: Sound Map* takes up this aim in respect of the first of these challenges. In the discovery of this unique landscape of media archive and nuclear bunkers, I have undertaken a sonic ethnography that queries the relationships between the aural, atmospheric, and post-atomic cultures that surround the site. It is an exploration of the aural conditions of the archive that is inclusive of the enduring nuclear cultures that surround the grounds, buildings, and media of the film archive.

4.4 - Archive and Aurality

Kathleen Stewart describes the observation of these kinds of relationship as an 'atmospheric attunement', for Stewart it is a practice process that aims to include the 'sentience of a situation' within the written account of them.[192] In *Atmospheric Noise: The Indefinite Urbanism of Los Angeles* (2021),[193] Marina Peterson uses the same

[192] Stewart states that 'what affects us - the sentience of a situation - is also a dwelling, a worlding born from an atmospheric attunement.' See, Stewart, 'Atmospheric Attunements', p. 5.

[193] Peterson, Marina. 2021. *Atmospheric Noise: The Indefinite Urbanism of Los Angeles* (Durham, NC, USA: Duke University Press).

methods of attunement to incorporate the influence of noise and atmosphere through an archival study of the Los Angeles Noise Abatement Zone; a large land area including streets and houses set for demolition on condition of their proximity to the airport. Throughout the book Peterson engages in an act of sonic atmospheric attunement that takes its subject from John Divola's photography of the area before it was demolished in the 1970s. The images that Peterson engages with and the archival research that she has conducted are used as a conduit for understanding sound and atmosphere, as well as their interactions and influences. *The Nuclear Archive: Sound Map* engages with the BFI archive in a similar way to Peterson's study, where sound and atmosphere is considered in its potential to communicate the post-atomic auralities of the archive 'as a quality coalescing across multiple registers: that of the aerial and the ephemeral, dynamic relationships between forms of matter, and the indeterminacy of forms and concepts.'[194] For Peterson, attuning to noise is 'an attuning to the atmospheric' it is a process of opening up to the sentience of the situation that Stewart describes, and through her archival research Peterson activates Divola's images as an act of listening. This is an approach that is reflected in the development of my concept of noise-prints, where the aural remnants of post-atomic effects can be captured and reproduced through sound arts practice.

Peterson's study demonstrates how practices of listening can reveal the aurality of archive materials and she adapts her sonic ethnography to this effect. Along with her co-author Vicki Brennan, Peterson calls for a 'a sonic ethnography that focuses on listening, departing from an investigation of a soundscape to one that attends to how people listen.'[195] *The Nuclear Archive: Sound Map* conducts a sonic ethnography that shares in this endeavour, where interviews take place within the sonic field of the bunkers, films and technologies that are their subject. Following Peterson and Brennan's sonic ethnography my investigations of the post-atomic auralities of the BFI archive generate a collection of materials that 'consider how field recordings are caught up in their event, providing material that helps one hear that event along with those who are there, participating in it and with each other.'[196] The concern of this

[194] Peterson, 'Atmospheric Noise', p. 5.
[195] Peterson and Brennan, 'A Sonic Ethnography', p. 372.
[196] Ibid., p. 374.

research is to uncover how the post-atomic aurality of nuclear sites can be captured and reveal themselves through creative practice. It is a practice that is aligned with Stewart's observation of the 'sentience' of a situation and Peterson and Brennan's sonic ethnography; however, this process of observation faces unique complications when activated within sites of nuclear activity.

4.5 - The Nuclear Site and Non-Site

In the Second Chapter of this thesis, Robert Smithson's work is introduced as an example of a practice of documentation, a process of 'reporting as seeing'[197] where the textual representations of his works surpass the boundary of documentation to art objects. Due in-part to the often remote and vast nature of their chosen site of work, land artists such as Robert Smithson utilised a toolset of documentation, such as, text-based works, photography, and other visual media, to develop the concept of a 'non-site' artwork. Smithson was key to a group of artists associated with the 'land art' movement that emerged within the Cold War period of the mid-twentieth century, where 'artists moved their production directly into the land, creating works that can be experienced only at the outdoor site of their making.'[198] According to James Nisbet (2014), the 1968 'Earth Works' exhibition featuring works by artists including Robert Smithson and Robert Morris, represented a 'watershed moment' in establishing the importance of site-specificity within the visual arts.[199] Influenced by the science fiction novels and films of the mid-century and the geological and ecological significance of the material and site of work, Smithson sought to represent sculptural artworks 'as if they were alien entities' that 'appear to their spectator without any presumption of historical or ecological boundedness.'[200]

In contrast, the 'non-site' work that Smithson defines is a mobile, accessible representation of these 'ecologically bound' site-based works, which can be

[197] White, 'Unnatural Fact', p. 165.
[198] Nisbet, James. 2014. *Ecologies, Environments, and Energy Systems in Art of the 1960s and 1970s* (London: MIT Press), p. 4.
[199] Ibid., p. 93.
[200] Ibid., p. 92.

represented within a gallery setting. 'The non-site was a category of work that could be displayed in a gallery, including sculpture, photographs, film, and even textual material. Work at a site cannot travel, be reproduced, or be experienced anywhere other than the specific location where it resides in the land.'[201] In the context of artwork that draws from or is activated within post-atomic landscapes, the non-site artwork can be employed not just as a useful tool for relocating artwork from potentially dangerous environments, but also as a device that is able to expose the radioactive threat, sociological trauma, and the stories of effected lands and communities.

Noi Sawargi's essay titled 'Don't Follow The Wind' (2016)[202] profiles an art exhibition of the same name, situated within the Fukushima evacuation zone. The exhibit, which was installed in 2015, situates a significant number of artworks within some of the most contaminated lands effected by the fallout of the meltdown at the Fukushima Daiichi Nuclear Power Plant. Although the works cannot be visited by members of the public, due to the highly restricted access to the area in which they are placed, for Sawargi this does not mean that the exhibition is necessarily closed. 'The works are there, installed as a matter of principle, on view every afternoon, night and morning, come torrential rain or tempest wind.'[203] The exhibition site is open to the wind, open to the growing mosses and seasonal shifts, in the same way that the art objects are exposed to the seeping radiation; ageing, decaying, and radiating, like a post-atomic-cultural relic.

In contrast to Cusack's 'sonic journalism', where a listener/practitioner observes the site for the purposes of documentation and with the intention of causing little or no immediate and lasting impact on the site itself,[204] these works are intended as permanent interjections within the post-atomic landscape of the Fukushima evacuation zone. Within the framework of art history, this disparate exhibition of works could also be considered a type of land art. These art objects situated within the

[201] Ibid., p. 93.
[202] Noi Sawargi, 'Don't Follow The Wind', in *The Nuclear Culture Source Book* ed. by Elle Carpenter (London: Black Dog Publishing, 2016), pp. 79-83.
[203] Ibid., p. 82.
[204] See Section 1.4, 'Technology, Sonic Ethnography'.

exclusion zone, expose, and come to represent the invisible ghostly presence of the manmade radiation that emits around, from and through them. The presence of these artworks in conjunction with the activeness of their surrounding radiation, resets their ecological boundaries to include their nuclear materiality. When considering the works of the 'Don't Follow The Wind' exhibition this resetting of boundaries is amplified and foreshadowed by the invisible threat of radiation. Their presence also evokes Susan Schuppli's description of 'material witness' which I have introduced in the previous chapter, where the works could be interpreted as existing as 'non-human entities and machine ecologies that archive their complex interactions with the world, producing ontological transformations and information dispositions that can be forensically decoded and reassembled back into history.'[205]

In addition to the works installed within the exclusion zone, a further exhibition titled 'Don't Follow the Wind Non-Visitor Center' was presented at the Watarium Museum of Contemporary Art, in Tokyo, 2015. The materials that were exhibited acted as representations of the works placed within the exclusion zone, generating what the land artists of the mid-century might describe as a 'non-site' work. In the context of Sawargi's essay, this exhibition represents an attempt to 'transpose the art which "cannot be visited", like radioactivity, into the "can be visited" exhibition, like a radioactive substance.'[206] In other words, we can consider the art in situ as a representation of the 'invisible-real' of radioactivity, where the non-site exhibition returns the object to the 'visible-real' of radioactive substance. Sawargi's essay suggests that the conditions of site, and accessibility of artworks, has the potential not only to change our understanding of the post-atomic landscape, but also to reevaluate its material, cultural and energetic connections. The non-site artworks of the 'Don't Follow the Wind Non-Visitor Center' perform a transduction of the atomicity of the site-based works through their exhibition. This process of atomic transduction is reflected in *Radionuclide Websites,* where instead of land or exclusion zone, the digital site is enlisted as a host to radioactive decay. In my practice I take this idea of

[205] Schuppli, Susan. 2020. *Material Witness: Media, Forensics, Evidence* (London: MIT Press), p. 3.
[206] Sawargi, 'Don't Follow The Wind' in *The Nuclear Culture Source Book,* p. 82.

transduction one step further in the creation of a set of hardbound books that represent these websites.

Figure 23. 'Sr90' (Strontium-90), one of the books in the series of hard-bound binary translations of the *Radionuclide Websites* titled the *Radionuclide Websites: Binary Code Book Set.*

The *Radionuclide Websites: Binary Code Book Set* (2022) consists of a full binary code translation of seven of the *Radionuclide Websites* as well as the jQuery library that the functions of the websites were built around. The book set exists as an exhibitable artwork, as well as an archival document printed on acid-free archive-quality paper stocks. The work has presented in gallery spaces, and at the Nuclear Energy Agency workshop in Dessel, Belgium that I discuss in detail in the final chapter of this thesis. The books were exhibited at 'Season' gallery in London, throughout the Winter of 2022-23 along with *The Nuclear Archive: Sound Map* and film materials from my research at the BFI (Fig. 24). The non-(web)site presentation of these digital nuclear materials transduces the websites to a text format and artwork, that carries with it the atomicity of the *Radionuclide Websites*. This translation of website to text document and artwork opens new avenues for the continuation of the *Radionuclide Websites* and mitigates for the threat of digital erasure and degradation that Igor Štromajer's *Expunction* highlights.[207]

[207] See Section 3.3, 'Radionuclide Websites'.

Figure 24. The Nuclear Archive: Sound Map, Radionuclide Websites: Binary Code Book Set, and other related works in exhibition at Season Gallery, London (2022).

Like the *Radionuclide Websites: Binary Code Book Set*, the sound map also exists as a non-site work and a transposition of the post-atomic that is activated within the BFI archive through a combination of Pete's recollections, nuclear mythologies, and sonic attunement. In the same way that Kyoko Hayashi's recollections of her visit to the Trinity Test Site narrows and enmeshes the timelines and consequences of the bombing of Nagasaki, Pete's recounting of stories from his days as a Cold War era armourer link the semi-derelict bunkers and the materials they housed to the reality of the BFI site as a modern media archive.

Although this is a fieldwork that documents the immediacy of a site of specific nuclear heritage, the outcomes are not confined to a sonic profiling of a space or landmark. It is instead an investigation of how the site can be engaged through sound arts practice; where fear of 'the bomb' and its potential for annihilation is recalled and reimagined by Pete it can also be retained through a sound practice that explores the vagaries of

site, document, and artwork. Through this approach, the infrastructures of nuclear material storage are preserved by their continued presence within the context of the BFI's media material archive. This is highlighted in the following piece of writing which is a partial transcript from the page 'Bunker D11' in *The Nuclear Archive: Sound Map*.

> Audio 1 - Soundwalk: Bunker D11 to the Balance Pond
>
> *Bunker D11 is one of the largest MOD structures left on site, it is twinned in design by the D12 bunker adjacent to it. The two bunkers serve as effective storage areas for larger items such as magnetic tape machines, film playback devices, cutting desks, and film projection equipment. This soundwalk begins in the far-back corner away from the bunker entrance, it's a dark room containing a large film viewing device and concrete table, topped with a copper plate. Above the concrete table, original light fittings and extraction hoods hint at its former use as a bomb assembly point. The dehumidifier at the entrance reverberates differently through each of the rooms as I work my way back to the entrance hall and outside to the balance pond; a small haven for birds, surrounded by blackthorn and rosehip. On the outskirts of the archive's grounds the road can be heard more clearly in the distance than at other locations on site. The funnelling sound of air through the D11 dehumidifier can still be heard behind the large, closed steel door.*
>
> Audio 2 - Helen: Bunkers D11 and D12
>
> *Atmospheric regulation is relatively simple in bunkers such as these, their thick concrete walls are encased in earth and plant life that insulates them from the influence of external forces. This inherent defence mechanism, paired with dehumidification devices allows them to become excellent repositories for technical equipment, much of which is no longer in production but is still required to secure the future of the materials and their content that the BFI archivists are charged with protecting.*
>
> Audio 3 - Pete: The Shifting Lobby
>
> *For Pete, navigating the narrow halls and rooms filled with film production lights, screens and devices, the bunker's nuclear history remains in abundance – a pitch floor, lightning conducting clips, wooden barriers, and original door frames, all contain memories of the functions of handling nuclear materials in bunkers such as this.*
>
> Audio 4 - Pete: Bomb Storage
>
> *Pete is in many ways the living embodiment of the film archive devices that surround him. There are few traces here of the materials and technology that were once handled here, but their presence is evocatively reintroduced to this space by Pete's recollection of them. Pete's voice re-telling the precise nuclear*

histories of the site within the bunker's walls, performs a sonic transduction of space, memory and knowledge that is amplified within the reverberating chambers and hidden corners of the bunker.

These audio recordings and their accompanying texts are examples of the methodological approach that I have outlined. Within the sound map they are a sound and text-based record of a practice of sonic atmospheric attunement. The modulating presence of modern dehumidification and refrigeration devices that pervade the recordings, are an evocation of the thermal auralities that I have explored in the Second Chapter of this thesis.[208] Feeding back to my early experimental practice of *Writing for Window Boxes*, the aural architectures of the site of practice are also revealed through a documentation as praxis approach that includes sounds and images captured during the act of making. This approach is a demonstration of how post-atomic auralities are energised by their atmospheric conditions, it is a discovery of how sound can generate and influence new cultures and knowledge, such as Pete's storytelling and his observations of a site of nuclear heritage and active site of practice, or Helen's shared knowledge of the importance of atmospheric regulation in archival storage. It is through the analysis of these interactions and the process of attuning to them that a method for revealing post-atomic auralities begins to unravel productively, generating encounters that expose the connectedness of sound and atmospheric influences.

4.6 - Chapter Conclusion

This research evolves, unfolds, and proliferates in the wake and waves of nuclear cultures, incorporating archive, site, documentation, data, and discussion into the practice process in an endeavour to understand the physical and cultural phenomenon of sound and its post-atomic contexts. *The Nuclear Archive: Sound Map* project is an exploration of these connecting influences; it is an observation of energetic exchanges

[208] Within *The Nuclear Archive: Sound Map* I refer to a developing concept of the 'thermo-aural'. This idea for communicating 'thermoception' through sound arts practice was a key concern at the start of my research journey but as my practice developed it was revealed to be a thematic concern best reserved for post-doctoral research.

or what Kahn describes as a series of 'energetic transductions',[209] where the sounds of dehumidification technologies and cold storage facilities are presented among the memories, stories, and the uncovering of knowledge through sonic ethnographic techniques. This is achieved by a sound arts practice that relies on the documentation of the various site visits and interviews with Pete and the BFI archivists.

