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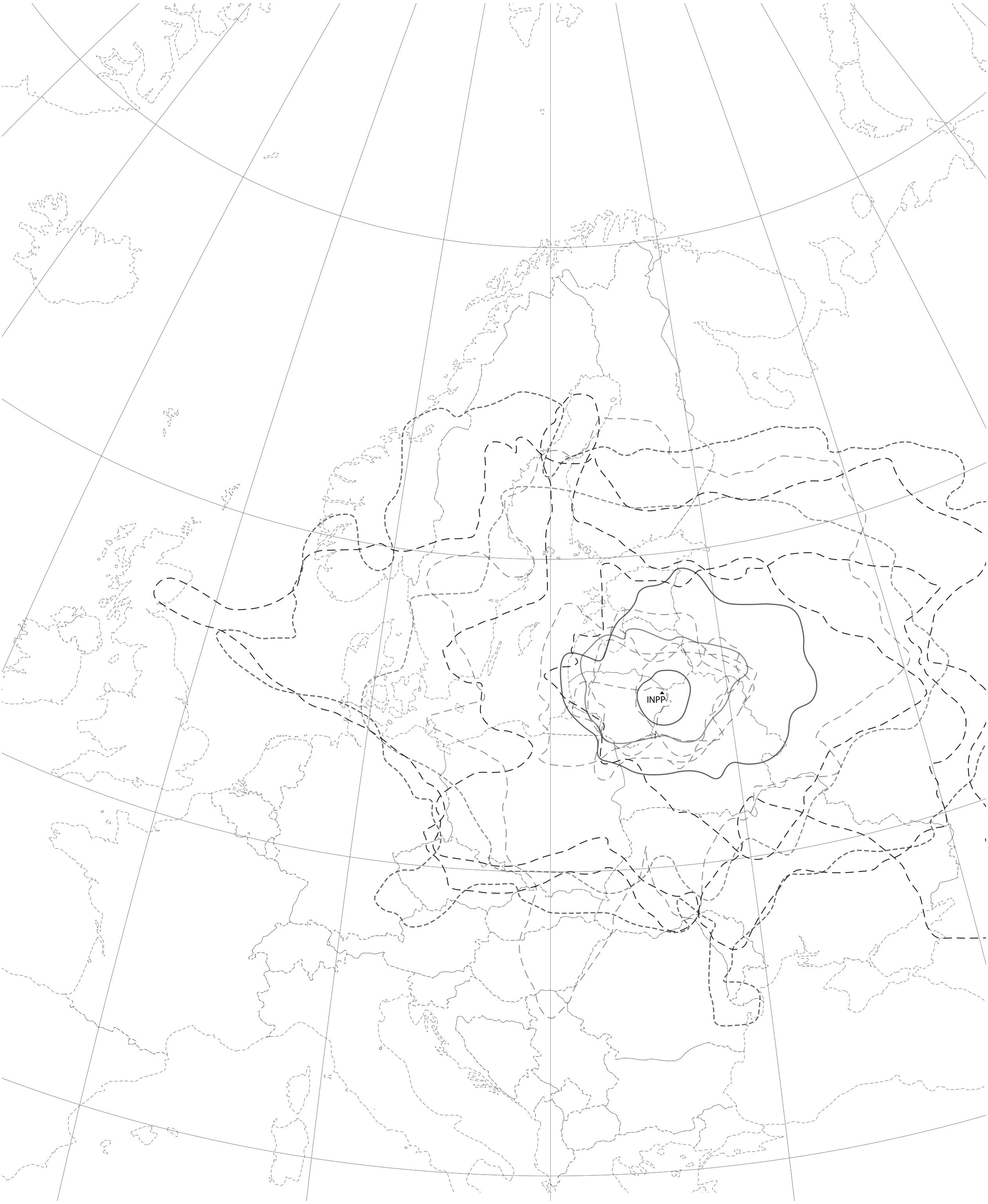

AFTERMATH

Visaginas, Lithuania 2026

AFTERMATH OF MEGASTRUCTURAL PATHOLOGIES

TRACING LIMINAL LANDSCAPES OF THE NUCLEAR ANTHROPOCENE

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Fragile Territory

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key words: Nuclear heritage; Liminal landscapes; Megastructural pathologies; Intangible heritage; Post-nuclear territories; Anthropocene; Spatial traces

Contents

Foreword

Imagination of the modern human for a while has been captivated by the promise that knowledge can liberate humanity from the limits imposed by nature.

This promise and belief forced the reorganization of entire landscapes. Erasing forests, redirecting rivers, reactors raised as monuments to scientific progress. Yet this act of mastery leaves behind conditions that cannot be entirely mastered.

This work begins from paradoxal uncertainty observing the moment in nuclear megastructural lifespan. A moment when machine ceases to produce and begins to remember, when it surrenders to the landscape.

The walls might disappear, the towers might be dismantled and the halls emptied, yet the territory continues to carry the invisible inheritance, exceeding the lifespan of the object itself.

This work asks what forms of memory architecture constructs for phenomenon that cannot be seen. How can the territory continue to be inhabited after the withdrawal of principal function yet within the remains of active consequences?

The project denies the idea of nuclear age monument, nor advocates for its disappearance, not trying to resolve the contradiction. It proposes that architecture may learn to care for what it cannot fully contain, erase or forget.

Part 1. Introduction

Problem statement

Note 01
A nuclear ruin remains an active political object.

The retreat of nuclear megastructures leaves behind a condition of liminality. It creates an intangible, enduring and spatially unresolved heritage that architecture has not yet learned how to fully address (Ross, 2023).

Unlike conventional industrial ruins, nuclear infrastructures do not decay into harmless material remains (material archives) (Dawney 2020), but into political, radiological, ecological and cultural pathological traces – invisible, impossible to neutralise or fully remove. The presence of these conditions produces a permanent endangerment narrative and situates affected territories in a state of uncertainty and liminality: after operation and before closure; after modernist promise, before post-industrial reconciliation (fig. 3, 4, 5).

Note 02
The end of operation does not constitute an ending.

YEAR 1974
Construction of Ignalina Nuclear Power Plant begins

YEAR 1983
Reactor Unit 1 enters operation

YEAR 1986
Chernobyl disaster

YEAR 1987
Reactor Unit 2 enters operation

YEAR 1990
Lithuanian Independence

YEAR 2004
Lithuania joins the European Union
Shutdown of Reactor Unit 1

YEAR 2009
Shutdown of Reactor Unit 2

YEAR 2010–Present
Decommissioning Era

YEAR 2026
State of Investigation
Legacy infrastructure

YEAR 2038–2050
Projected Completion of Surface Demolition
Reactor core dismantling

YEAR 2070
DGR site preparation and construction

YEAR 2048 – 2067
DGR site preparation and construction

YEAR 2068-2070
Commissioning and Operation

YEAR 2080
Final DGR completion

Fig. 3. The territorial dissection reveals the coexistence of two systems operating across radically different timescales. The first is the hydrogeological landscape inherited from the retreat of the last glacier, whose groundwater networks established the conditions for habitation and ecological succession.

The second arrived in 1983 with the construction of the Ignalina Nuclear Power Plant, a technological megastructure dependent upon the same geological foundation. Their coexistence produces a landscape of continuous negotiation, where deep geological processes and engineered systems generate overlapping regimes of control, protection, and latent risk.