Listening to *The Nuclear Archive: Sound Map* it is difficult to isolate the direct influence of our sonic-atmospheric surroundings; how might the cold weather, loud machinery and the interjections of birdsong, planes and light aircraft have influenced Pete's memory of working on sites such as this? Peterson describes this as attending to 'emergent forms and concepts; to interconnections and entanglements that are material, sensory, imagined, and social; to movement and shape-shifting forms; and to a proliferation of effects.'[210] In the following chapter I will expand my evaluation of Peterson's *Atmospheric Noise* in the context of my concept of noise-prints, where post-atomic auralities are captured within the recorded media of the archive. I will also describe a media-led exploration of the BFI archive site that engages the 'material, sensory, imagined and social' implications of nuclear material storage that Peterson describes.

Throughout this research I establish my arts practice as an experimental fieldwork and engagement of atmosphere. The methodological approach that I have outlined includes a form of praxis that integrates the act and site of making through documentary methods that are attuned to the atmospheric influences of sound and environmental effects. In the opening chapters of this thesis, I have conducted a series of experiments that perform transitions between the influences of heat, sound and the less perceptible effects of radiation. Furthermore, with the digital practice, *Radionuclide Websites*, I have re-imagined the boundaries of my nuclear-sonic practice, where sound and atmosphere have been interpreted through the creation of novel digital-atomic materials. *The Nuclear Archive: Sound Map* described in this chapter is one of the outcomes of a partnership with the British Film Institute that

[209] See Section 2.6, 'Transduction'.
[210] Peterson, 'Atmospheric Noise', p. 8.

expands my experimental fieldwork to an unexplored site of nuclear cultural significance. In the next chapter, I present a series of artworks that query the interrelations of film, video, sound, and radioactive materials within the context of the BFI archive, and ask how this approach can further reveal the potential of the archive as a site of post-atomic listening?

Chapter 5: The Nuclear Archive

5.1 – Introduction to Chapter

This final presentation of practice within this thesis was co-activated by the fieldwork undertaken during the making of *The Nuclear Archive: Sound Map*, where stories of deteriorating tape technologies, as told by the technologists at the archive site, and the creaks and drones of ageing MOD relics and modern dehumidifiers meet with the material substrates of film stocks and televisual media. The emergence of a memoir activated by Pete Sharp in the grounds and bunkers of the archive site are an example of how sonic ethnographies can combine with my practice of sonic atmospheric attunement to reveal post-atomic auralities. The work that I describe in this chapter performs a series of transductions, the basis for which I have explored through Douglas Kahn's writing on the relationship between sound and the electromagnetic spectrum in Chapter Two.[211] Each of the works that I present herein have evolved from my digital artwork *Radionuclide Websites*, and consists of the following three interlinked practice pieces and their multi-format outcomes:

- *Bunker D11* (2022, Installation & film)
- *The Post-atomic Ear – Radionuclides* (2021-2022, multi-format film media)
- *The Nuclear Archive* (2022, short film)

This chapter traces a route between these three works, describing the processes undertaken in their production and conducts an examination of the potential impact of an arts practice that engages with both media and nuclear material. From this analysis of my practice, I will further develop my concept of 'noise-prints', describing how they can be identified and reactivated by the location of their playback and the properties of their recorded media.

[211] See Section 2.6, 'Transduction'.

5.2 - *Bunker D11*

Figure 25. Film still from Bunker D11 showing the VHS tape deck and screen used for the final recording of the radionuclide materials at the BFI archive site in Gaydon.

Watch: https://vimeo.com/danbeck/bunkerd11

USB Media Location: Film > 6-Bunker_D11.mp4

Bunker D11 (2022) is an installation and film documentation that took place within the walls of one of the largest original MOD structures still used by the BFI at its archive site in Gaydon. Activated and shot on the afternoon of my final visit, the film presents the installation of a VHS tape deck playing back a transcoded selection of edited clips taken from *Radionuclides Websites*.[212] D11 still retains many of the original features from its use handling nuclear weaponry, including concrete and copper bomb assembly tables, storage units, lighting fixtures and other fittings. Among these MOD relics, the BFI now stores an arsenal of film cutting tables, video tape machines, projection and lighting equipment that span the history of film and televisual media.[213] Throughout this chapter, I will delve deeper into the various stages of transduction, documentation, archival research, and practice that were formative of both this and

[212] Although the BFI had placed restrictions on my filming of the grounds and buildings during my research, there were no similar limitations in place to prevent me from filming my practice on site.
[213] See, 'Bunker D11' in *The Nuclear Archive: Sound Map*.

the other practice pieces that I will introduce. Before doing so, I wish to dwell for a while on the sonic-atmospheric interactions that this final phase of practice from my study of the BFI site in Gaydon have revealed, and ask how these transformations of sound, site, and media engage the 'digital radionuclide' source as a tool for uncovering its post-atomic auralities.

In Chapter Three I make the case for the digital radionuclide and the inherent atomicity that the *Radionuclide Websites* project contains; where a digital radionuclide can move beyond the representation of atomic mass and decay, and act 'as a recognition of atomic burden, rendered in the practice I present.'[214] With *Bunker D11* I make use of these digital radionuclides to initiate a return of the radioactive substances that were once stored within the walls of the archive as a part of the UK's Cold War era nuclear armoury. This VHS tape is the final media-format-transduction of the web-based source material, having passed through several stages of conversion, to and from digital file to 35mm film reel, and video tape. The process has significantly modified the digital radionuclide source, once a crisp high-resolution sound and moving image, the VHS tape is now a carrier of multiple audiovisual artefacts, each one a voiced representation of the ageing technologies that the space now hosts. In addition to the familiar clicks and pops associated with ageing film devices, and the distinctive colour and grain of the physical 35mm film media, the sound and image also contains remnants of the archive itself. The atmospheric is present within the airborne debris, dust and hair that comes between the contact points of film reels and play heads, the technologists and I present through our physical contact with the film and video materials, the grease and moisture of clumsy fingers. Thermal interactions are also present in the warping effects of electrical components within the signal-chains of multiple tape-recording and film playback devices. Each of these captured elements coalesce into a noise-print of the Bunker D11 archive space that contains markers of the BFI's film and video technologies, the sonic architectures of a heavily armoured nuclear bunker and the materials they once protected. When considered in connection with the *Nuclear Archive: Sound Map*, each of these points of contact between these film media are further encoded with meaning; in Charles Fairall's shared knowledge of

[214] See Section 1.3, 'An Enquiry of the Nuclear in Sound Studies'.

video tape formats and the archivists' concern for the sustainability and preservation of the archive, for example.

Bunker D11 is an engagement of documentation as praxis and an evocation of Park's 'cultural atmospherics' that I reference in the Third Chapter of this thesis.[215] Documenting the playback of the radionuclides within the bunker walls conducts both a performance and capture of a post-atomic aurality that is unique to *Bunker D11*. This aurality is also present in my D11 recordings of Pete Sharp's stories of the feared consequences of the nuclear weapons he was once charged with protecting. It is this multifaceted 'voicing' of the archive, radionuclide, and space that distinguishes *Bunker D11* from other techno-oriented nuclear practice. Rather than entering the space as passive observer or flooding the space with sounds, speakers, and recording devices, in an attempt to uncover the 'hidden' presence of atomicity, *Bunker D11* communicates and engages with the space in the language of the archive. In doing so, it picks up accents, noise, and reflections that leave their mark on a range of recorded media that can become post-atomic carriers of them. Through a process of transduction, the audible tones, and visual forms of the digital radionuclide, like the croaks of the 'toads of trinity', are interwoven with the post-atomic legacies of the military complex that this site once served, as well as the threats of expiration, decay, and obsolescence faced by the media, its associated technologies, and the cultural content of the archive that now occupies the site in its place.

Bunker D11 is an example of the post-atomic auralities that this research sets out to find, where an atmospherically attuned call-and-response is enacted between the archive and the *always*-effects of its atomicity. The voicing of this installation within Bunker D11 evokes the alarms and sirens that signal nuclear disaster, while remaining in contact with the structures of the nuclear military complex, and the waste materials of nuclear energy production. This imprint of atomic burden is documented by *Bunker D11* in the capture of a unique noise-print of the BFI archive's site, media, and atmospheres. It is an approach that seeks alignment with Engelmann and Dyer's speculative feminist meteorology, and an atmospheric attunement which is

[215] See Section 3.2, 'Art, Air, and Atmosphere'.

constructive of 'an imaginary that is co-constitutive of the material, cultural and electromagnetic media through which it is produced.'[216] John Durham Peters describes media as 'vessels and environments, containers of possibility that anchor our existence and make what we are doing possible.'[217] *Bunker D11* presents as one of these 'containers of possibility', although the threat of radiation is not direct, it is anchored to Pete Sharp's collected historical accounts and the unique sonic reflections of the digital radionuclide traversing the atmospheres and structures of the nuclear bunker. In its documentation and presentation as both practice and archive material, *Bunker D11* is an 'ensemble[s] of nature and culture, *physics* and *techne',* [218] both in the context of the production of the digital radionuclide, and the contact points that I make as I travel with it on its journey through the cultural atmospherics of the nuclear archive.

5.3 – Noise-prints

> The atmospheric is audible as well as visible, heard as much as breathed. Substantiated in sound, it emerges in moments in which noise matters.
>
> – Marina Peterson[219]

Noise-prints are a formulation of unique sonic reflections. Activated through my sound arts practice, a noise-print can both interpret and document aural, atmospheric, and cultural effects that are revealed when observing the site and act of practice. Within this thesis my practice aims to enter into dialogue with the *always*-effects of the post-atomic, a task which is made more daunting by the almost limitless potential half-life of the discussion at hand. It is important therefore to understand *Bunker D11* as not just a voicing 'of' or 'in' the atmospheres of the archive, a distinction which I have interrogated in Chapter Three of this thesis, but also an act of listening, and point of

[216] Engelmann, Dyer, Malcolm and Powers, 'Open-Weather: Speculative-Feminist Propositions', p. 243.
[217] Peters, 'The Marvelous Clouds', p. 2.
[218] Ibid., p. 49.
[219] Peterson, 'Atmospheric Noise', pp. 5-6.

record that reaches out to the significance of the audible and visible atmospheres that Marina Peterson describes as 'moments in which noise matters'.

As I expose my digital radionuclide material through a series of media transductions, what emerges through the film documentation of *Bunker D11* is a tangled sonic thread, which is constructed from many points of contact within a milieu of atmospheric and cultural artefacts. This includes the sonic architectures of military structures, magnetic tape machines, optical audio tracks, digital glitches, and the hum of electronic circuitry, each contributing to the generation of a unique noise-print of the nuclear archive. It is also important to acknowledge my own presence within this messy network of interactions. Film and sound media are by their nature easily marked and in the same way that greasy fingerprints leave behind audible and visual traces, my presence within this noise-print is indelibly etched at each stage. In the Second Chapter of this thesis, I describe Peter Cusack's 'sonic journalism', where he acknowledges his presence within his recordings of the Chernobyl exclusion zone as 'essential' to his recorded materials. Within the context of *Bunker D11,* as with the invisible effects of radiation, my presence is much harder to detect than Cusack's footsteps on broken glass windows or dosimeter clicks, but I am equally 'there'. I am present in the hushed sounds of my movements and body during my process of documentation, in the design and programming of the *Radionuclide Websites,* in my decision to transcode the films through a specific series and type of media, my choice of recording devices, and the aesthetic placement of cameras and microphones.

Within the sonic field of this research my presence is most notable in the documentation as praxis approach that I undertake throughout, and this is a relationship that I will explore in greater detail as I conclude this thesis. Within the context of *Bunker D11,* my presence is one of noise generator, glitch architect, and human interlocutor, I am an example of Mark Peter Wright's 'noisy nonself'; 'silent authors, those who grip the microphone, become media phantoms within the signal and noise of sonic capture.'[220] I have used the term 'noise-print' throughout this thesis,

[220] Wright, Mark Peter. 2023. *Listening after Nature: Field Recording, Ecology, Critical Practice* (New York, NY, USA: Bloomsbury Academic). p.21.

however, within the scope of Wright's 'media phantoms' this terminology is further loaded with meaning. Where a noise-print can be a point of capture, a recorded signal, it can also be a mark, deliberate or coincidental, which is traceable to me, the archive, Charles, or Pete. Instead of a closed circuit, or sonic document, archival studies can utilise noise-prints through a process of 'critical audition',[221] where sound and specifically noise can act as a wayfinding instrument that 'prompts listening conversations that accommodate the forensics of building place, with sound, while recognising the dangers particular to that which we cannot, or do not, hear.'[222]

Figure 26. Pete stands inside a 'rabbit hutch' at BFI Gaydon, known to the BFI as Bunker A1 this space would have been used to store the nuclear war heads, also known as the 'Gauntlets' of V-Force era nuclear weapons.

[221] Wright describes critical audition as 'the pedagogical assemblage of materials and meaning'. Ibid., p.83.
[222] Ibid.

Listen: Track 2 – Pete in Rabbit Hutch A1

Link: https://www.iless.eu/phd_audio.html

USB Media Location: Audio > Track2-Pete-in_hutch_A1.wav

This recording was taken with Pete Sharp on location at the BFI Archive in Gaydon. In advance of our visit, the archivists had cleared away the bramble, nettles, and rosehips surrounding Bunker A1, allowing us access to one of a cluster of single chamber bunkers that run parallel with the road leading to the larger bunkers of D11 and D12. Pete's excitement at viewing this bunker is due to their use as storage units for nuclear weapons during the MOD's custodianship of the site. Behind a heavy, rusted metal door, in the centre of a concrete room no larger than two meters square, a large metal cap with a heavy weighted hinge mechanism covers a small hole in the ground, surrounded by thick concrete (Fig. 26). As we enter the room together Pete begins to explain how the bunker could have housed the 'Blue Danube' gauntlet, which was the radioactive part of the first British nuclear weapon brought into service. At 35 seconds in the recording, Pete tries to move the metal cap, thinking it is seized, he gives it a kick. You can hear in the recording the low frequency reverberation of metal-on-metal as the cap moves a fraction, a few seconds later the recording captures a wave of electrical interference. As I monitored Pete through headphones on the recording device and listened to his explanations, I wondered what might have caused this effect. It had not happened at any other point during our day on site or during my other visits to Gaydon. Could it be possible that Pete's kick had stirred up some radioactive remnant of the Blue Danube gauntlet? The site survey report that I included in the previous chapter found no trace of radiological activity at Gaydon, which while assuring, contained several caveats as to the limitations of the surveys that took place:

> *The short range of alpha particles imposes limitations on our survey. Areas contaminated with Plutonium-239 which have been painted over, to avoid any re-suspension of active material, would not be detected and would not be a hazard unless construction work unearthed the contaminated areas. Such areas are commonly painted in a bright colour to indicate the presence of a contaminated area during future refurbishment.*
>
> *The alpha measurements made apply only to the surfaces surveyed; any localized contamination away from the areas monitored would not be detected.*

> *The survey is limited to the 4 bunkers indicated in the report, which were identified by the site manager as the areas where maintenance and storage of the weapons occurred.*[223]

It is very likely that the audible interference occurring at this moment in the recording is purely coincidence, an anomaly, but the idea that this moment could be a release of dormant radioactive potential activates the interference as a post-atomic event by either interpretation. This anomaly is a part of a noise-print that combines the archival practice of capturing Pete's knowledge sharing, with the atmospheric conditions influencing the reverberations of our voices, the concrete and metal structures, and the presence of the long-tail of radioactivity's phantom effects. Attuning to these anomalies is an example of what Wright describes as 'following sound's flow', where both 'real and imagined, territories […] can be bridged by technology.'[224] Within the context of archival studies, such as this one, Marina Peterson's *Atmospheric Noise* provides a prerequisite to this understanding of the potential for noise to act as a carrier of atmospheric effects.

Peterson's study of the effects of noise on the communities and landscapes surrounding the Los Angeles International Airport in *Atmospheric Noise*, brings into focus the many ways in which archival studies can engage with atmosphere and noise. Following a method of atmospheric attunement, Peterson describes her sonic ethnographic approach as, 'rather than describing sounds I hear, I listen with others, attending to how they listen.'[225] Peterson's study is largely informed by what would ordinarily be considered 'mute' materials, such as photographic archives, historical documentation, and written testimony. Nonetheless, within her study, sound is engaged as a multi-faceted and networked atmospheric device, rather than seeking out sounds to capture, her sonic ethnography traces 'noise as it is heard and made meaningful',[226] for Peterson, this is actualised through a process of 'paying attention to emergent forms and concepts; to interconnections and entanglements that are

[223] See Section 4.3, 'The BFI Film Archive', (Fig. 19).
[224] Wright, 'Listening After Nature', p.112.
[225] Peterson, 'Atmospheric Noise', p. 7.
[226] Ibid., p. 8.

material, sensory, imagined and social; to movement and shape-shifting forms; and to a proliferation of effects.'[227] By transposing the radionuclide websites through the machines and media of the BFI archive, my captured audio is transformed by the movement of material substrate. Dust, heat and light combine within a matrix of physical contact points with the recorded sounds, where magnetic tape heads decode and transmit a 'shape-shifting' noise-print of the radionuclide material.

The image below (Fig. 27 - top) shows the 35mm film reel of the radionuclides, playing back on the Steenbeck Editing Table at the BFI site in Gaydon. My engagement with the radionuclide websites, the film technologies, and nuclear bunkers reflect Peterson's study, it is as an attempt to 'dwell in the vagaries, the gaps - where the formless begins to take on a form yet falters, where the sensible moves back into sense, taking shape as limits or exclusions that nonetheless have physical substance and qualities.'[228] Throughout this process I have returned to my workshop space as a place of 'dwelling' that is activated through my documentation as praxis approach. The second picture in the image (Fig. 27 – bottom) shows a homemade version of the BFI Steenbeck, where two turntables and a desk lamp with a baking paper diffuser were used for the cutting of the original film materials into individual frames and the radionuclide reels that form a part of *The Post-atomic Ear – Radionuclides* (2021-2022). I will explore this in greater detail in the next part of this chapter. In the same way that *Bunker D11* can be considered a vessel for my practice within the archive, its atomicity, media technologies and atmospheres, my actions with the home-made cutting table are equally generative of practice and re-enlist the radionuclides in the practice of experimentation that shaped my methodology.

[227] Ibid.
[228] Ibid., p. 13.

Figure 27. Top - Production still, radionuclide film on Steenbeck editing table at the BFI National Archive site in Gaydon. Bottom - Radionuclide Websites on my 'home-made Steenbeck' cutting table, a desk lamp and two turntables.

Peterson describes her approach as a 'flat' ethnographic methodology, more akin to an intersectional analysis of atmosphere that draws out 'indeterminacies that are in or across the message, that are meaningful in their exclusion.'[229] Where my methodology diverges from this is in the contribution of creative practice as integral to my research,

[229] Ibid.

it is a practice of coaction (a praxis of documentation), and in being so is openly more speculative, and generative in its documentary approach. Peterson's 'dwelling in the vagaries', however, strikes at the purpose of the methodology that I have brought forward throughout this research, where a sensitised observational practice of the act and site of making is enabled through documentation as praxis, and the generation of artworks that are attuned to atmospheric effects. The materials, sound, and visual works that I have produced as practice within this research could be interpreted as a series of complex techno-oriented experiments, but I would encourage you to consider them instead as a collection of sensitised art objects that present as a sonic engagement of the post-atomic. Whether present in the noise-print of Pete's interactions at the BFI archive or in my experiments with technologies and media, post atomic auralities are revealed through an expansive listening exercise that 'takes shape' in the crossing of the boundaries between the site and act of practice.

5.4 - *The Post-atomic Ear – Radionuclides*

Figure 28. Film still from The Post-atomic Ear – Radionuclides (original 2k Digital Video).

Watch: 'The Post-atomic Ear - Radionuclides (Original 2k Digital Video)', this digital video file represents the first translation of the website-based artwork to film media.
Link: https://vimeo.com/danbeck/radionuclides2k
USB Media Location: Film > 7-TPAE_digi_2k.mp4

The Post-atomic Ear – Radionuclides (2021 - 2022) are a collection of multi-format representations of the *Radionuclide Websites* that contributed to the development of both *Bunker D11* and *The Nuclear Archive,* which I will introduce in the final part of this chapter. The practice is a composition of digital and physical film materials, including, VHS and 35mm Polyester film, each of these formulations is composed from a fifteen-minute edited film, which collects one-minute samples of seven of the active radionuclide webpages as well as an accelerated version of one 'complete'[230] cycle of the website's functionality (the changing of colour and frequency until the website's expiry). This edited collection of original digital materials ends with a set of still images from my time exploring the BFI site at Gaydon and includes images of the grounds and buildings as well as the audio equipment used during the field study.

There are dual purposes to my decision to include these images – firstly, as a response to a site-based fieldwork within the BFI archive, the images at the end of the film are intended to help situate the radionuclide film within its space of activation, which is in some sense a time capsule added to the end of the reel. It is also a coda for this research that in the future could provide a reference point for the discovery of *The Nuclear Archive: Sound Map*, the sound recordings and their noise-prints, Pete Sharp, or even this thesis. In a further practical sense, these film stills provided me with a physical material representation of the BFI archive site at the moment that the work was initiated, which could be cut-up, modified, deposited, and discovered in the future. The inclusion of these images may appear initially to the viewer as arbitrary or disconnected from the preceding film content, however, as I will discuss further,

[230] Although the film contains frames that start and end in sequence with the entirety of the website's process, due to the limitations of capturing over 16 million possible variations within a seven-minute 24fps film capture, there are, in fact, millions of missing colours and patterns that are generated as the website completes its full cycle.

understanding the film as a material for distribution at this early stage, significantly expanded the potential for it to perform as an active participant within my practice.

The Post-atomic Ear – Radionuclides are also a multifaceted example of documentation as praxis, where documentary materials and the processes undertaken as a part of my research are joined together and activated as practice outcomes. My engagements with these materials within the BFI archive site explore how the materials and environments of the archive can be engaged as productive of practice. *The Post-atomic Ear – Radionuclides* challenge Groys' assertions on the dormant nature of art documentation, which I have referenced in the First Chapter of this thesis.[231] The films are an investigation of how the observation of archival practices (media transduction, duplication, and playback) can enlist document and archive as practice outcomes.

The Post-atomic Ear Radionuclides – Full List of Assets				
Title	Format	Res.	fps	Duration
The Post-atomic Ear - Radionuclides (Original 2k Digital Video)	H264, Stereo AAC	1440p	24	00:15:00:00
The Post-atomic Ear - Radionuclides (35mm capture for VHS transfer)	Apple ProRes 422 HQ, Linear PCM stereo audio	576p	25	00:14:46:00
Radionuclide - Cs137	35mm Polyester Film, Optical Stereo Audio	N/A	24	00:00:57:00
Radionuclide – Sr90	35mm Polyester Film, Optical Stereo Audio	N/A	24	00:00:57:00
Radionuclide - Cs134	35mm Polyester Film, Optical Stereo Audio	N/A	24	00:00:57:00
Radionuclide – Pu242	35mm Polyester Film, Optical Stereo Audio	N/A	24	00:00:57:00
Radionuclide – Kr85	35mm Polyester Film, Optical Stereo Audio	N/A	24	00:00:57:00
Radionuclide – Pu240	35mm Polyester Film, Optical Stereo Audio	N/A	24	00:00:57:00
Radionuclide – Cm244	35mm Polyester Film, Optical Stereo Audio	N/A	24	00:00:57:00
Radionuclide - Frequency & RGB Colour	35mm Polyester Film, Optical Stereo Audio	N/A	24	00:07:30:00
The Post-atomic Ear – Radionuclides (VHS)	VHS (PAL), Linear Stereo Audio	576p	25	00:14:46:00

Figure 29. A table listing each of the exhibitable elements of 'The Post-atomic Ear – Radionuclides'. The 35mm film reel has been cut into individual reels, each containing one of the radionuclides included in the original film. The VHS tape is currently only available in its

[231] See Section 1.7, 'Documentation as Praxis'.

full-length format, although it can be duplicated as a collection of short clips in the same way as the 35mm film reel edits.

The Post-atomic Ear – Radionuclides can be exhibited in-part, as individual film titles, or as an ensemble piece composed of a collection of digital, 35mm, and VHS transmediations of the source material (Fig. 29). Each process undertaken during this experimentation with film media and nuclear material half-lives transforms the audio-visual source from digital copy (on more than one occasion) to polyester substrate, and magnetic tape, collecting audible and visual artefacts of each of these technologies as they progress. During my investigation of the BFI site at Gaydon I collected a large number of interviews with technologists and staff at the archive. Discovering the archive through this sonic ethnography realigned my understanding of the site as an archive not just of film but of post-atomic effects. Listening back to the interviews and recordings that I made between visits, the correlation between the site's former use as a nuclear storage facility and its current function as a cultural archive became increasingly apparent. While compiling and editing my recordings from my initial visits I started to consider the potential for the archive to be activated, not just as a storage site for the work that I was collecting and creating, but also as a participant in the development and preservation of the archive itself.

The Post-atomic Ear – Radionuclides are the result of a combination of programmed audio-visual effects (the website visualisations and frequency changes), research documentation, technological skills and machinery, and the historical association with nuclear materials within the BFI archive site. Each constituent part of this work has a unique relationship with the history of Gaydon and the BFI archive, both culturally and directly through their physical grounding in the site, its technology and methods of cultural preservation. As an ensemble work, they enable us to trace what is present within the noise-print of *Bunker D11*, like an overlaid blueprint of a complex device. Before I come to my final practice piece *The Nuclear Archive*; a short film that documents the many varying ways that I have utilised these film materials, I will first outline how my engagements both at the archive in Gaydon and in a number of other locations have contributed to this body of work.

5.5 – Archive and Practice

Figure 30. Top-left: Original capture of web-based radionuclides, top-right: film cannister containing 35mm Cinevator transfer, bottom-left: BFI Berkhamsted, a technician works on the digitisation of the 35mm print for transfer to VHS, bottom-right: production shot from the recording of the 'Bunker D11' installation.

The work undertaken to preserve and retain the films that are situated in the BFI archive is reliant on a network of resources. This includes multiple locations, film laboratories, technical equipment, and the skilled technicians that operate and maintain them. I have described *Bunker D11* as an example of John Durham Peters' understanding of media as both 'vessel and environment' for the post-atomic effects of the BFI archive. The image in (Fig. 30) illustrates the journey that these materials have taken as I worked with them in my home studio, with the BFI technicians at their film laboratory spaces in Berkhamsted, and in Gaydon's bunkers. The film cannister in the image (Fig. 30 - top-right) contains the Cinevator print, a technological process that allows a digital copy of a film or set of images and/or sounds and subtitles to be directly transferred to 35mm polyester film stock. The Cinevator is a machine

developed by the Norwegian company Piql, it allows filmmakers and film custodians to create 35mm prints of films that were otherwise produced entirely digitally. As well as manufacturing the Cinevator, Piql offer an archival service that utilises 35mm film as a storage medium for digital files, where binary code is printed directly to film frames. This method of applying binary code as an archival language for a physical medium is demonstrated within this practice through the printing of archival quality books containing direct binary code translations of the *Radionuclide Websites*.[232]

From the perspective of the BFI archive, the Cinevator process is in many respects the reverse of what media archivists and their curators have set as their priority over recent years, the digitisation of physical materials, either due to the threat of material decay and obsolescence, or for the purpose of duplication and the improved accessibility of an archive's stored assets. However, as Piql's archival use of the format testifies, modern film stocks are now made from very stable and resilient materials, with lifespans that can survive for centuries, and given the ideal conditions provided by the temperature and humidity regulation of a modern media archive, the potential for these materials to outlive their digital duplicates is a very real prospect. Throughout my interactions with archivists at the BFI, the importance of 35mm film material was repeated to me on multiple occasions. These discussions with the archive technologists inspired my decision to use *The Post-atomic Ear – Radionuclides (original 2k Digital Video)* as the source content for a 35mm film print that I had made using the Cinevator process.

Transcoding the project from a web-based artwork to digital video, and 35mm polyester film, transforms the work, not just in respect of its timeline, but also in regard to the perceived value of its newly acquired material form. This transduction of web-based work to film material also initiates a transformation of the *Radionuclide Websites* from a media of transmission to a recorded format. Kyle Devine states that 'media of transmission overcome space but cost time, while media of recording overcome time but cost space.'[233] By attuning *The Post-atomic Ear – Radionuclides*

[232] The *Radionuclide Websites: Binary Code Book set was* included in my exhibition of works at 'Season' gallery in Hackney, 2022. See Section 4.5, 'The Nuclear Site and Non-Site'.
[233] Devine, 'Decomposed', p. 152.

through a practice of transduction, can a state of flux be observed between the recorded material and its transmission, and how might this query the boundary lines of Devine's definition?

The image (Fig. 30 - bottom-right) shows the recording of the installation piece *Bunker D11,* in this image you can see the original MOD era doors, that Pete had informed me earlier that day were double hinged so that in the event of an accident with the explosive materials handled in the bunker, the doors could be swung open in either direction. Immediately after my recording in D11, in a BFI van parked outside the bunker, I conducted an interview with Charles Fairall, a specialist technician and expert in tape technology. The interview with Charles took place on a chilly, late-afternoon in November, between us on the dashboard, a shotgun microphone nestled atop a pair of thick winter gloves captured the closeness of the compact van cabin. Editing these interviews, my open-backed monitoring headphones are a porous membrane; my voice part-muted by the polar-pattern directionality of the microphone, there is a scattering of hardy winter birds singing in the nearby balance pond. Having talked for more than an hour about the technologies and history of the BFI's video tape archive, we came to the subject of duration.