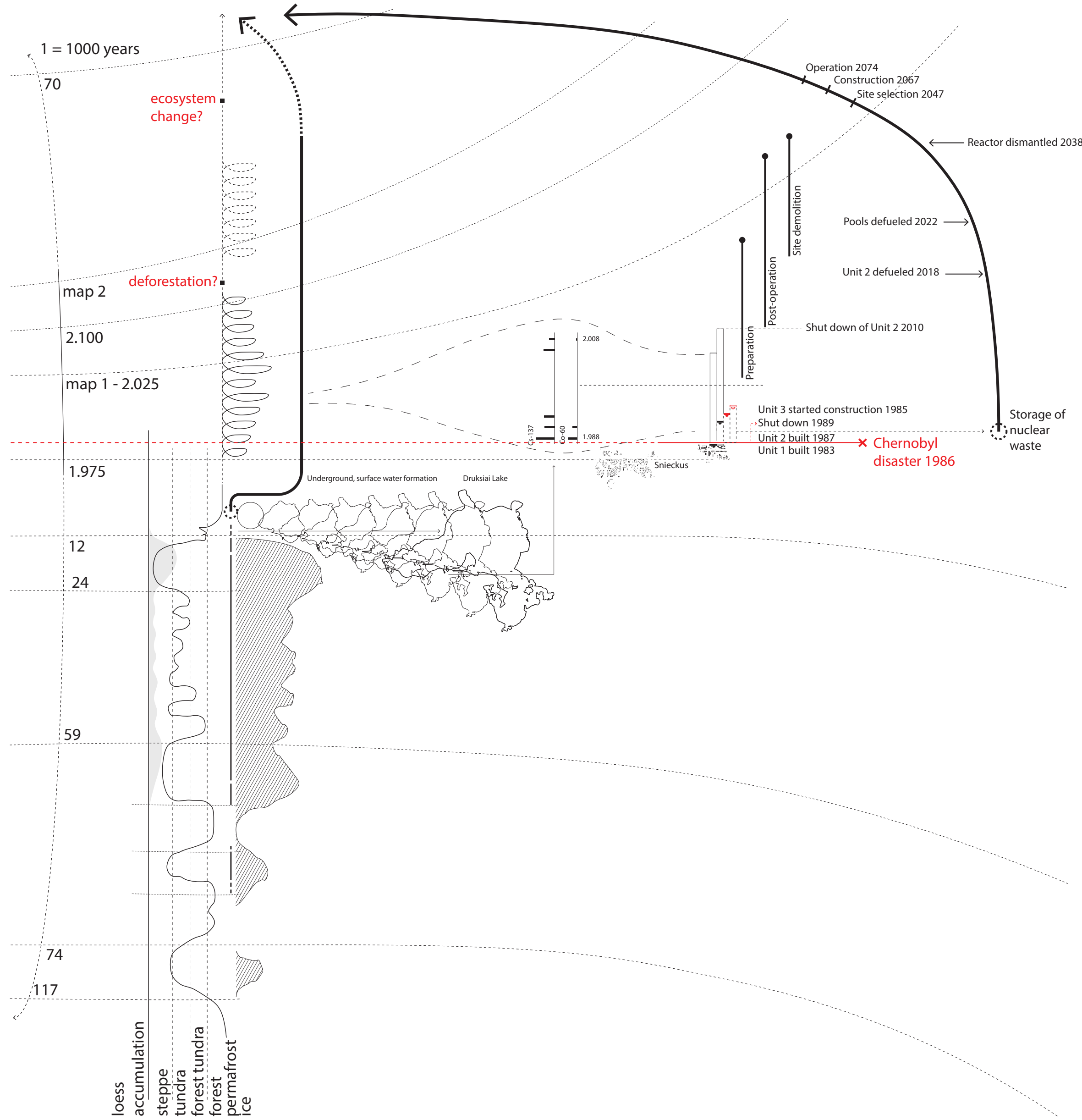


Fig. 4. View of crucial events of current

Fig. 5. View of crucial events of future

The Ignalina nuclear power plant (INPP) and the associated monotown, Visaginas, exemplify the fragility of the territory within the described post "technocratic utopia" condition. Both were established in the political landscape defined by rapid, enforced Soviet modernisation and aggressive control over nature in the 1970s (fig. 6).

Note 03
The town inherits a function that no longer exists. Entire settlements orphaned by infrastructure.

However, the Chornobyl incident in 1987 revealed the rise of unprecedented environmental risks and exposed deep weaknesses of technocratic rationality (Balockaite & Rinkevicius, 2008). The political shift, which emerged as a response, resulted in the cessation of being a host to the world's largest RBMK reactors (producing 70–80% of the electrical energy necessary for Lithuania (Gaigalis et al., 2015).

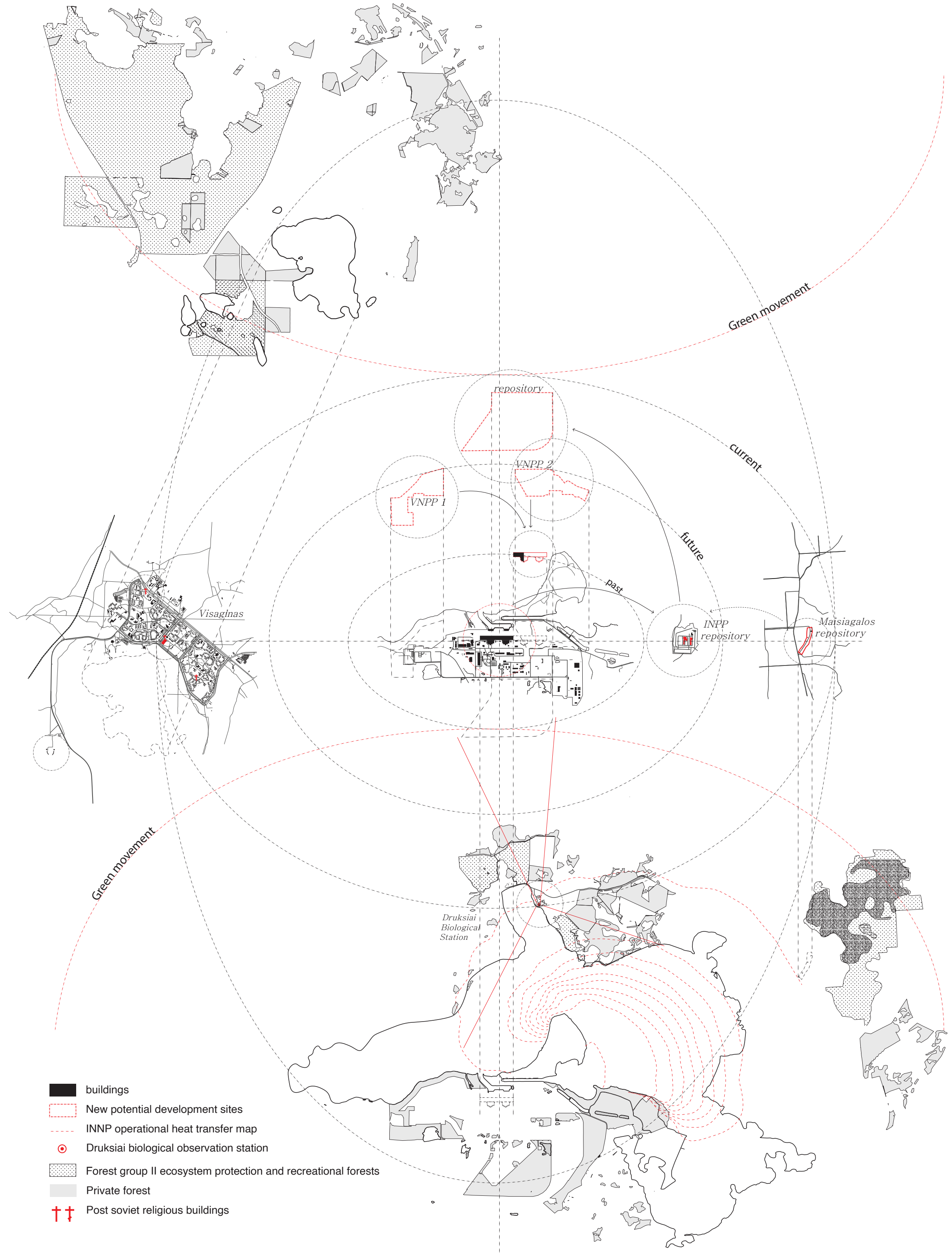
Note 04
Heritage emerges not only from preservation, but also from unresolved change.