Figure 31. The Post-atomic Ear – Radionuclides 35mm Cinevator print, pictured pre-edit on a spooling machine on the day it was captured for video tape at the BFI Archive site in Berkhamsted.

Listen: Track 7 – Charles Fairall – What Will Last?

Link: https://www.iless.eu/phd_audio.html

USB Media Location: Audio > Track3-Charles-What_Will_last.wav

> **Charles Fairall:** *I think it's really important to consider the scale of what it is you're preserving. What you have is a few minutes of content, so in the scheme of things, it's a very small amount of electronically generated media. What you've done with it, to commit it to film, works fine for the confines of that project but if you were to apply that to the same principle of a million television programmes the idea about producing half a million hours of 35mm film material, that doesn't make so much sense. In an isolated case where you have very fragile technology, which is your website, I think it's a very interesting proposition to put it on 35mm film.*

For Charles, the *Radionuclide Websites* exist as a 'small amount of electronically generated media', this is an understandable, and in-part, accurate observation for a film technologist to make, especially when presented with my process of creating a linear capture of one minute of film per radionuclide site. However, there is an alternative viewpoint that runs counter to this evaluation of the scale of the task he describes in comparison to the work that I have created. If we take, for example, the Radionuclide Website, Plutonium-240's conceptual timescale of 6,561 years in relation

to the one minute of its associated captured footage on digital, film, and VHS tape.[234] The project can be evaluated as aligning more closely to the large-scale endeavours of a media archive, such as the one at the BFI that Charles describes. Charles' example of a million television programmes, averaged to a length of 30 minutes per show, captured at 24fps, would generate an archive with a total running time of 30 million minutes of sound and moving image. In contrast, the Radionuclide Website, Plutonium-240, with its theoretical duration of 6,561 years would generate, over the course of the half-life of its associated radionuclide, 3,448,461,600 minutes of moving image and sound. At current prices, a Cinevator print of this length would cost £114,948,720,000 to produce and would have an end-to-end length of 95,553,736 kilometres.[235] When it comes to understanding the impacts of radioactive isotopes, numbers are very important.

What this highlights is that the act of capturing one minute of the half-life of this project should be considered as much a large-scale performance of erasure as it is a small-scale act of preservation. The practice I present here is a document, a touch-point, and bridging of the timelines of the archive and of radioactivity. It is a witness to isotopes of Krypton, Strontium, and Caesium. As an audible frequency and spectrum of colour, locked within a timeline of atomic mass and archival futures, they are both container and vessel for an imprint of JavaScript, film substrate, and the play heads of magnetic tape. *The Post-atomic Ear – Radionuclides* are a presentation of the millennial timescales of the half-lives of radioactive materials enmeshed with the conceptual duration of their web-based transmission. In addition, they are investigations of the technological limitations of each chosen recording device and its associated material media. Through this process, *The Post-atomic Ear – Radionuclides* perform a transduction of the *space*-time of Plutonium-240 to the language and material of the film archive, but they also highlight their weaknesses as a platform for this and proffer challenges to the function, curation (what is to be erased or included), and the preservation of the wider archive's assets.

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[234] See, 'Plutonium-240'. [n.d.]. *Iless.Eu* https://plutonium-240.iless.eu/ [accessed 2 April 2024].

[235] These figures are based on the quote acquired for the film print of *The Post-atomic Ear - Radionuclides*, which was received from the film printing company 'CPC London Ltd' on the 9th of August 2022.

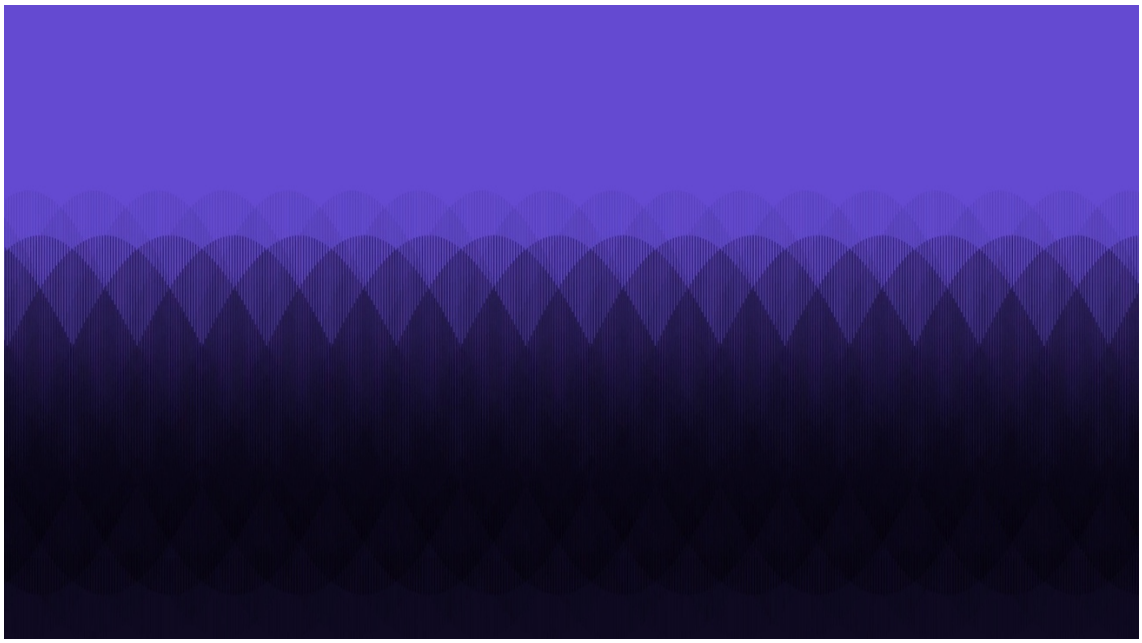

Figure 32. A survivor against all odds – one still-frame from the seven-minute cycle of colours and tones that avoided the erasure of the recording process undertaken in the making of The Post-atomic Ear – Radionuclides.

Charles' evaluation of the project aims and his comparison of it with the feasibility for the long-term storage of large media archives, is reminiscent of the many conversations that I have encountered throughout my research with academics, artists, and institutional representatives of nuclear institutes and companies, whose interests circulate around the post-atomic consequences of our nuclear actions. For the purposes of this practice, the media of the audio-visual archive have allowed my digital radionuclide source-materials to be truncated, instantly shedding much of their atomicity through a process of transduction. This process has allowed them to transition between programme and document, live-score and recording, electronic signal and material. The websites' inherited atomicity is linked to a process of continuous audiovisual transformation that is inseparable from the length of the radionuclides' half-life. In other words, their atomic weight or burden is shed through the transduction of the site to film media and the limitations of its frame rate and physical medium, and yet, the half-lives of the radioactive materials they represent continue to have no such short-cut. In my final practice piece that I present as a part of this research, *The Nuclear Archive* (2022) documents the activation of these film-based

radionuclides throughout my research and introduces them to a new site of current nuclear activity.

5.6 – *The Nuclear Archive*

Figure 33. Film still from 'The Nuclear Archive' (2022).

Watch: *The Nuclear Archive*

Link: https://vimeo.com/danbeck/nucleararchive

USB Media Location: Film > 8-The_Nuclear_Archive.mp4

The Nuclear Archive (2022) is a film that presents each location, transposition, and activation of the Radionuclide Website materials during my research. It is a practice outcome that presents as both an exhibitable art film and as a piece of documentation as praxis. It was exhibited alongside other nuclear focussed art at 'Radiant Objects: encounters in the nuclear age', Fringe Arts Bath in 2023.[236] As well as containing footage of my activities across the various BFI archive sites, it also includes sound and

[236] More information on the exhibit can be found at 'Radiant Objects: Encounters in the Nuclear Age'. [n.d.]. *Fringe Arts Bath (FaB)* https://www.fringeartsbath.co.uk/radiant [accessed 2 April 2024].

video that I gathered during my attendance at a week-long conference in Dessel, Belgium.

The Nuclear Archive further develops the significance of my own presence within the noise-prints that I have captured and includes shadowy outlines on captured screens, off-camera discussions with archivists, and the sounds of my body and movements behind the recording devices. In the context of Wright's 'noisy non-self' that I refer to at the start of this chapter, *The Nuclear Archive* reveals these sonic ephemera as an example of how a noise-print can prompt forms of 'critical audition'. Within the soundtrack of the film, I have made no efforts to obscure my involvement, snippets of conversations intended for the cutting room are retained, the cold fields and forests in Dessel are heard as sniffles and wind distortion in my phone camera microphone, a device deliberately chosen for its discretion. Each of these audible markers serve as a part of the assemblage of materials that align *The Nuclear Archive* with the methodology I have carried through my research - documentation as praxis and sonic atmospheric attunement. In my original version of *Bunker D11* I included a shot where I walked into the frame to start the VHS tape, I battled with the decision to remove myself from this film in exchange for the aesthetic advantages this would provide when I graded the final piece for exhibition. Although I decided that for *Bunker D11*, what was lost in my disappearance was retained within the soundtrack, *The Nuclear Archive* is a recognition of the action of erasure that takes place in all film and sound practice and attempts to tether the actions I undertook in making this film to this research and its origins, to me.

The soundtrack of the film is equally aligned with my practice methods, utilising the same technique that I have employed in my early explorations of my workspace described in the First Chapter of this thesis, where audio is combined and displaced from the associated image on screen. The soundtrack overlays and undulates between the soundtracks of the digital radionuclides heard through the BFI Steenbeck, the VHS transfer, and the original digital audio capture. As the camera focusses on the turrets and corrugated steel walls obscured by the forests surrounding the Dessel nuclear storage facility, we hear the whirring turntables and crackling speakers of the Steenbeck. At the halfway point in the film, the full recorded cycle of the radionuclide

websites transitions from a framed shot of the VHS monitor to the original digital file, while their respective soundtracks are transposed in the opposite direction. This displacement of the sonic and visual representations of the radionuclide materials, draws out and places emphasis on their differences and the transformation that has occurred during the archival study. As the noise-print of the archive replaces the shrill high-pitched frequencies of the digital radionuclides, the image becomes increasingly erratic, confined to a fixed-screen-width, the density of the waveforms in the *Radionuclide Websites* algorithm come in and out of phase, generating a complex shape shifting pattern of flashing colours that elicits imaginaries of nuclear exposure.

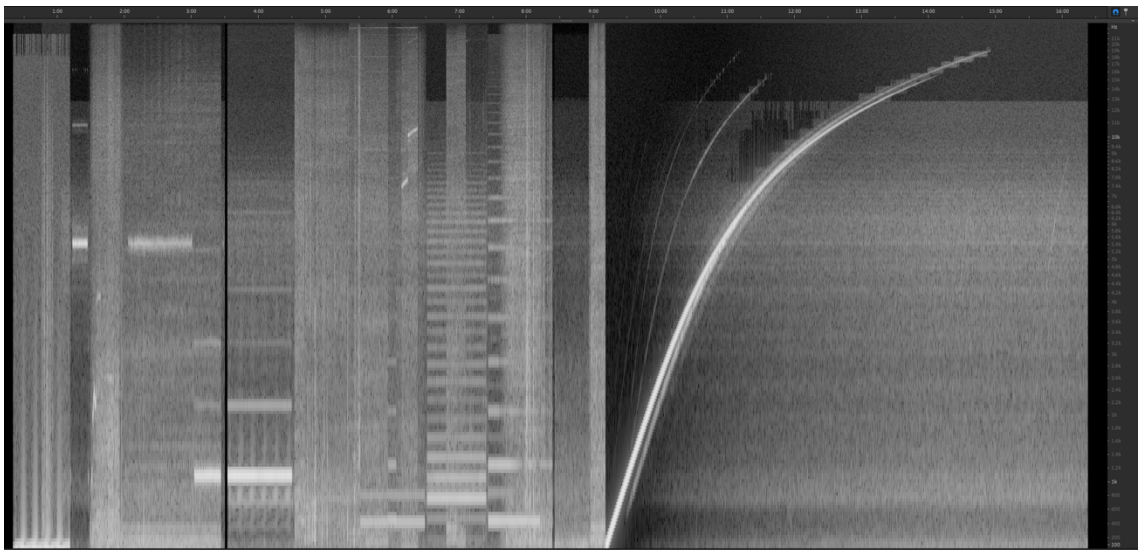

Figure 34. This sonograph image of the soundtrack from *The Nuclear Archive* shows the intensity of particular frequencies within the soundtrack overtime. The large curve seen on the right side of the image shows the ramping of frequencies as the film accelerates through the programmed sequence of the *Radionuclide Websites*.

The clarity of the audio from the digital file at the start of this sequence evokes the slow ramping frequencies of air raid sirens. As the digital audio file is gradually transitioned to the VHS tape recording, audible artefacts from Bunker D11 begin to be introduced, the noise and atmospherics of the bunker space increasingly interject and become more prominent. The effect of this is visualised in the sonograph image (Fig. 34) by the curve on the right of the image that shows a bright white stripe.[237]

[237] A sonograph image visualises the intensity of frequencies within an audio signal over time. The horizontal axis represents the length of the audio signal and the vertical axis the frequency in Hz, starting at the bottom with low frequencies and high frequencies at the top.