Thus, the site became the embodiment of 20th-century Soviet technocratic contradictions - rushed modernity, uncertainty and faith in scientific progress, accompanied by systemic risks, applied as a tool of progress (Balockaite & Rinkevicius, 2008) (fig.7).

Note 05
Modernisation accelerated faster than its ability to foresee consequences.

Fig. 6. The glacial soils of the region supported dense coniferous forests that became an essential condition for the establishment of the Ignalina Nuclear Power Plant. Their continuous, dark mass served both ecological and political purposes: concealing the nuclear complex and the monotown of Visaginas from the horizon while acting as a protective environmental buffer. Soviet modernization, however, simultaneously depended on and violated this landscape. Vast areas of forest were cleared for the construction of reactors, infrastructure, and transmission corridors, leaving permanent scars that never regenerated. The resulting voids reveal the aggressive territorial logic of the nuclear project, where nature was transformed into both camouflage and resource.

Fig. 7. The political landscape shifted from a regime of accelerated Soviet modernization and environmental control to one of ecological preservation. Following the Chernobyl disaster, growing awareness of technological risk exposed the limits of technocratic rationality and transformed environmental concerns into political resistance. Movements such as Sajudis and protests around the unfinished third reactor framed environmental justice as a demand for national independence. After independence, this shift was materialised through the establishment of protected areas, regional parks, and conservation policies, replacing the logic of production with one of ecological stewardship.



Part 1. Introduction

Following the shutdown of the second reactor in 2009, the region has entered an unresolved in-between state of reversal (fig.8.1).

While site clearance and full plant demolition are scheduled between 2038 and 2050 (Widuto & European Parliamentary Research Service, 2026), the unavoidable traces will remain embodied within the territory.

Note 06
The landscape continues to operate according to forgotten engineering decisions.

Approximately 22,000 assemblies of unique composition nuclear fuel (Babilas et al., 2018), contaminated structures, altered hydrological systems, extensive motiveless infrastructure (fig. 9, 10,11) and socio-cultural stigmatisation (fig. 12) will continue to define the territory long after the main function of energy production ceased.

Note 07
In Butterfly City, Visaginas appears suspended between pride and uncertainty, carrying the memory of an industry that no longer guarantees its future.

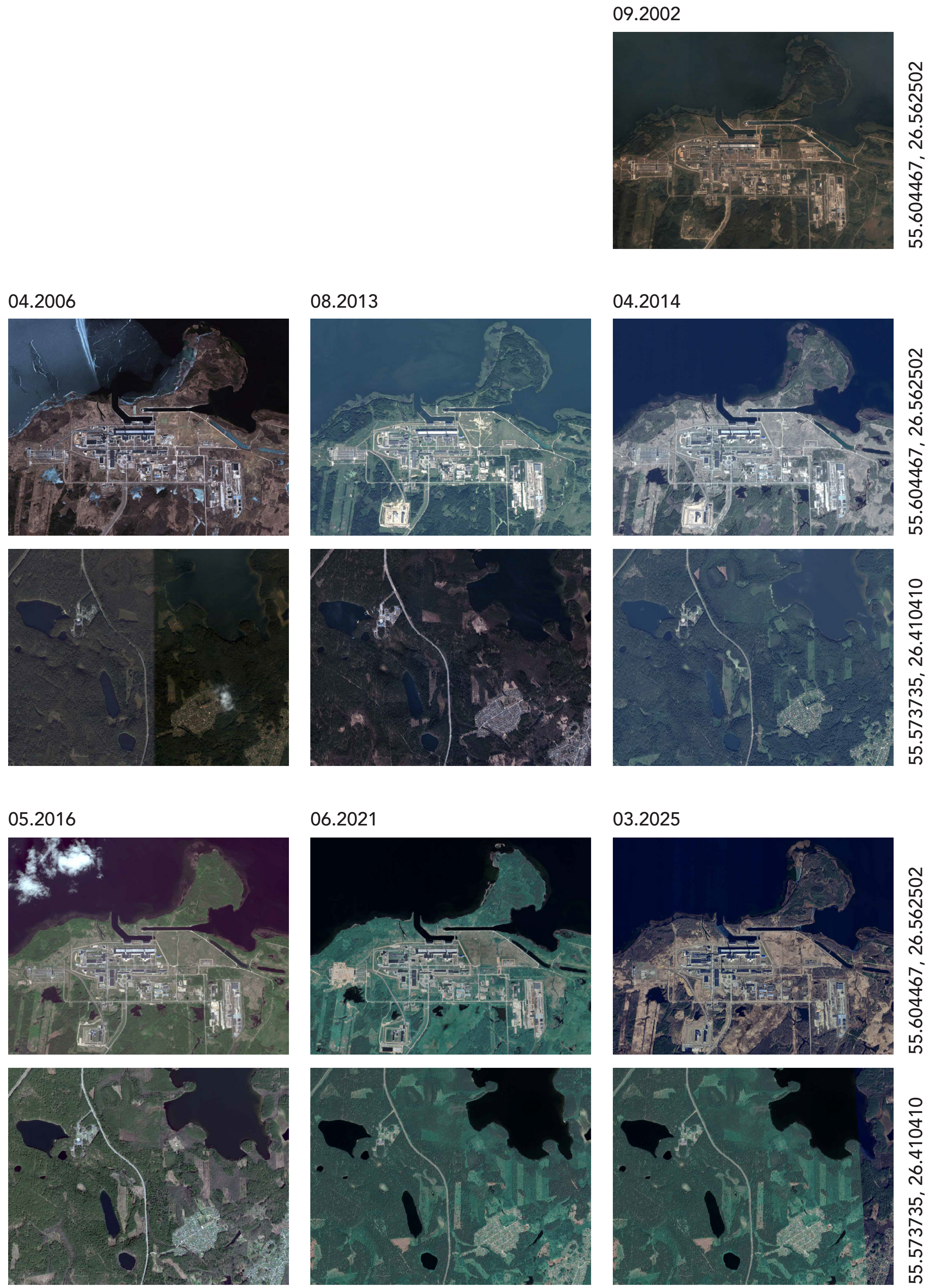


Fig. 8.1 Satellite images from Google Earth Pro

Fig. 9 The erected magistrales carried flows of electricity outward to Lithuania, Latvia, Belarus, while fragmenting ecological continuity. Steel poles rose in meadows and forests, humming continuously and offering nesting sites for storks, weaving non-human life into the electro-vascular system. For the time while the megastructure functioned as a producer energy flowed outward, yet on the first day of 2010 the arteries turned into life-support tubes. INPP became a consumer of energy, sustained by the same infrastructure that once defined its power.

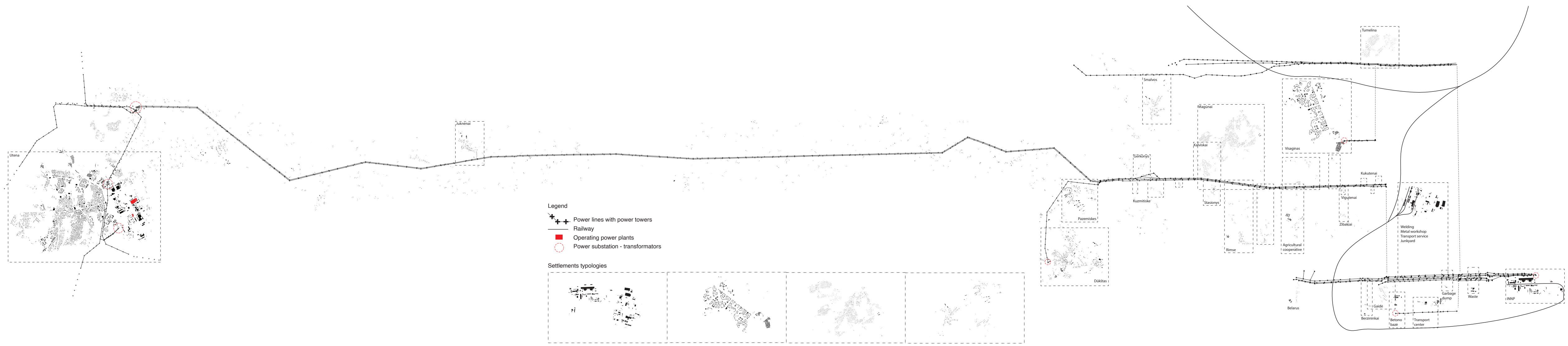
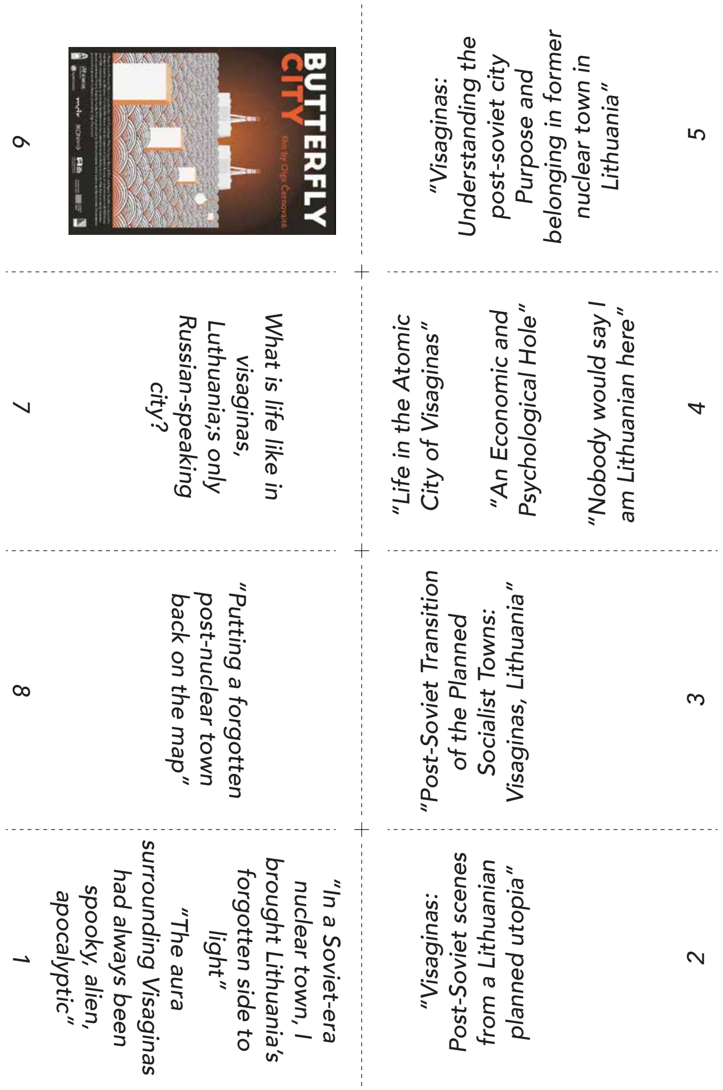


Fig. 11. The existing powerlines grid from INPP to Utena



Works of:

1. Neringa Rekašiute
2. Darmon Richter
3. Rasa Balockaite
4. Viktorija Mickute
5. Siarhei Liubimau
6. Olga Cernovaite
7. Ilze Kuzmina
8. Job Zomerplaag

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Fig. 12. Compilation of media narratives, research publications and cultural artefacts illustrating the identity of Visaginas (dependancy).

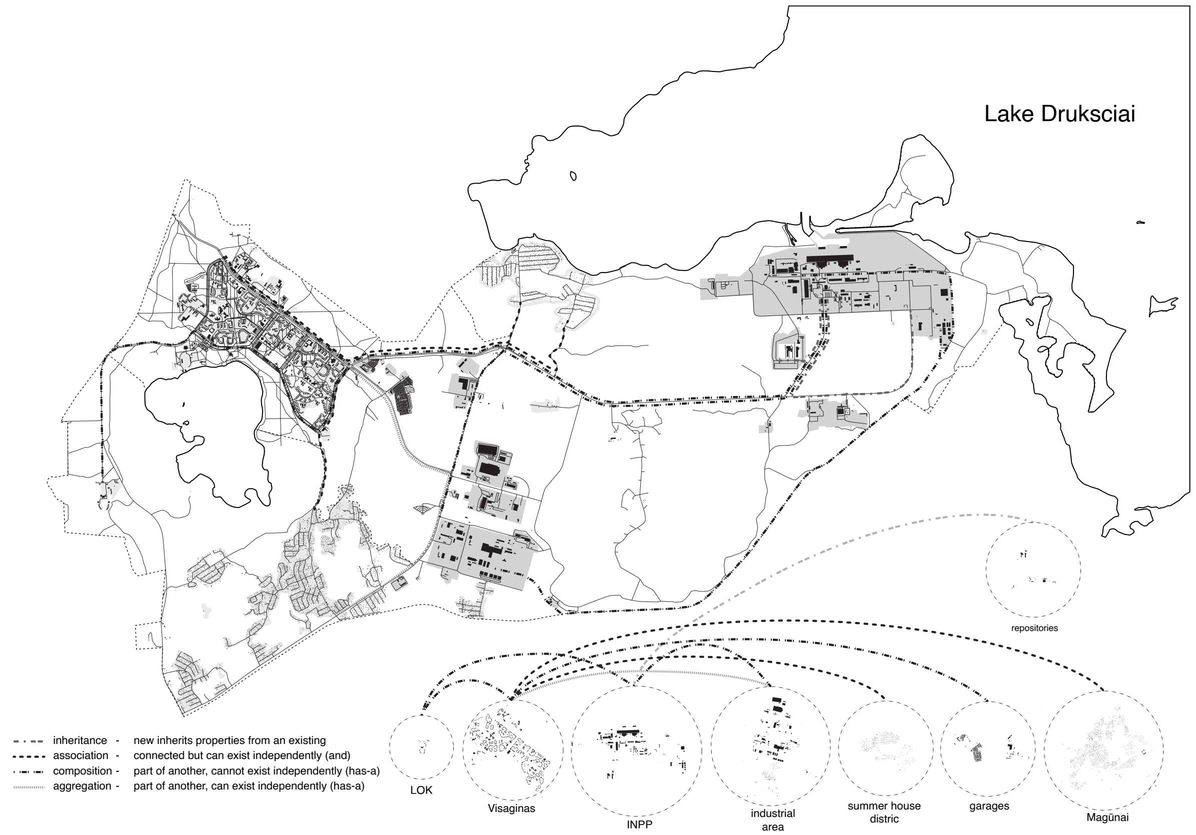


Fig. 10. The infrastructure relationships of INPP and Visaginas

Note 08
Efficiency measures what can be removed.