Beginning at the lowest frequencies the image is clearly defined and uninterrupted by other noise or sounds, which are represented by the grey area that becomes more prominent as the transition between the soundtracks develops. As the range of recorded frequencies increases beyond the capabilities of the individual listener's ability to perceive them, a new sound emerges. It is audible within the film's soundtrack from around 12m50s, although this may be more or less noticeable at different times depending on the listener – a new ramping of frequencies can be heard, cycling in pitch throughout the remaining recording. This warped audio effect or 'media phantom' is not present in the digital file and it is unclear when this sound first appears in the recorded media, but as with the unexpected complexity of the waveform visualiser's algorithm, it is a unique imprint entirely of the technology's making. These sonic reflections can be seen in the sonograph image as light scratches (Fig. 35), they are aural imprints that are unique to the noise-print constructed through my practice and are both a marker and carrier of the post-atomic within *The Nuclear Archive.*

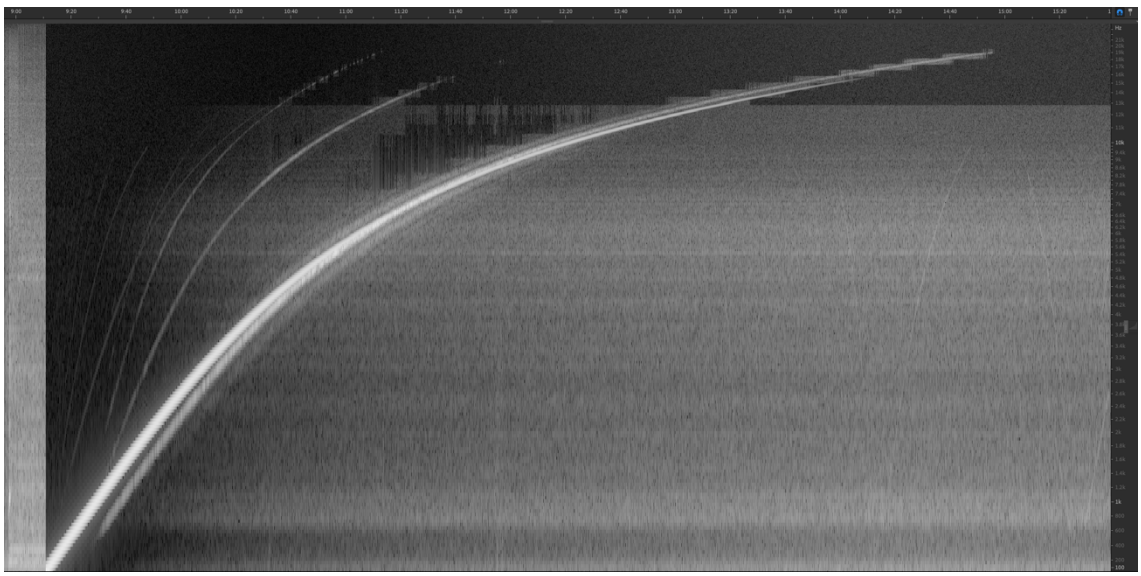

Figure 35. A sonograph image shows etchings of post-atomic artefacts in the noise-print of *The Nuclear Archive*.

The Nuclear Archive presents the variations, artefacts, and technologies of the archive site through the language of its film media, with edits that include the direct playback of materials on 35mm film editing machines, VHS players, and digital audio-visual capture devices. The external shots in the film are from Dessel, Belgium and focus on

the expansive grounds of Tabloo, a nuclear waste visitors centre, which was constructed as a part of the wider development of a large-scale, above-ground storage facility for the low-level nuclear waste products of the Belgian nuclear energy industry. As well as documenting and presenting each of the significant locations and sites of my practice at the BFI, the film explores how the activation of these materials away from the archive site, can open up new avenues for connecting film and media archives with the challenges presented by our interactions with nuclear materials. In describing this practice as it developed throughout my research partnership with the BFI, I have been able to trace a path between these two different 'nuclear archives', linking my radionuclides and the machines and media of the BFI archive, to a space designated as a medium-long-term storage facility for radioactive waste.

5.7 – Tabloo

Figure 36. A film slide cut from 'The Post-atomic Ear – Radionuclides' on my homemade Steenbeck device, sits atop a large mushroom in the grounds surrounding Tabloo, Dessel. The concrete table-like structure of the visitor centre can be seen in the background.

The Nuclear Archive is a tracing of the many interactions I have initiated through my media-based radionuclides as a part of my research, both on-site at Gaydon and

further afield. The film manifests as a noise-print, a unique capture of conversation, research and practice actions, technologies, and the skilled handling of them. In addition, it performs a relocation of the boundaries of the archive to Dessel, Belgium, and the nuclear waste storage facility that can be seen in the film obscured by forests and fences. In November 2022 I was invited to present the practice from my BFI partnership during a nuclear energy industry workshop at Tabloo titled: 'Remembering the Past in the Future: Building Awareness of Radioactive Waste Repositories Together'. The event was organised by the 'Expert Group on Awareness Preservation' (EGAP), a division of the Nuclear Energy Agency (NEA),[238] whose mission is to ensure that high-level nuclear waste sites are remembered into the future. The event was attended by a large cohort of nuclear energy industry representatives, as well as artists, scientists, and academics working within the scope of nuclear futures.

My decision to present at Tabloo was not an easy one to make. As an artist-researcher building awareness and knowledge of the *always*-effects of our nuclear actions, I was uncomfortable sharing a platform with those whose mission it is to promote and profit from our continued and increased use of them. In the context of global energy production figures, competition for nuclear energy producers is still dominated by the high-carbon emissions associated with the burning of natural gas, oil, and solid fuels.[239] Faced with the catastrophic environmental events of global heating that are occurring now, and in varying extremes across the world, the nuclear energy industry markets itself as the viable 'clean' alternative to the burning of fossil fuels. Like the nuclear military complex, it is an industry of ransom, that signals its virtues on the threat of an inevitable apocalyptic alternative. However, this image of 'clean power' only provides a partial picture of the realities of this industry, where the long-lives of nuclear waste products are but one part of a complex of impacts that include the global politics of

[238] The NEA are a multinational intergovernmental agency focussed on sharing research and knowledge of what they describe as 'nuclear energy for peaceful purposes' with their member nations. 'About Us'. [n.d.]. *Nuclear Energy Agency (NEA)* https://www.oecd-nea.org/jcms/tro_5705/about-us [accessed 19 February 2024].

[239] *The United Nations Energy Statistics Pocketbook* (2024), shows that as a percentage of global energy production between 1990 and 2021 'oil, coal and natural gas, in this order, are the largest energy sources, together representing 81.2% of total primary energy production.' United Nations: Department of Economic and Social Affairs. 2024. *Energy Statistics Pocketbook 2024* (New York, NY, USA: United Nations). p.6.

nuclear secrecy, the colonial and environmental effects of mining and transporting heavy metals, processes that often take place within the borders of countries that are excluded from the benefits of nuclear power, and the spectre of nuclear accidents past, present, and future.

Although I was sceptical of joining a workshop where the majority of participants were nuclear industry advocates, I was assured by the presence of a keynote from the anthropologist and author Rosemary Joyce, and the participation of many contemporaries working within nuclear culture research, including the founder of the Nuclear Culture Research Group, Ele Carpenter. In addition to this, from the perspective of this research Tabloo is a fascinating place to visit, its modern building is constructed and designed in the shape of a large concrete table. It was built in this way so that the structure could theoretically remain in place for hundreds or even thousands of years into the future. This forward planning is a direct part of the work that EGAP carries out on behalf of the nuclear energy industry to demonstrate that they take seriously their responsibility for the long-futures of the radioactive materials that they utilise and generate, which was the main focus of the discussions and presentations at the event.

I wanted to find ways that I could use my artwork as a point of action within what I found to be a surprisingly open space of discussion among the attendees, despite the clear positive bias of much of the audience towards the nuclear energy sector. I decided that as well as presenting my work, I would take the opportunity to carry out a series of practice actions, finding ways to engage and distribute my radionuclide materials on the site throughout the course of the week. My purpose was to see if it was possible to active my methodology in a way that would attune the archive and my media-based radionuclides, with the storage facilities, boundaries, and environments of a space that is currently storing radioactive materials. Asking, how does the inherent atomicity of my practice keep company with this site of radioactive potential, and how might placing these objects within the hands of those responsible energise them further?

Figure 37. Top-left – Nuclear storage facility seen from the public paths situated around the Tabloo visitor centre. Top-right to bottom-right, radionuclide slides deposited in different locations around the Tabloo centre and grounds.

My practice was exhibited at Tabloo throughout the workshop, alongside Cécile Massart's collection of works that aim to highlight the importance of marking waste repository sites for future generations.[240] As well as screening *Bunker D11* throughout the four days of the conference, I provided copies of *The Nuclear Archive: Sound Map*, alongside reference copies of the *Radionuclide Websites: Binary Book Set*, the handbound binary code translations of the websites. Members of the conference were encouraged to take home individual slides which I had prepared during the cutting process on my home-made Steenbeck. In this chapter I have described the inherited atomicity of each frame captured from the *Radionuclide Websites*, in distributing these frames at Tabloo I return to my earlier description of praxis 'where the process of observation is generative of a document that has impact'.[241] As a practice action,

[240] See, 'Nuclear Culture by Cécile Massart'. [n.d.]. *Nuclear Culture* https://cecilemassart.com/ [accessed 2 April 2024].
[241] See Section 1.7.1, 'Praxis and Practice'.

distributing these film materials activates them as a responsibility to their owners, regardless of whether that responsibility is felt. They are an engagement of documentation as praxis, but they are also the wayfinding instrument that I describe at the start of this chapter, an art of multiple potentials and a traceable asset that attests to the presence of the nuclear archive. Each of these individual slides is representative of an infinitesimally small portion of the atomicity of the radioactive materials they represent, yet they carry with them a piece of the entire noise-print of the nuclear archive. As they rest in the hands, pockets, wallets, and laptop bags of their new owners or find that they are lost to some other place, what new markers might they pick-up on their single frame image or their one twenty-fourth of a second of audio?

5.8 - Noise-prints and the Archive

Through my practice at the BFI, I have explored how the materials of the archive can be interpreted and utilised in ways that reach beyond their conventional archival potential. Film and televisual materials within the BFI National Archive are primarily accessed by audiences through the BFI's online platforms and public screening events. The content of the archive is made available through curated collections and events, as well as 'BFI Replay', a streaming service for digitised archive materials. In addition, the archive is indexed via a public online database with search tools that contain key information on each stored asset at the archive. Although these services are vital for providing access to the content of the archive, distributing the archive's physical media formats - 35m film reels and video tapes - is a more complex process. It was clear throughout my interviews with the archivists at the BFI that the best approach for ensuring the long-term futures of film materials was cold storage, with a minimum of handling and intervention once they are properly stored, canned, and indexed. This ideal of storing film media in a minimum contact environment conflicts with the archivists' understanding of the inherent cultural value of the materials held within the archive.[242] If material film substrates, tape reels, and video technologies are considered by the BFI as of equal importance to their content, how then can these be

[242] See Section 4.3, 'The Nuclear Archive: Sound Map'.

shared with audiences without putting them at risk? This is a question that complicates the decisions facing the archivists when items within the archive are requested by a wider audience.

Much of the work that is described in this thesis will be indexed and stored within the BFI archive site at Gaydon. Confined to metal film cans and cold storage my practice will inherit the timelines of the archive's wider film-media assets, and they will be exposed to the processes of long-term-cold-stasis that large media archives such as the one at the BFI offer. In addition to this, *The Nuclear* Archive and *The Post-atomic Ear – Radionuclides* 35mm film reels will become accessible to the BFI archive's audiences and may be requested for screenings and exhibitions or made available on the BFI's online digital platforms. Through my distribution of individual film slides cut from these films, the unique noise-print and post-atomic auralities that I have described as contained within my practice are able to maintain their existence outside of this museological archive, outside of their 'cold stasis'. Beyond offering a tracible element to these archived materials, each individual slide adopts a new timeline that diverges from my archived materials at the BFI. This expands their potential to be activated in ways that would not ordinarily be suitable for an asset held for preservation within an archive. Through my practice actions at Dessel, the responsibility for a fraction of the noise-print of the digital radionuclide and the nuclear cultural space of the BFI archive now rests in the hands of an audience gathered with the aim of preserving the memory of nuclear waste products - nuclear scientists, civil servants, employees of the Nuclear Energy Agency, and artists. Whether they are stored carefully, discarded, or lost each of these individual frames serve as a reminder of the *always*-effects of the digital radionuclide source that they are imprinted with. Consequently, each of the works that I have produced during my partnership and exploration at the BFI, become assets that attest to the presence of my practice within the archive.[243] This strengthens their connection to their respective film technologies, the expertise of the archive's technologists, and the post-atomic cultures that are connected through them.

[243] These connected artworks are an example of the 'inter-document' that Dekker, Giannachi and van Saaze describe. See Section 1.7.2, 'The Document as Art Object'.

Through my documentation as praxis approach, I provide a means for generating practice within and for an archive that bypasses some of the conflicts that arise when methods of preservation collide with the necessary demands of an audience, listener, or practitioner. At the start of this chapter, I describe the significance of the still images that appear as film slides at the end of *The Post-atomic Ear - Radionuclides*. I have described the purpose of their inclusion within the film through their potential for generating alternative, future modes of distribution for this research, as well as becoming a traceable asset, a coda, that links the archive materials to my research. These depictions of the BFI archive ensure that the bunkers, film technologies, and nuclear histories of the archive can be retained in the materials that the archive serves to protect, as well as communicating to future audiences that there is a wider body of practice to be discovered beyond this film material. These are discoverable through *The Radionuclide Websites* and in the many varying distributions of their other material-media formats.

The practice that I have developed through my research - sonic atmospheric attunement and documentation as praxis, provide alternative methods for engaging with the archive and influence how this practice might be interpreted and received by future audiences. My practice actions in Dessel activate the film cuttings as an alternative distribution method for the archive's material format and highlights how the unconventional distribution and reception of these materials uncovers a new set of transformations, or transductions that modify and engage the noise-prints they contain. Theoretically, each individual frame distributed during this practice process could be recovered at some unknown point in the future. If one were to be discovered, professionally canned with leaders added, the resulting film would contain one twenty-fourth of a second of sound and image. This fraction of my practice would carry within it both the original noise-print of the archive and the contacts, conditions, and history of its encounters outside of the archive space.[244] If such a film were to be made

[244] A film leader is a length of film added to the start and/or end of a reel to protect, identify and help with the loading of a film reel. Often consisting of coloured bars and clock tickers, the leaders are visible in *The Post-atomic Ear – Radionuclides* and throughout my practice at the BFI.

it would represent a further transduction of my research to practice, and could be played back in an exhibition setting, a cinema, or stored within an archive.

In the presentation of my practice at the EGAP event I was able to communicate my research as a shared concern with other assembled artists and academics, while also activating my practice as a reminder of the responsibilities facing those representing the nuclear energy industry. With *The Nuclear Archive* I retain an asset that makes record of this communication, which can be shared to wider audiences through its inclusion in the BFI archive and its exposure to other audiences such as in the *Radiant Objects* exhibit and further screenings and exhibitions. In combination with the archived materials at the BFI, my practice is an exploration of the complexities that occur when processes of audition (playback), distribution, and sound gathering are attuned to nuclear cultures, as well as those of sound and film practice. It is in the observation and sensitisation to the shifting narratives that occur between archive, audience, and practice that I have situated my concept of noise-prints as a new approach for engaging with(in) archives.

5.9 - Chapter Conclusion

The etchings on the sonograph image from *The Nuclear Archive* soundtrack (Fig. 34 & 35) are an example of how documentation as praxis is a 'process that sharpens on the surfaces of things taking form'.[245] Where the echoes of nuclear bunkers resonate with the sounds of their documentation, the media of the film archive, and the playback of the multi-format radionuclide. My work at Tabloo in Dessel where my site-based interventions and covert actions included me handing out and hiding my radionuclides around the site, as well as in one particular instance dropping a frame at a depth of 225 meters within the HADES underground research laboratory, are an attempt to activate the potential of this nuclear archive material.

[245] See Section 1.7, 'Documentation as Praxis'.