Note 09
Containment often relies on the assumption of future care.

The current most realistic decommissioning strategies for INPP are handled according to efficiency criteria (fig. 8), sometimes compromising long-term planning and safety, heavily relying on strategies of burial, concealment or postponement.

Note 10
Every dismantled structure removes evidence of operation.

Although necessary from an economic perspective, this process sacrifices the material, spatial, and cultural evidence of one of the most significant technological landscapes of the 20th century. Materiality and conceptuality can be lost if actively not collected, documented or interpreted before sites are dismantled, erasing the networks of meaning, practice, and local identities (Ross, 2023).

By concealing and erasing the nuclear materiality and memory, the complex socio-environmental legacies are being reduced to an engineering problem.

Note 11
Architecture can make the trace legible.

The research proposes to rethink the engineering and regulatory nature of architecture behind the process of nuclear megastructures decommissioning. Treating pathologies/ traces as a distinct artefact of the Anthropocene (Spaulding, 2023) forces architecture beyond containment, symbolism or the state of oblivion, to move towards acknowledgement of the liminality, permanence and mediation.

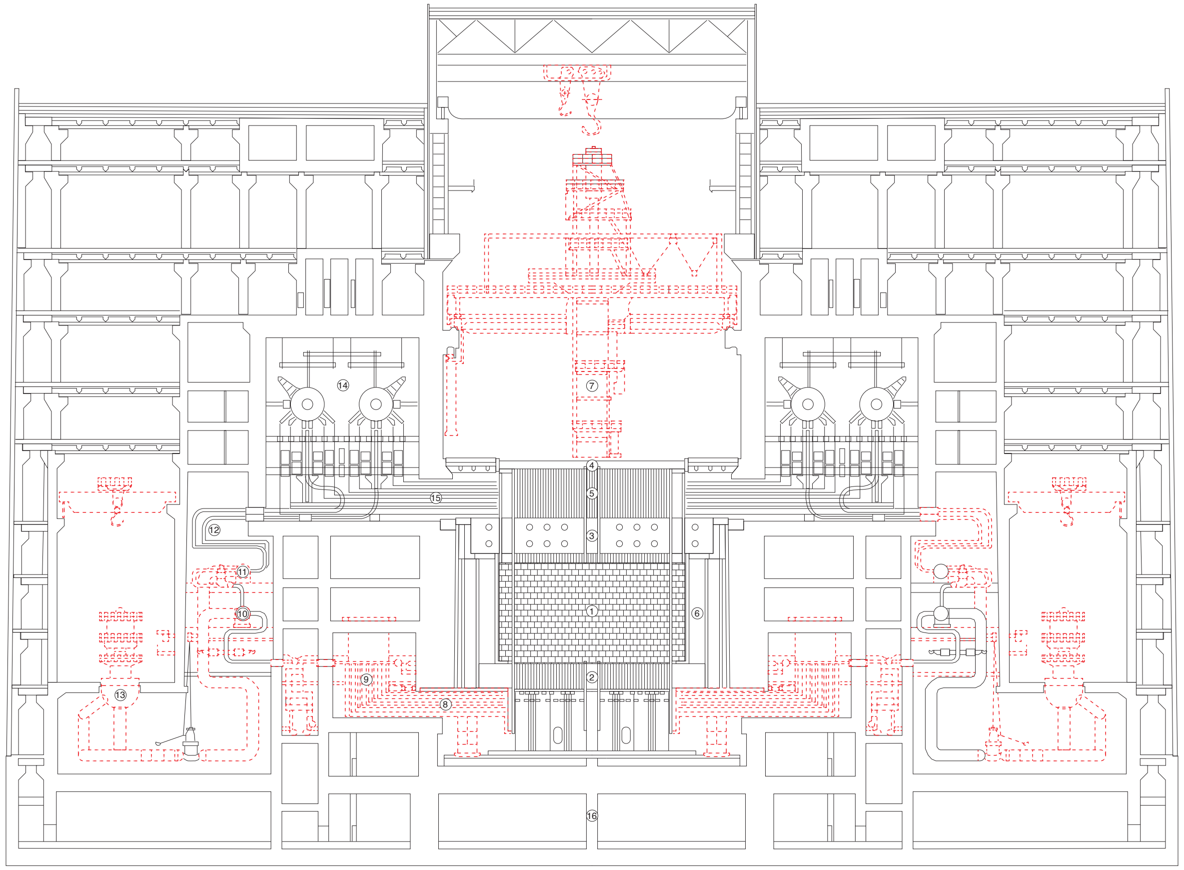


Fig. 8. The operational regime of the Ignalina Nuclear Power Plant has been replaced by a decommissioning framework defined by international nuclear safety regulations. Much like its rapid Soviet construction, dismantling follows an accelerated and highly standardised logic, reducing the megastructure into regulated fragments according to predetermined timelines. Prioritising efficiency and risk reduction this process leaves little room for the preservation of technological heritage. As a result, unique RBMK systems and structures are systematically dismantled and disposed of, erasing the material evidence of late-Soviet nuclear engineering.

Relevance

"With over 400 nuclear power reactors around the world, decommissioning will be an ongoing challenge for some decades. "– Kirk et al. (2025)

Note 12
A technological event becomes a marker within the Earth's strata.

Note 13
Human activity enters the geological record.

Multiple consequences of the last (second) nuclear age activity (plutonium pollution, radioactive isotopes, and contaminated sediments) left global traces major enough to mark the start of the new geological layer formation (Spaulding, 2023). Despite that, the nuclear industry has already entered the "Third Nuclear Age" due to a renewed arms race, multipolar competition of entanglement of nuclear and non-nuclear forces, and a state-driven model of innovation (Naylor, 2019), accelerating the construction of new nuclear infrastructures.

While technically sophisticated, new developments and inventions are being framed as a solution for a reliable, stable base load of low-carbon electricity, industry still displaces responsibilities into the distant future and reduces the opportunity for public engagement. The questions of memory, legitimacy, accountability and cultural continuity often remain outside the scope of design. This reveals the pattern of risks repeating the unresolved pathologies of the last century – the failure of megaprojects, territorial sacrifice, secrecy and social exclusion (Lehtonen, 2021).

Note 14
The industry advances faster than its cultural frameworks.

Note 15
Secrecy has survived every nuclear generation.

For architecture, a discipline that works within the concept of matter, time and meaning, the idea of confronting the absolute condition of the Anthropocene is particularly calling. As nuclear traces operate across temporal scales that exceed conventional design horizons, the architecture has the potential to contribute by creating spatial frameworks that alter the existing engineered physical containment policy.

Note 15
Containment protects matter. Mediation protects memory.

Objectives and Motivation

"Early narratives of progress bound up with national achievement co-exist with those of stigma, destruction and disaster;"
Ross, 2025.

The primary objective of this proposal is the development of an architectural framework that acknowledges the nuclear traces as a permanent condition rather than an aberration for the location of the Ignalina region.

The project investigates how architecture can become a negotiation between highly specialised technocratic environments and broader society. The project addresses the challenge of nuclear legitimacy and blurs the societal boundaries, diluting the secrecy of the nuclear industry. As well raises a question of alternative methods of nuclear heritage preservation through the idea of "timescales", avoiding the narrative of nostalgia or endangerment.

Note 16
Permanence, often assigned to monuments, here belongs to consequences.

The motivation for this topic emerges from personal long-term engagement with the territory of INPP and Visaginas, and embodied observation and exposure to the managed secrecy of the nuclear industry. Additionally, the interest lies in the suspended/liminal condition of the landscapes - between use and abandonment, visibility and secrecy, progress and aftermath. The case of INPP and Visaginas incorporates the convergence of geological permanence, technocratic ambition and unresolved future with unique fragility.

Note 17
The project does not eliminate uncertainty. Liminality is a condition, not a transition.

Note 18
The project preserves a process rather than an object.

Research and design questions

How can architecture operate as a continuous reminder of responsibility within a post-nuclear territory, without relying on erasure or nostalgia?

What lives on when a nuclear megaproject retreats, and how are its traces currently managed?

What can spatialize the intangible heritage and temporalities of the nuclear industry without reducing them to a didactic narrative?

How can architectural space mediate institutional secrecy and public exposure without denying the danger?

Can liminality be a defining architectural condition rather than a transitional phase to be resolved?

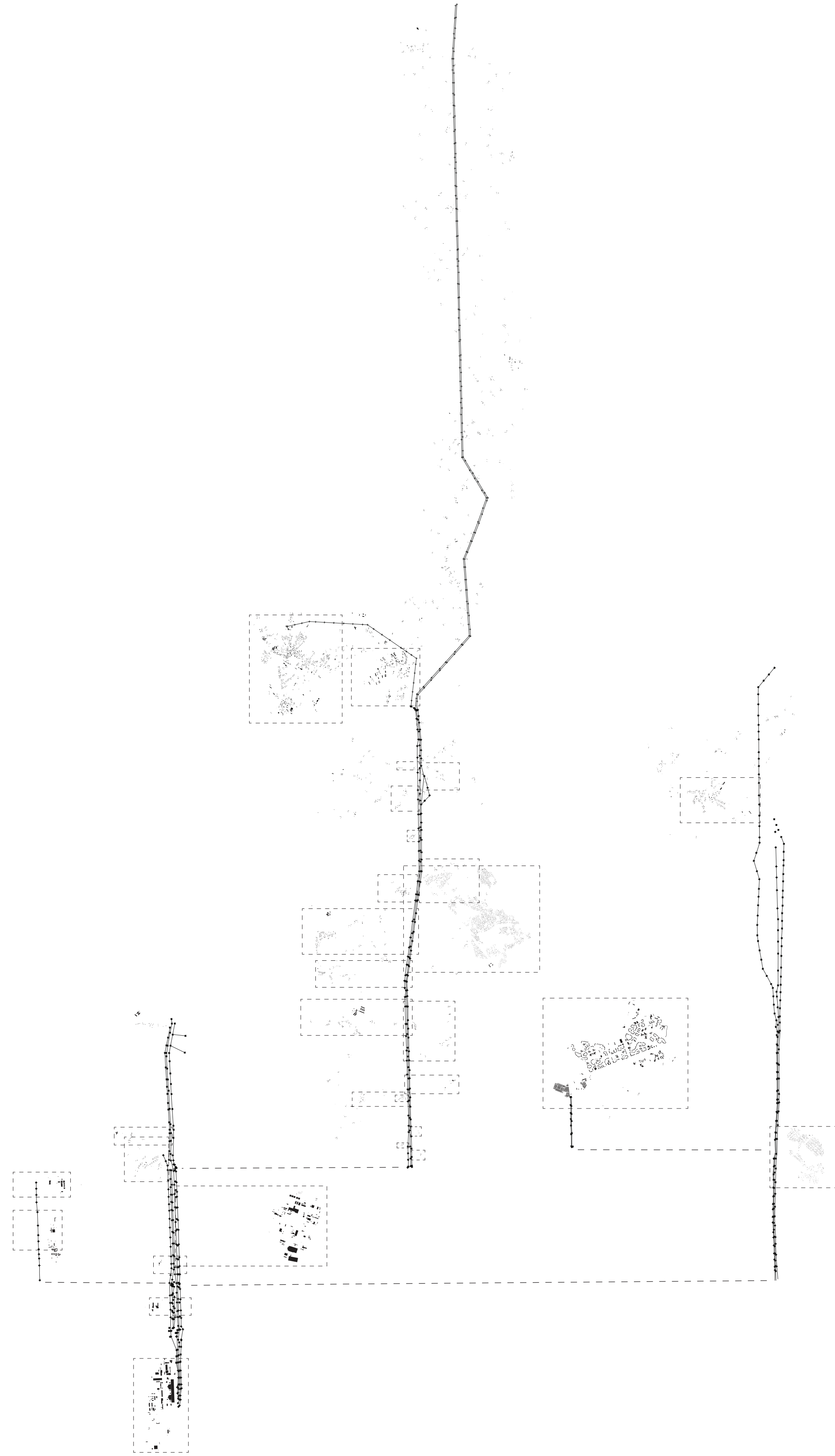


Fig. 13. Surroundings and power line web unfolded

Scope

The territory of the former nuclear megastructure enters a condition in which the original source of meaning (INPP) fades away while responsibilities and left behind traces persist. Thus, the research challenge is based on the disconnect of nuclear institutional temporality and the consequences of the industry. The research investigates the introduction of a new institutional typology, breaching the secrecy of the nuclear industry and legitimising the absence of nuclear heritage through alternative methods of preservation and public engagement.

The selected location of the proposal belongs to the former INPP and is approximately 1km from the reactor complex. The future for the site includes the construction of a Near-Surface disposal facility (NSDF) for the low-level, short-lived radioactive waste, which will result in tonnes of displaced soil and long-term monitoring requirements of another nuclear landscape.

Thus, the site was selected for the programmatic attempt of this proposal to combine the management of tangible traces and the acknowledgement of intangible traces of the former nuclear megastructure.

The proposal introduces a multi-layered deep repository research complex, consisting of interrelated zones of technocratic and ideological, ritualistic domains. These spaces range from highly controlled scientific environments to openly accessible ideological and cultural platforms, allowing negotiation regarding nuclear processes. It includes the nuclear waste encapsulation plant, observation/research laboratories, deep geological repository and publicly accessible spatial thresholds understanding the timescales of nuclear traces: human, biological and geological. Ultimately, the project explores the ability of architecture to sustain a culture of responsibility within a post-nuclear landscape after the physical infrastructure that produces it has disappeared.

Theory

"If ever I say to the moment:

'Linger a while! You are so fair!'

Then you may cast me into chains,

Then I will gladly perish."

- Faust I, lines 1699–1702

(translation varies by edition)

In the middle of the 20th century, humanity entered the Faustian bargain of boundless energy supply against the backdrop of potential devastation in the face of nuclear wastelands (Musch, 2016). The danger of the negotiation did not follow malicious intents, but in the willingness to accept long-term consequences in exchange for immediate gains. However, the generation that received the immediate benefits is not the same that will bear the full burden of decommission processes and nuclear future dilemma.

Finish facility - Onkalo Spent Fuel Repository is an example of the materialisation of future costs of past ambitions. The finish operating company, Posiva Oy, promises the ability to create a containment for nuclear waste for at least 100 000 years, solving complicated engineering and technical aspects of encapsulation and deep repository operation (Posiva - Long-term Safety, n.d.).

Note 19
A myth may outlive a technical manual.

However, the question of memory preservation and human intervention remains unresolved. The documentary of Michael Madsen about the Onkalo repository from 2010 calls out humanity to

"remember to forget".