Through a practice of transduction and documentation, my multi-media-format engagements at the BFI archive convert the timeline or half-life of the original digital artworks I have introduced in the Third Chapter of this thesis, from an equivalent 'live-score' of radioactive decay, to a noise-print of the archive itself. This is represented by the leftover audible effects of tape heads, film substrates, atmospheric interferences, and the captured glitches of digital audio-visual media technologies. It is an observational practice that is in attunement with Kathleen Stewart's definition of 'ordinary affects' 'an animate circuit that conducts force and maps connections, routes, and disjunctures.'[246] Throughout this chapter I have presented a series of artworks that consider the BFI archive as a site of post-atomic aurality, and I have described how this process has contributed to the development of my concept of noise-prints. My documentation as praxis approach, which is formative of this collection of nuclear archive works, is an example of what Peters describes as a fascination for 'all the mischievous work done behind the scenes.'[247] I highlight this in the description of my home-made Steenbeck cutting table, my activities with my film frames at Dessel, and through my interactions with the archive as a space of audition for my digital radionuclides. It is an approach to sound arts practice that interrogates the points of contact between recording devices, their media, and the recordist. The result of this process of 'critical audition' within the archive space is a noise-print which is unique and carries with it an imprint of the nuclear archive that can take on a multitude of different roles. By cutting up and sharing single frames of the 35mm film at Tabloo, I provide an example of the potential for documentation as praxis to be employed as a 'praxis action' that engages the media-based radionuclide with the storage and preservation of the waste products of the nuclear energy industry.

The practice I have presented engages the materials, atmosphere, and cultures of a unique nuclear site through a novel method for the presentation and documentation of them, which I have termed 'noise-prints'. It is as Peters describes a practice of 'environments and small differences, of strait gates and the needle's eye, of things not understood that stand under our worlds.'[248] In observing these 'small differences',

[246] Stewart, Kathleen. 2007. *Ordinary Affects* (Durham, NC, USA: Duke University Press). p. 3.
[247] Peters, 'The Marvelous Clouds', p. 33.
[248] Ibid.

changes in definition; clarity, frequency response, resolution, and the technological and atmospheric interventions of a combination of digital, environmental, and analogue effects, that my practice begins to stretch the definition of what nuclear cultural materials are and how they might be handled. It is an exploration of what can be revealed through the crossing of these boundaries in practice; culture (sound and moving image) and the nuclear (radionuclides).

Thesis Conclusion

6.1 – Practice Outcomes

List of practice pieces in chronological order:

- *Writing For Window Boxes* (2020)
- *Geiger Environs* (2020)
- *Geiger Counter Compositions* (2021)
- *37°N* (2021)
- *Radionuclide Websites* (2022 - present)
- *The Nuclear Archive: Sound Map* (2022)
- *Radionuclide Websites: Binary Code Book Set* (2022)
- *The Post-atomic Ear - Radionuclides* (2021 - 2022)
- *Bunker D11* (2022)
- *The Nuclear Archive* (2022)

The body of work that I present within this thesis is a unique contribution of sound arts practice, consisting of ten artworks that are an amalgam of experimental film, sound, and digital works. Each is an engagement of my methodology that includes sonic ethnography, documentation as praxis, and atmospheric attunements. This practice has displayed in the form of online installations, at symposiums and workshops across the nuclear and cultural sectors, as well as in conventional gallery settings at 'Season' gallery in Hackney, London 2021-22 and at 'Fringe Arts Bath' in 2023. As a result of this body of work, I have developed the original concept of 'noise-prints' - a new mode of enquiry within sound arts practice that recognises the atmospheric interactions of sound and site as codified markers of cultural effects. In the final chapter of this thesis, I make the argument that noise-prints not only contain an imprint of these effects but can also be activated as a 'wayfinding' instrument that reveals the post-atomic. The 'noise-print' concept is a direct outcome of the practice that I have developed during this research and is revealed in the sound arts techniques and methods that I have described throughout this thesis. This portfolio of work constitutes a practice-based research approach that not only contributes a unique set of post-atomic sound artworks but also provides a methodology for continuing this practice within future research projects, and art practice. The methodology that I introduce in the First

Chapter of this thesis highlights two integral ideas for achieving this - documentation as praxis and sonic atmospheric attunement.

Following a theoretical analysis of Nicole Starosielski's 'thermocultures' and Douglas Kahn's theories of energetic exchange or 'transduction' within sound-based artwork, I have considered how thermal and other atmospheric effects might reveal post-atomic auralities. Through my practice experiments, *Geiger Environs* and *Writing for Window Boxes* (2020), I employ documentary methods as a toolset for moving beyond the observation and record of practice, to an atmospherically attuned form of praxis. Although they are both film pieces, their soundtracks drive the narrative of the on-screen activities, where thermal conditions and the space of 'home-work' are observed as a fluctuating influence on my practice. This work is expanded in the activation of the Geiger counter device in *Geiger Counter Compositions* (2021), a piece that performs a sonic crossing of the boundaries of my workshop to a space of digital exploration, where dosimeter readings become sonic agents within my space of making. I present these works as a demonstration of 'documentation as praxis', where the observation of my site of practice is the primary focus of the artwork that is produced. By establishing this observational practice approach, I bring to light the ways in which the 'work of art' can reveal a practice that is attuned to the cultures of atmosphere, and energy exchange. Each of these experimentations are an aural observation of atmospheric and energetic exchanges and an example of the praxis approach that I introduce in the Second Chapter of this thesis.

The online installation *37°N* (2021) takes my digital practice one step further, where a transposition of the sounds of nuclear generators combines with the live streamed video footage of the decommissioning of the Fukushima Nuclear Power Station on the ten-year anniversary of the disaster. In the absence of any audio stream from Fukushima, the remote sensor data and information that I had gathered from open-source digital archives structure a form of data-led post-atomic listening. Delivered via the remote sounds of a nuclear generator in Sweden, the live sensor and historical data that enact the changes in the sound and video during the installation generate a noise-print which is unique to the Fukushima event of 2011 and its continued effects in 2021. From this space of home-work and digital information gathering I developed the

Radionuclide Websites, a web-based representation of nuclear material half-lives. During my sonic fieldwork at the BFI, which I have described in the final two chapters of this thesis, these digital radionuclides are employed as source material for the continued discovery of post-atomic auralities within a media-archive with unique nuclear connections.

6.2 - Presentation of Research

Throughout this research period I have sought out a variety of opportunities that have enabled me to share the results of my research and the practice I have produced. Within my home institution I have presented at Research Network UAL events as well as at the regular presentations of practice that are convened by the Creative Research in Sound Arts Practice (CRiSAP), which is the UAL research centre I am based at. In addition to this, I have shared my work through external symposiums, workshops, and panel discussions convened by a variety organisations and institutional departments. My practice has entered exhibition at Fringe Arts Bath (2023), Season Gallery (winter 2022-23) in Hackney, London,[249] and in a temporary exhibition of works at the Tabloo Visitor Centre in Dessel, Belgium (2022). Further to these exhibitions within my research period, I have a firm proposal from the BFI's Art Film Curator for a public event and Q&A, which will take place at the BFI Cinemas on London's Southbank in 2025. The event will include a screening of *The Nuclear Archive* on a specially produced 35mm Cinevator print, that has been produced with the generous support of UAL's 'Student Support Fund' and Techne's 'Research Training Support Grant.' Each exhibition and presentation that I have undertaken during this research has enabled me to present my work in different contexts, this has contributed to the development of my research approach and its outcomes.

'Remote Sensing' was an online symposium that took place in April 2021, the event was convened by Dr Rachel Emily Taylor and Dr Leah Fusco at the Camberwell College of Arts. The symposium questioned the impacts of COVID on academic research and

[249] Season Gallery closed in August 2023 and is now 'Galleria Objets'.

highlighted the ways in which remote sensing could open up new avenues for arts practice and research 'that may be geographically, culturally, or historically hard to reach.'[250] All of the practice that I have presented at the inception of this research project was produced during COVID restrictions. These enforced periods of isolation and home-work define the early stages of my research and have made notable contributions to my practice methodology, this includes my focus on the atmospheres and observations of the site and act of practice. However, within the contexts of nuclear cultural practice, the troubles of accessing what is 'hard to reach' pre-date any COVID enforced lockdowns and social distancing measures.

Returning to *Writing For Window Boxes* and my Geiger counter compositions from the First Chapter, the passing of time between now and the realities of COVID lockdowns; the mass loss of life and the universal experience of fear and concern for those most vulnerable, adds to the weight of what are quite gentle observations within these films. Caught up in this early experimental practice my sonic atmospheric attunements to the site of home-work reveal the 'cultural atmospherics' of a COVID defined work environment. Within this thesis I highlight how the challenges of accessibility that faced researchers during COVID are shared by those working in irradiated landscapes, or the products of nuclear industry and their material waste management. In the Final Chapter of this thesis, I describe how I treated the decision to present at a nuclear energy event at the Tabloo visitor Centre, in Dessel with caution. I was reluctant to associate my research with an organisation that is working towards an increase in the use and capacity of nuclear energy production and knew that a large proportion of the audience would endorse this approach. However, exposing my research to this new audience provided me with the opportunity to offer a direct challenge to a cohort of highly influential figures within the nuclear energy industry. In addition to this, I took the opportunity to adapt and test my methodology within a site of current nuclear cultural significance. In the Final Chapter of this thesis, I describe how the single frames cut from *The Post-atomic Ear: Radionuclides* carry within them a noise-print of the nuclear archive. My practice actions at Dessel allowed me to connect the post-

[250] 'Remote Sensing 2021', p. 3.

atomic auralities captured on these media-based radionuclides within a site that will host post-atomic consequences for potentially thousands of years into the future.

Each of the events I have participated in have allowed me to find new ways to test the limitations of my research and the praxis approach that I have outlined throughout this thesis. My presentation of *37°N* at the Remote Sensing Symposium is an example of this, where I was able to describe the potential for live sensor information, streamed video, and historical data to develop a remote sense of the *always*-effects of the Fukushima event. As a part of this, my presentation included a reading of a sonic atmospheric attunement that was accompanied by the playback of a clip from the online installation. This sonic atmospheric attunement was published in the resulting documentation from the event and is an example of the performance of my methodology, which is repeated in the actions I have included in this thesis.[251]

Further to Remote Sensing, in June 2021, I made a presentation at the Research Network UAL (RNUAL) Spring Symposium titled: 'Creative Practice and Community Data in the context of Nuclear Culture.' This presentation focussed on the processes, documentation and methods that contributed to the creation of *37°N*. At the time of this presentation, I had undertaken a revaluation of my research proposal, which included a visit to the Trinity Test Site as an information gathering exercise. I will evaluate the impacts of this decision in more detail as I continue my conclusion to this thesis. Due to social distancing and lockdown conditions my research was undergoing a repositioning of the aims of my practice. I had begun to consider the ways that field studies, archival research and creative practice could be reimagined in the context of the community data and digital archives that feature in the Second Chapter of this thesis. During my presentation I argued that *37°N* represented the first example of post-atomic listening within my research, on reflection the auralities of the post-atomic had already started to reveal themselves in my earlier work with Geiger counters and the documentation of their aural effects. However, the discussions and feedback that I received from making this presentation helped me to understand how my practice could be developed further and reveal more of the post-atomic aural

[251] See Appendix, 'Item1'.

cultures that my research sought out. This event also prompted discussions on the ethical implications of performing sound-based field studies and directed my research towards a new understanding of how community data and digital platforms can reveal alternative routes for a sound arts practice that engages with post-atomic influences.

6.3 - Research Question

My research question asks: What are the connections between sound and the nuclear, and how might novel methodologies for sound arts practice activate these relationships? Throughout this thesis I have revealed how sound can communicate the post-atomic through my sound arts practice. In the First Chapter, I began this enquiry with a process of experimentation, where radiation readings from Geiger counter devices are combined with a process of sonic atmospheric attunement. My work with Geiger counter readings and remote data provide examples of how this methodology can be primed to atmospheric and energetic exchanges. Through the development of a sound focussed practice of atmospheric attunement, sounding environments are recognised within this research in their potential to communicate 'atomicity' through a process of audition (recording, playback, and sound emission). I have argued for an expansion of the term 'atomicity' that includes within its description of atomic mass a sense of 'atomic burden', or the 'weight' of effects and impacts that proliferate from nuclear materials. Throughout this thesis I explore the aural emissions and unique qualities of irradiated materials and nuclear events to seek out new ways to communicate the *always*-effects of their post-atomic cultural consequences.

With the development of my documentation as praxis approach, I have explored the potential for sound arts practice to communicate the unique auralities that emerge from the observation of the site and act of practice. During the first two years of this research, my practice focussed on the conditions, consequences, and accessibility of sites with nuclear history, combining community projects, such as Safecast with other environmental data sources. In my piece titled *37°N* (2021), the live streamed images of Fukushima's decommissioning are enlisted in a web-based installation that explores how this data can be transposed from document to audio-visual artwork. This thesis

has explored academic definitions and examples of atomicity in the arts through an analysis of nuclear cultural research, the post-atomic, and geo-humanities. Susan Schuppli's 'material witness', Jacob Kirkegaard and Peter Cusack's sonic ethnography, and Sasha Engelmann's 'elemental lures', each provide supportive examples of practice that share in my aim to uncover an elemental or fundamental association between the nuclear and its associated cultural outputs. However, as I have highlighted through both Douglas Kahn and Kathleen Stewart's warnings on the subject, there are pitfalls in this endeavour, and key to this is the proximity and frequency in which the academisation of the nuclear within the humanities begins to collide with the institutions, language, and politics of the global nuclear agenda. This includes the nuclear military complex, geological studies, national and international nuclear energy agencies, and the nuclear lobby. Through my practice at the BFI and at Tabloo in Dessel, I have explored how post-atomic auralities can uncover and document these tensions of site and atomicity through an atmospherically attuned listening practice that is prompted by the *always*-effects of the nuclear.

6.4 – Original Contributions: Situating Sound and the Post-Atomic

In my initial research proposal, the Trinity Test Site was highlighted as an important place to visit as a part of my research. The site and surrounding deserts continue to endure and bear witness to the fallout of hundreds of nuclear bomb tests, detonated both above and below ground. Trinity is activated and maintained as a site of nuclear cultural heritage and scientific discovery, with a visitor centre and memorial site commemorating the moment that the first nuclear device was successfully tested. It was an event that thrust the world into a new era of atomic effects that were entangled with military, colonial and environmental violence, technological advancements, and the fear and uncertainty of the ensuing Cold War. Having begun this research journey in 2020, during the onset of the COVID-19 pandemic, a rethinking of the significance of site-based fieldwork in relation to this research emerged.

It is without doubt that Trinity endures as a powerful and evocative space, a post-atomic landscape bound in memory, material and timescales that continue to unfold.

It is however with this in mind that I decided that a trip to the site was not necessary for this research. Discovering Hayashi's writing during my research, and in particular, her own journey to the site documented in *From Trinity to Trinity* had some influence on this choice.[252] Her engagement with the site as a hibakusha; survivor of the bombing of Nagasaki, is a deeply revealing interaction, a necessary and sensitive act of remembrance and an attunement to the site that is both appropriate and powerful in its message. Taking into consideration how I might expand on this through my research compounded an ethical consideration, that included and reached beyond the necessary evaluation of the environmental impacts of trans-Atlantic travel and the right of access to the communities and territories impacted by the advancements of the atomic era.

Throughout this research I have taken care in the selection and observation of the site of my practice. Within each of the works that I have presented within this thesis, the atmospheric surroundings of practice are recognised as a tightly knotted bundle of effects and artefacts that are generative, cultural, and valued in their presence within my work. In my early experimentations, the sounds of my home - the creaking of floorboards, coffee making, and washing machines, are employed as carriers of dosimeter readings, opening queries to my research that are concerned with the ethics of sonic ethnographic practice within sites of nuclear disaster. In the interpretation of the practice presented in the first two chapters of this thesis, I have made clear how this practice-based research links to the academic fields of sound arts and nuclear culture research, taking points of learning from the sonic ethnographic practice of R Murray Schafer's 'Soundscape Project', and Jacob Kirkegaard and Peter Cusack's sound-based investigations of the Chernobyl exclusion zone.

Listening attentively to my recordings from this period of the research, a more complex understanding of what I have termed 'noise-prints' takes shape. As my practice of documentation captures the fluctuating temperatures, seasons, and the ordinary events of this site of 'home-work', the recordings and images are awash with the 'cultural atmospherics' of the global COVID pandemic. These sounds are a

[252] See Section 3.4, 'Elemental Memory'.

moment, and marker of working among chilli plants, the remnants of newly acquired obscure hobbies, the quiet building of a Geiger counter – the hum of desktop fans, and the patter of pets in the hallway. Despite their slippery nature in respect of our perception of them, I present these evocations of site and making as the *always*-effects of praxis, that enrich us and make what we make. They also demonstrate the powerful potential of sound documentation as a device for situating and communicating what I introduce later in the thesis as sonic atmospheric attunement. This phase of my research was an attempt to find a sonic pathway into a network of cultural atmospheric effects, uncovering where and how meaningful connections could be made with the *always*-effects of the post-atomic. Throughout this research I have made these connections through a methodology that observes a variety of different definitions of the site of practice, which includes nuclear sites, fieldwork, and digital spaces.

6.5 Original Contributions: The Digital Site and Fieldwork

Within this thesis, what constitutes a post-atomic 'site' is interpreted and reinterpreted through my practice engagements. The experimental work in the First Chapter of this thesis considers how methods of attunement and documentation can provide access to sites of nuclear cultural significance and looks for ways of connecting my own practice to them. My use of microphones, Geiger counters, and video recording techniques begin the process of capturing my engagements with the nuclear within my workspace and provide a platform for me to move my practice into a diverse range of places. I have highlighted *37°N* as an example of how the events of the nuclear disaster in Fukushima can be recalled and activated through remote sensing technologies and their associated data sets. In the First Chapter I describe how sound arts practice has relied on the conventions of sonic ethnography to reveal the post-atomic aurality of sites such as these. Through my remote and digital practice, I offer an alternative to this, where instead of visiting these sites, I employ a process of sonic atmospheric attunement to reveal their post-atomic cultural connections. In the same way that Fukushima is linked to my experimentations with remote sensing data, I connect the enduring effects of the Chernobyl meltdown of 1986 to the resurgence of

Cold War narratives since the Russian invasion of Ukraine in 2022. The *Radionuclide Websites* audiovisual cycles are linked both to the half-lives of the materials that were released and still endure in Chernobyl and the continued threat of the nuclear military complex. Both *37°N* and *Radionuclide Websites* represent how my approach to this research and my sound arts practice can reveal the consequences of the nuclear and reimagine the boundaries of post-atomic sites of enquiry.

From these earlier practice examples, I was able to bring this newly acquired understanding of the nuclear site to a more conventional sonic fieldwork. Having made progress with my practice of sonic atmospheric attunement and documentation as praxis, I was able to explore the BFI National Film and Television Archive with an expanded methodology for listening within a site of nuclear cultural significance. From my sound mapping practice, I have presented examples from within my recordings of where post-atomic cultures emerge and generate post-atomic auralities. These include the audio recordings of Pete Sharp's visit to the site, as a former nuclear armourer his observations and engagements with the site provide moments that are rich in detail and are directly evocative of the site's nuclear history. I have highlighted examples in the final chapters of thesis where the capture of these evocations of site, be they thorough digital practice, media transductions, or sonic ethnography, reveal a noise-print; a unique audio representation of a post-atomic aurality that is tracible to the site of its making.

This research reveals how practices of atmospheric attunement cross energetic, cultural, and material boundaries. There is however a further unexpected point of enquiry that my practice has uncovered, which offers a new pathway for research beyond this thesis. That is, if digital works can assume the properties of materials such as radionuclides, what might we learn from considering these works as part of a network of 'digital atmospheric' effects? The *Radionuclide Websites* started as a digital experiment, a testing of the boundaries of atomicity. As the project developed and the audiovisual effects of the digital radionuclide began to take on new shapes and forms, I was struck by the scale and impact of their inherited atomicity. I was aware that I had placed these websites within a fragile network of communication, where languages, technologies, and their purposes are in a permanent state of flux. Ascribed

with a nuclear-millennial-timeline, the long-term storage of these digital radionuclides within this space, opens up and shares many of the complexities facing the storage of their nuclear-material counterparts. I acknowledge these challenges in my practice, through the production of the *Radionuclide Websites: Binary Code Book Set* (2022), my practice actions in Tabloo, Dessel, and all of the media-based iterations of the websites that I have worked with throughout my archival study at the BFI.

Within this research, the concept of a space or locality of 'digital atmospherics' starts to reveal and unravel itself, where the timelines of the atmospheric and geologic effects of the release of radiation in energy production is transduced directly to a digital medium of its own making. It is this material connection to the environments of our digital spaces that ground them to a political ecology and can offer new insights for building a better understanding of 'place' for future information networks. Although it was not the purpose of this research to delve deeper into this subject, it is quite possible that developing a concept of 'digital atmospherics' may be key to building an adaptive understanding of locality and environment for the digital space. This is made more vital when considered in the context of the rapidly expanding potential and implementation of the technologies we currently describe as 'artificial intelligence'. It is possible too that our use and handling of this trans-communication of digital environmental effects could play a vital role in reversing damage and restoring our own at-risk environments.

6.6 Original Contributions: Documentation as Praxis and Noise-prints

Within this thesis I present documentation as praxis and noise-prints as an original contribution and new method of enquiry for sound arts practitioners. Documentation as praxis is a practice approach that interleaves the making and site of practice within the practice outcome. In the First Chapter of this thesis, I describe how this approach is productive of an expanded form of art documentation that can be generative of what Dekker, Giannachi and van Saaze describe as an inter-document in the context of Lynn

Hershman Leeson's *Roberta Breitmore.*[253] Dekker & Giannachi (2022) further describe these inter-documents as 'environments that comprise primary, secondary, and auxiliary documents.'[254] Through my use of digital data, web-based installations, and recording technologies the whole portfolio of practice that I have presented in this thesis could be considered an inter-document. In addition to this, documentation as praxis places a unique focus on the action of making and looks to include the aural and atmospheric connections that sound arts practice can reveal. It is generative of a practice that is derived from the documentation of the creative process, including observations of the workspace environment, its contents and occupants, and the interconnecting influences of both the space of making and its extended environment on the output work. Following Marina Peterson's application of atmospheric attunements in her sonic ethnographic approach, I have utilised what I have termed as 'sonic atmospheric attunements' as a method for further analysing the environments of the site of practice. It is the combination of these two approaches to practice that have led to the development of my original concept of 'noise-prints' and expanded my research out from the digital and the site of 'home-work' to the nuclear bunkers of the BFI archive site in Gaydon.

The BFI partnership allowed me to test the limits of this methodological approach and to discover the potential for sound arts practice to engage with post-atomic auralities. Through a detailed study of the archive, my on-site work at the BFI described in Chapter Four and Five of this thesis, contributed to an expansion of my concept of noise-prints, revealing how as well as functioning as capture points within a timeline of events, they could be activated as media-borne markers and carriers of post-atomic effects. As a modern media archive, my interviews with technologists, a nuclear veteran, and the archivists at the BFI site opened up the potential for my practice to engage post-atomic auralities in a listening exercise that reveals the unique properties and praxis potential of these noise-prints. In addition to my methodology engendering this post-atomic mode of listening, my practice has found different ways of unearthing new voices for communicating nuclear cultures.

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[253] See Section 1.7.2, 'The Document as Art Object'.
[254] Dekker, Annet, and Gabriella Giannachi (eds.). 2022. *Documentation as Art: Expanded Digital Practices* (London: Routledge), p. 5.

Through my development of the concept of noise-prints as markers and wayfinding instruments within the sonic record, a reimagination of nuclear materials as atomic-media positioned them not so much as witnesses to the atomic as direct voicings of it. Within this thesis I have described the relevance of both Susan Schuppli's 'material witness' and Sasha Engelmann's 'elemental lures' to this research, however, where recent nuclear cultural theories, such as these, have placed emphasis on the non-human communiqués of rocks, sand, glass, mountains, and environments, my practice of sonic atmospheric attunement opens up to the atmospheric potential of sound and atomicity. With my practice I listen for these connections and ask questions of what these post-atomic auralities might reveal, where listening to the glitches of the 'Blue Danube', the birds in the balance ponds, and the storied accounts of nuclear veterans, might reveal nuclear futures, fears, histories, and new techniques for communicating their impacts.

6.7 – Post-atomic Auralities

This research has explored the ways that sound arts practice can expose the post-atomic cultural and environmental effects of the nuclear through an aural sensitivity to them. I have looked for ways to connect sound and the post-atomic through a combined methodology of sonic atmospheric attunement and documentation as praxis. This practice approach is delivered in the gathering and transduction of digital data sets, art documentation, and recorded media. As a result of this practice, I have described 'noise-prints' as a novel method for sound arts practitioners. A noise-print utilises sound playback, recording, and monitoring to activate recorded media as unique imprints of aural cultures that are traceable to their point of origin and the enduring effects of the nuclear. I have introduced 'The Toads of Trinity' as an example of how sound recordings can become carriers of atomicity, where the croaks of the Western Green Toads of the Trinity Test Site can communicate both the weight of the events in 1945 and the more recent threat of global heating. In my sound mapping project and the subsequent detailed film-media-led study of the BFI National Film and Television Archive, I have uncovered examples of post-atomic auralities that include

Pete Sharp's recollections of the nuclear weapons 'clutches' that were once housed on the BFI archive site. I have described how my installation and the resulting film *Bunker D11* is an enactment of an atmospherically attuned call-and-response, which is generative of a noise-print which is unique and carries with it an imprint of the nuclear archive.

Post-atomic auralities emerge from this listening practice, which presents as an amalgamation of theory and practice within this thesis. This research is an exploration in which sound takes root in the invisible effects of radioactive isotopes and engages in a sound arts practice where actions, documentation, and sonic atmospheric attunement are combined as a methodology for listening with the effects of the post-atomic. Over the past four years of this research, I have listened out for the post-atomic in everything from creaking floorboards, Geiger counter clicks, nuclear bunkers, film substrates, websites, and film media. I have placed in the hands of those tasked with the custodianship of our post-atomic legacies the noise-print and image of a Cold War era nuclear bunker and relic of digital-atomic material. I have activated these digital radionuclides as post-atomic carriers of nuclear bunkers and made record of their connection to the Cold War recollections of a nuclear veteran. In many ways Pete Sharp is as much a symbol of the post-atomic as any element of this research. Listening to his knowledge and experiences within the bunkers of the BFI archive, the reminders of the *always*-effects of the nuclear abound. They are present in the concrete walls and heavy metal doors of Bunker D11 and the 'rabbit hutches' he was so excited to see. In the threat of radiation carried through his stories and the still present possibility of some radioactive remnant, a post-atomic aurality, emerging through the sounds and glitches of my recording device.

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List of Exhibitions and Events

Event: The Research Network UAL (RNUAL): 'Block 3 Symposium - Disciplinarity'
Date and Location: Online/London, 22/06/2021
Title: ‘Creative Practice and Community Data in the context of Nuclear Culture’
Activity: Presentation of research

Event: The Research Network UAL (RNUAL): 'Spring Research Symposium'
Date and Location: Online/London, 07-11/02/2022
Title: ‘The Nuclear Archive: A Presentation of Findings from the BFI National Film Archive’
Activity: Presentation of research

Event: Entangled Futures Lecture Series (UAL)
Date and Location: Online/London, 01/03/2022
Title: ‘One Scroll From E-Waste’
Activity: Panel Discussion and Presentation of Research

Event: Remembering the past in the future: Building awareness of radioactive waste repositories together
Date and Location: Tabloo, Dessel, 22-24/11/2022
Activity: Presentation & Exhibition of works - *Bunker D11, The Nuclear Archive: Sound Map, and The Radionuclide Websites: Binary Code Book Set*

Event: Season Gallery – Winter 22/23
Date and Location: Hackney, London, Winter 2022-23
Activity: Exhibition of works - *Radionuclide Websites*, *The Radionuclide Websites: Binary Code Book Set*, *The Nuclear Archive: Sound Map, The Post-atomic Ear – Radionuclides* (selection of film media)

Event: CRiSAP Soirée

Date and Location: London College of Communication, 09/03/2023

Activity: Presentation of the Nuclear Archive Sound Map

Event: Fringe Arts Bath (2023)

Date and Location: The Printworks, Bath, 26/05-11/06/2023

Activity: Exhibition - *The Nuclear Archive*

Appendix:

Item 1: Remote Sensing Symposium – Booklet (2021)

USB Media Location: Appendix Items > 1-Item-1_Remote-Sensing_p42-43.tiff

37 degrees north transcript

Daniel Beck

At 2.46pm local time (5.46am GMT) on 11th March 2011, a 9.1 magnitude earthquake struck off the coast off the Japanese mainland, the ensuing waves resulted in the flooding and destruction of three reactors at the Fukushima Daichi Nuclear Plant and a nuclear emergency was declared at 5am on the 12th March 2011. Between the hours of 2.46pm and 5am on that day, hundreds of earthquakes and aftershocks were recorded in the vicinity of the initial quake.

37°N was a live streamed event that took place on the ten-year anniversary of the disaster in March this year, between the same hours of 2.46pm and 5am. The piece combines archive audio, a sound recording from an operating nuclear reactor and the real-time, live streamed footage from the decommissioning of the Fukushima Plant.

The audio from the live stream contains fluctuations, audible interruptions, each one representing a time accurate, instance of an earthquake that struck the Japanese mainland on the day of the quake. Each interjection in the stream lasts no more than a second or two, however each one is unique with varying changes to elements such as the distortion, amplitude and pitch of the audio.

As well as seismic information, live radiation, pollution and air sensor data is provided by communities local to the plant and is used to affect a number of changes in the video and audio stream - filter, decay, colour, frequency, pitch - digital community data, listening.