It is a paradoxical philosophy governing the world's first but not last deep geological repository. It raises questions about when humanity should warn future civilisations about buried danger or completely erase the memory of the site to avoid possible disturbing of the burial. The concept of forgetting depends on the memory's prior existence, thus if no one remembers, there is nothing left to be forgotten. The phrase creates a loop. The concept of "atomic priesthood" emerges specifically due to the impossibility of guaranteeing permanent forgetting. Based on the teachings of the priesthood, the memory of the nuclear waste presence can be transformed rather than preserved, including folkloristic characters, such as rituals and legends (Musch, 2016).

Note 20
The safest repository may be the one nobody finds

Note 21
Forgetting is not the absence of memory.

One of the fathers of nuclear energy in the US, Alvin M. Weinberg (1972), stated that "we have relatively little problem dealing with wastes if we can assume always that there will be intelligent people around to cope with eventualities we have not thought of." Consequently, according to Weinberg, nuclear waste constitutes an almost eternal commitment, which can only be dealt with through the presumption of a perpetual

"social apparatus succession".

(Musch, 2016).

Note 22
Future generations may inherit stories before they inherit facts.

Note 23
The repository depends on people who do not yet exist.

This discourse raises a sharp question of nuclear heritage and knowledge preservation. In recent research, such as “Nuclear Cultural Heritage” by Linda M. Ross, nuclear heritage is being distinguished by a tension between the inevitable loss of material traces and their enduring presence. This duality sets nuclear apart from other forms of industrial heritage (Ross, 2023). Following the existing decommissioning and dismantling safety procedures, material objects and infrastructures will inevitably disappear, while radioactive waste and altered landscapes will persist over geological time horizons. Thus, the nuclear heritage cannot be reduced to static industrial monuments but includes the intangible narratives, which are as significant as physical artefacts.

Note 24
Nuclear heritage exists between presence and loss.

The discussed duality of absence alongside presence reveals deep challenges for preservation, interpretation and intervention. Engaging with this complexity requires architectural approaches that avoid nostalgia or didactic fixation and instead work with diverse systems of traces that must be navigated rather than resolved.

Note 25
A dismantled reactor may remain more influential than a preserved one.

Consequently, the project attempts to engage the concept of heritage and knowledge preservation through the capture of intangible human traces, which can be done through coexisting materialities in the spaces of inevitable loss and long-term presence. Such an approach allows meanings to be negotiated and renegotiated according to place and time (Ross, 2023).

Note 26
Preservation is an act of interpretation.

Methods

The methodology of the project is rooted in the structure of the Borders & Territories graduation studio. Therefore, the project was developed through cycles of mapping, modelling, precedent analysis, theoretical inquiry and iterative design testing. The investigation approached the Ignalina former industrial site as a fragile territory structured through the overlap of spatial regimes.

Note 27
Mapping became a method of revealing absence

The first part of the project is rooted in mapping exercises and iterative observation of the gathered data around the themes of ground, surface, movement, objects, events and regulations. The build-up of the material was done through study of geological research conducted for INPP, NSDF and future planned strategies for the territory, as well as through study of existing literature and documentation of political events in archives. As a result, the distinct, site-specific markers of nuclear infrastructure were identified.

These elements of material, ecological and institutional domains were defined as the intangible and tangible traces of the industry as they continue to structure the territory beyond the lifespan of the system that produced them. The synthesis of mapping exercises and theoretical research resulted in the formulation of the design brief.

Note 28
The site is simultaneously a landscape and a protocol.

The second phase of the methodology involved a series of physical model experiments conducted throughout the Modus Operandi workshop, where each study focused on an isolated condition of the site (2.5D), assembly, and spatial situation and transferred the principles of mapping, however, not the representation of it (fig. 14).

Note 29
The nuclear industry acts as a geological force.

Note 30
The terrain becomes a record of extraction, containment and displacement.

The exercises brought attention to the geomorphological nature of the nuclear industry, particularly by studying the displaced soil mounts on the selected site due to NSDF construction (fig. 15). The model explored the extent to which the future repository itself becomes a new anthropogenic terrain, which directly influenced the selection of the project site. It introduced the idea of embedding architecture as a geological agent, turning new terrestrial matter into organised cultural territory, following the ideas of Gottfried Semper in "The Four Elements of Architecture".

Fig. 14. Modus Operandi outcomes.

Fig. 15. The exploded view records the displaced soil generated by the construction of the NSDF. Through excavation and redistribution, the ground becomes an active component of the nuclear landscape, transformed from a natural formation into an engineered instrument of containment. The landscape itself is mobilised as a tool of containment, demonstrating how nuclear processes transform geology into architecture.

Note 30
Every nuclear facility organises itself around a centre.

Note 31
The reactor inherits the role of the contemporary hearth.

In the reimagined scenario of Gottfried Semper, the hearth can be understood as a radioactive source of the nuclear facility -q the sacred space - the reactor, the hot cell or the waste canister. The heart dictates the organisational system around itself programmatically while also remaining protected (fig.16). Thus, the surrounding shield of the hearth becomes a gradient of mediated security and proximity, filtering the alpha and beta particles with gamma rays through different thicknesses and densities of materials (fig.17). This exercise inspired the understanding of the spaces handling radioactivity as a gradient with negotiated conditions of accessibility based on human-centred safety regulations.

Note 32
The facility is organised around human limitations.

Architecture mediates between human bodies and non-human forces.

Additionally, the human presence imposes an alternative regime of hierarchy in the nuclear facility, which is defined not through the grandiose of physical and chemical reactions, but the ability of the person to control it.

Fig. 16. The Modus operandi model traces the spatial journey of a nuclear fuel assembly through the power plant, documenting its movement across successive architectural and technical environments. As the fuel circulates, its radiological condition transforms, generating distinct regimes of containment, shielding, and human access. The model reveals how changing levels of radioactivity shape the organisation of space, making radiation an invisible force that structures the architecture and operation of the nuclear facility.