Interrupting and visible.

This information means something, it represents and indicates a point of concern and care for the health of the people, environment, nature and landscapes surrounding these communities.

[14:39] Rachel Emily Taylor
Thank you Daniel, I enjoyed the performative quality of your presentation and how you read over the sound
(1 liked)

The audio you are listening to now is from a point in the stream not long after dusk. Due to the time difference, the dark skies and slow distant lights of passing ships is the image I've become accustomed to most. The stillness of the image of the plant is always striking, it's something I continue to feel uneasy interrupting, but I've handed that responsibility over to the sensors. At this time of night, the pollution levels are low, so some of the audible distortions have taken on a more subtle quality, while the quakes still burn brightly into the image, as they strike with varying degrees of magnitude.

The plant is floodlit, all night long – the stream burns briefly bright with white light at each quake, awash with coded data, tangible data, community knowledge.

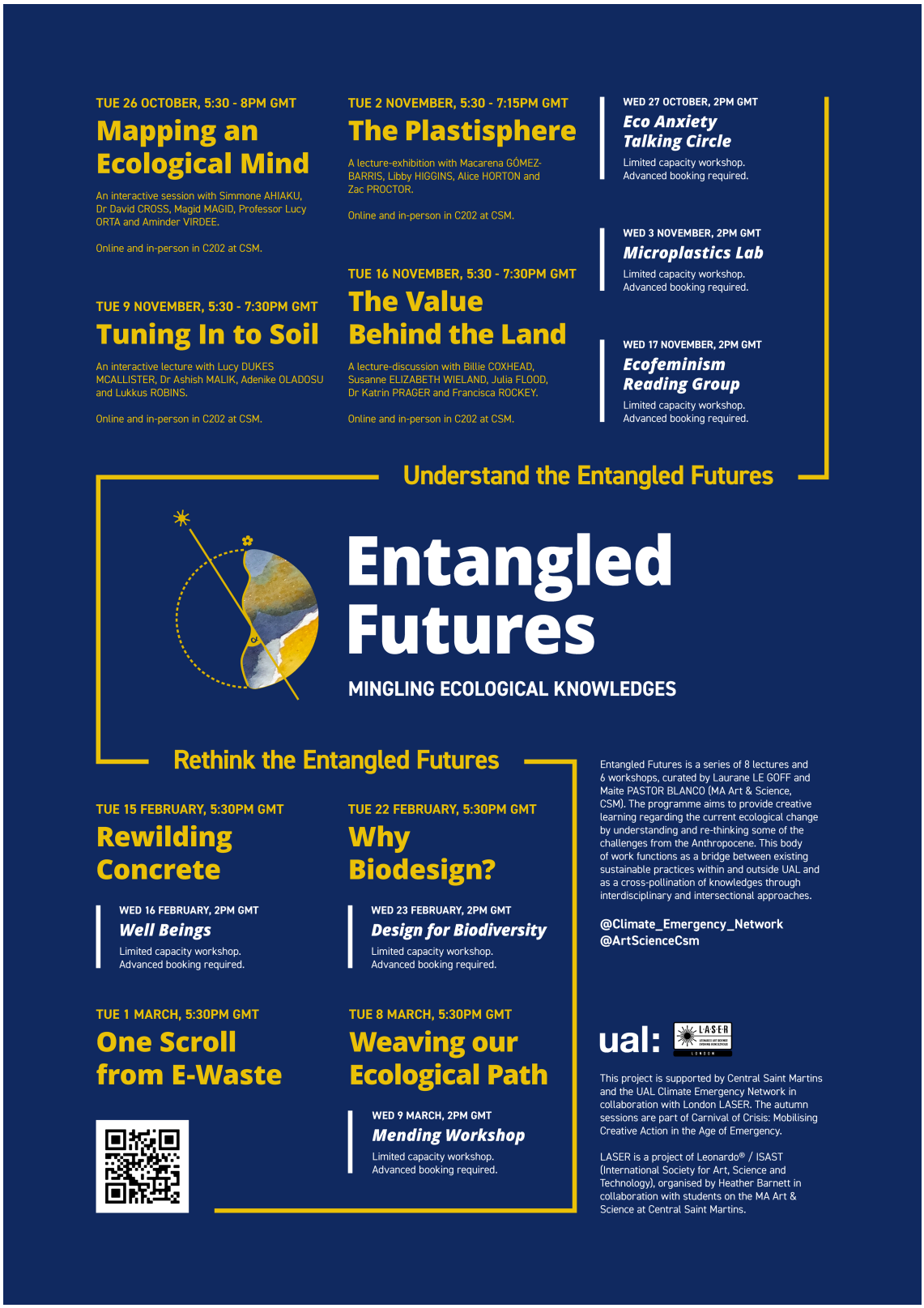
I'm thinking back to the video archives that formed much of the focus of my initial research, the faked film-sound of mushroom clouds added at later dates for dramatic effect, contrasting with the reports of observers of the early nuclear tests – a blinding flash before pulsing wave of sound and heat. Here the crunching of digital video data, slower and more ponderous than the accompanying audio turns this relationship on its head.

The sound interjecting first, like the toads of Trinity, like the cattle lowing Hercules toward Cacus' cave, protruding outward, with the invisible.

37°N Credits
Written & Produced – Daniel Beck
Additional Recording – Fredrik Johansson (Sounds Of Changes)

Item 2: Entangled Futures Lecture Series – Event Poster

USB Media Location: Appendix Items > 1-Item-2_Entangled_Futures_Poster.tiff



Item 3: EGAP Remembering the Past in the Future - Event Summary p. 10.

USB Media Location: Appendix Items > 1-Item-3_EGAP-Summary_p10.tiff

Introduction

The workshop *Remembering the past in the future: Building awareness of radioactive waste repositories together* was held in Dessel, Belgium, on 22-24 November 2022. Approximately 85 experts were in attendance, with representatives from 16 member countries (namely, Australia, Austria, Belgium, Denmark, Finland, France, Germany, Japan, Lithuania, Netherlands, Poland, Spain, Sweden, Switzerland, United Kingdom, United States) and the International Atomic Energy Agency (IAEA).

Work performed by EGAP from 2020 to 2022, combined with abstracts submitted from stakeholders from different perspectives beyond the nuclear field, gave rise to an outline programme for the workshop (see Annex I). Four broad topics were identified as being of particular interest to the emerging community of practice, warranting further discussion at the workshop. These topics were:

- Awareness preservation process at nuclear heritage sites;
- Existing regulatory approaches in awareness preservation and key challenges;
- Approaches for an unknown future;
- Conceptualising remembrance across generations.

The workshop followed up on these key issues through presentations and moderated discussions, devoting one session to each of the four topics. In addition, the workshop began with an introductory session on "where do we stand", which brought forward a number of national and international initiatives on engagement and for memory preservation.

Throughout the workshop, two artists were featured in a temporary exhibition at Tabloo. Cécile Massart exhibited a series of photos and compilation of drawings created during her travels to radioactive waste management sites throughout the world, presenting the (un)consciousness of the landscape by the public. Daniel Beck presented audiovisual tools and sound recording as part of his research to discover how the interplay of sound and naturally occurring environmental effects such as temperature, humidity and radioactivity can influence our understanding of 'place' within our natural environment.

The workshop concluded with a session using discussion groups to consider next steps for awareness preservation.

Item 4: EGAP Remembering the Past in the Future - Event Summary p. 28.

USB Media Location: Appendix Items > 1-Item-4_EGAP-Summary_p28.tiff

SESSION 3. Approaches for an Unknown Future

Efforts have been made to convey information about the modern world to future generations, societies or civilisations on a global basis or in specific countries. We are not able to predict when, where, and how such information is received. However, various approaches have been developed, regarding not only the transmission method, but also regarding the material of the recording media and the expression method, such as characters and symbols. This session examined approaches, considering different intended durations of time, i.e. those that are to be used for decades or hundreds of years, and those that are to be used for thousands or millions of years.

Sound Mapping Project & The Nuclear Material Archive
Daniel Beck, PhD Student, London College of Communication, United Kingdom

This presentation focused on two artworks made in partnership with the British Film Institute (BFI) National Film Archive. Situated within a Cold War era Ministry of Defence nuclear facility, the BFI's Master Film Store contains thousands of tons of film and television media. In order to preserve both the content and material integrity of this media, a world leading cold storage facility sits at the centre of a large site scattered with bunkers, storage rooms, and operational relics of its nuclear history. Both pieces presented sought to offer new ideas for the preservation and understanding of nuclear histories, exploring the potential for artworks and cultural archives to act as conduits for the preservation of post-atomic consequences.
The practice was presented in printed format as a sound mapping project that combines images and interviews with nuclear era veterans, archivists, and technologists, with field recordings taken at each of the bunkers, workshops, woodlands and modern storage facilities throughout the site. In addition to this, a further project presented a collection of audio-visual webpages designed to inherit the nuclear half-lives of radioactive materials, transmediated to 35mm film print and video home system (VHS) tape. The project explores the potential for film and sound-based media to act as witnesses to the legacies of nuclear materials, and questions the role the archive can play in preserving these for the future.

Markers That Convey a Message: Communicating with Future Generations
Arne Berckmans, Project Manager, ONDRAF/NIRAS, Belgium

Within the framework of obtaining a master degree in product development, a student of Antwerp University designed and tested a marker on its efficiency to conveying the message for future generations to deter them of intrusion into the tumuli. The marker was imagined to be positioned next to the tumuli covering the LLW repository in Dessel. The theoretical part of the study focused on determining what parameters influence the chances of survival of a marker and its message, the characteristics of the marker itself, the different ways of communication, a vision on how the far future would look like and reasons for loss of data.

Based on the above insights gained and using the principles of integrated product design, several concepts of a marker were developed that led to a final design. The marker had to carry a positive and a negative message and should function as a stand-alone, assuming that all other forms of communication cease to exist. The efficiency of the message integrated within the marker was verified using virtual reality (VR) technology. A small sample of twelve public volunteers, unaware of the reason of the tumuli or its contents, was asked to answer a set of questions after

Item 5: EGAP Remembering the Past in the Future - Event Summary p. 48.

USB Media Location: Appendix Items > 1-Item-5_EGAP-Summary_p48.tiff

Wednesday, 23 November 2022

Session 3: Approaches for the unknown future

Co-Chairs:

Pascale Künzi, Specialist for Stakeholder Involvement, Swiss Federal Office of Energy (SFOE), Switzerland; Morgan Packer, Specialist, Radioactive Waste Management and Decommissioning, Nuclear Energy Agency (NEA)

09:00-10:45	**Sound mapping project and the nuclear material archive** *Daniel Beck, PhD Student, London College of Communication, United Kingdom*
	Markers that convey a message: communicating with future generations *Arne Berckmans, Project Manager, ONDRAF/NIRAS, Belgium*
	Magazine of the Century – A communication experiment *Barbara Habermacher, Documentalist, Nagra, Switzerland*
	Nuclear heritage: Material practices anticipating and resourcing distant futures in the present *Gabriella Katalin Ivacs, Head of Section, Archives and Records Management, IAEA*
	"Marking" the Australian nuclear fuel cycle as future cultural and environmental heritage *N.A.J. Taylor, Alfred Deakin Postdoctoral Research Fellow, Deakin University, Australia*
10:45-11:15	*Coffee Break*

Session 3: Approaches for the unknown future (continued)

11:15-13:00	**How to create specific storages to preserve radioactive heritage objects?** *Thomas Beaufils, Lecturer, University of Lille, France*
	Art and intergenerational knowledge transfer *Ele Carpenter, Professor, Umeå University, Sweden*
	Memory of mankind *Martin Kunze, Founder, Memory of Mankind, Austria*

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Item 6: Season Gallery – Exhibition Leaflet

USB Media Location: Appendix Items > 1-Item-6_Season_Gallery_Leaflet.tiff

Daniel Beck - The Nuclear Archive

The Nuclear Archive is a multi-faceted sound-based exploration of a former UK Ministry of Defence site at Lighthorne Rough, Warwickshire. The base was constructed in 1955 as a weapons 'clutch' that provided remote storage for the nuclear equipped V Bomber aircraft situated two kilometres away, at RAF Gaydon. Following the closure of the airfield in 1974, the site at Lighthorne Rough was acquired by the British Film Institute in 1978. The site now houses a world leading film storage facility, generating highly controlled environments designed to maintain, and protect the millions of hours of film and televisual media that constitute the National Film Archive.

Outside of the BFI's Master Film Store, situated at the centre of this eight-hectare site, many of the original buildings and bunkers are still present and are in active use for a variety of purposes that serve the film archive. This work performs an act of listening within a space of contrasting nuclear history and archival future. It is a space that echoes, resonates, and hums with the sounds of cooling fans, dehumidifiers, birds, plant-life, and the passing planes and light aircraft that land and depart from the airfield they once served, as well as the modern buildings that sit alongside them

This multi-practice piece includes a sound map and a series of media transfigurations. The source-material is a series of web-based representations of radionuclides; the radioactive materials that are produced in the detonation of nuclear weaponry and nuclear energy production. The websites are designed to cycle through the full range of frequencies perceptible by humans and the full range of the RGB colour spectrum, over the length of their associated nuclear half-lives.

The Nuclear Archive questions the material future and legacies of our post-atomic timelines and actions, through the transcoding of both the site of the archive and web-based works to a series of archival formats, 35mm film stock, VHS tape, as well as a binary code translation of the sites to a set of handmade, archival quality books.

Artist Bio - Daniel Beck

Daniel Beck is a Sound Artist and Filmmaker, undertaking a Techne funded PhD titled The Post-atomic Ear at the Creative Research into Sound Arts Practice unit at the University of the Arts London. Combining sculpture, installation, live performance and experimental film making through a sound focussed art practice, Daniel's work explores how sound can reveal and unravel the complex interactions of material, environment, and community.

iless.eu

Item 7: Season Gallery **–** Exhibited works

USB Media Location: Appendix Items > 1-Item-7_Season_Gallery_Exhibition.tiff

Item 8: Fringe Arts Bath 2023 **–** Radiant Objects: Encounters in the Nuclear Age

USB Media Location: Appendix Items > 1-Item-8_Radiant_Objects-Film_Listing-p1-2.tiff

Radiant Objects:

encounters in the nuclear age

Film Guide

Cover image:
Kaori Homma, Arcadia with Dounreay (2022)

Content notice: These films explore themes relating to nuclear history, some featuring archive footage. Some works contain rapidly changing images and high frequency audio

Times are approximate

Daily: 11:10 & 13:30

Daniel Beck
The Nuclear Archive. 2023. 16min 30sec.

Situated within a former Cold War era nuclear weapons facility, the BFI Master Film Store is a unique site of nuclear history and cultural preservation. Shot on location, The Nuclear Archive is an activation of nuclear material half-lives within the walls, bunkers, media, and technology of this modern media archive.

Credits: The film was made in in partnership with the BFI and Techne (AHRC).

Website: iless.eu
Socials: @ilesssounds