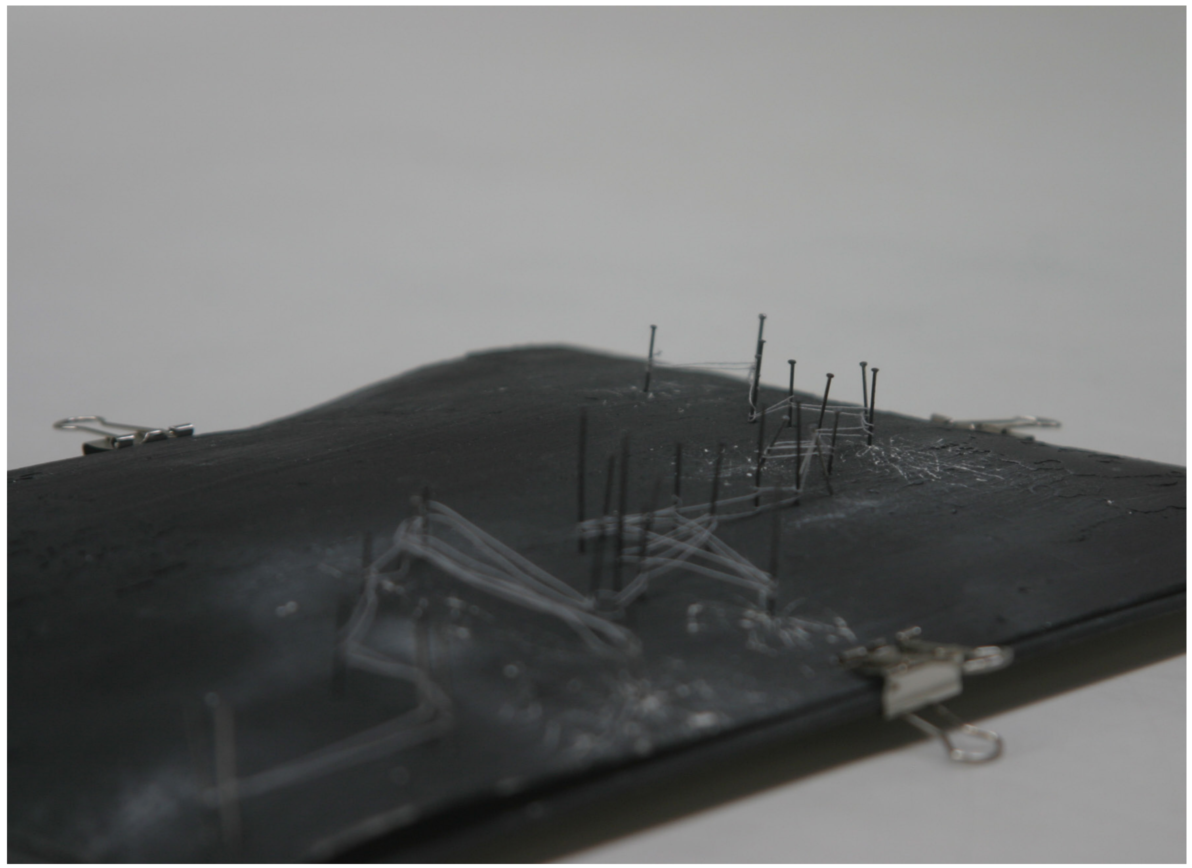
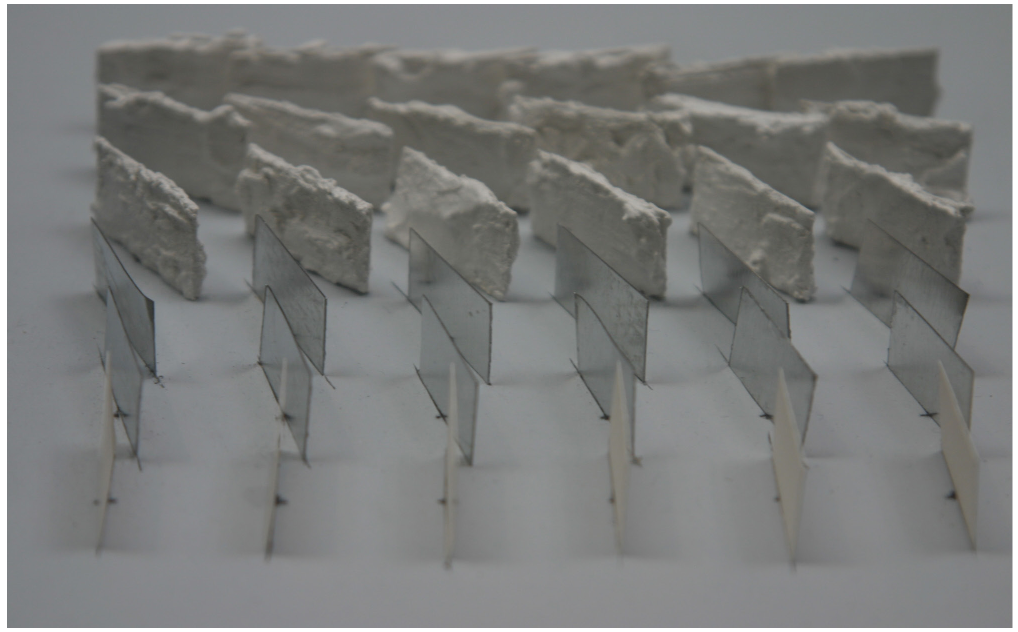
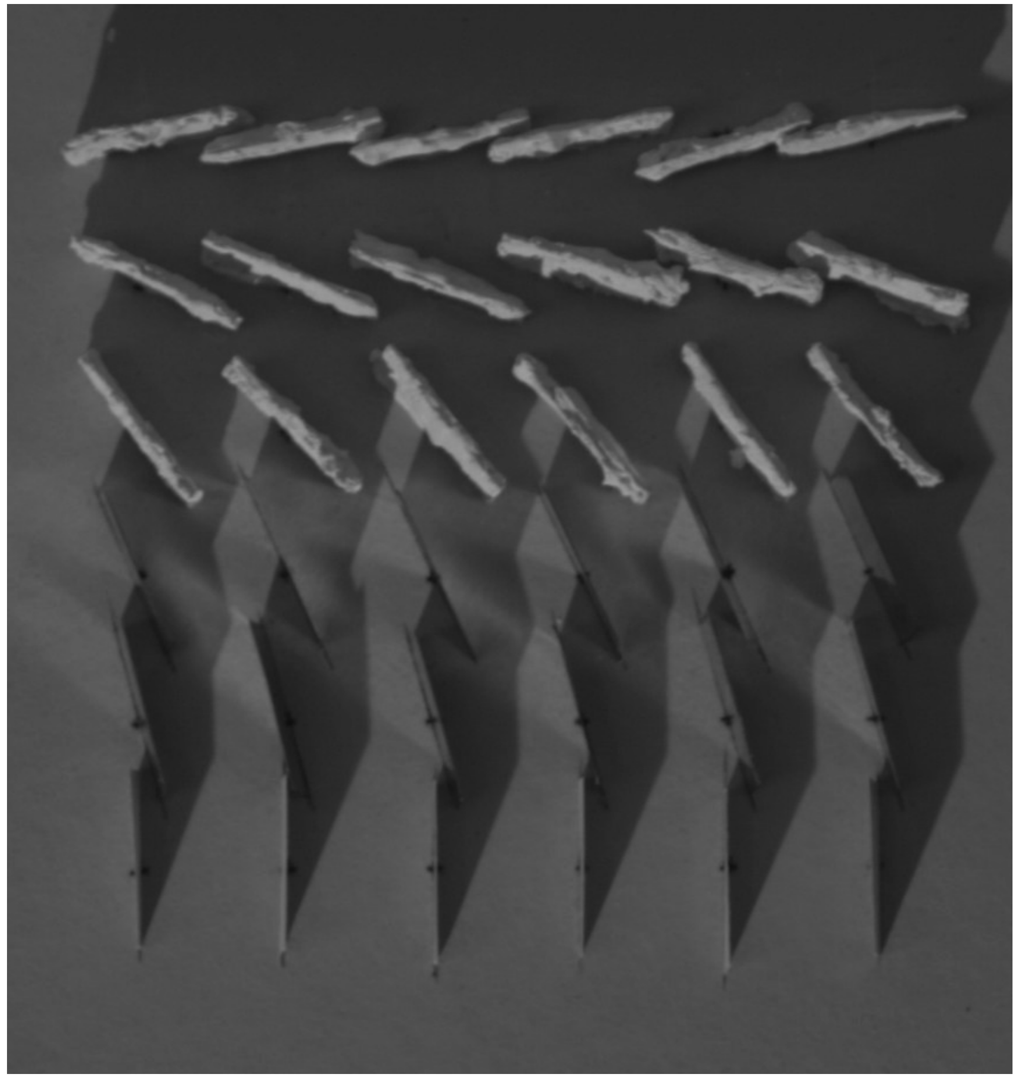


Fig. 17. The model translates the invisible behaviour of radiation into a spatial and material sequence using light as an analogue. Different barriers demonstrate the principles of shielding: paper interrupts alpha particles, metal absorbs beta radiation, and dense concrete attenuates gamma rays. By revealing how varying forms of matter resist different levels of penetration, the model illustrates how radiation becomes a generator of architectural thickness, materiality, and protective distance.





Note 33
Industry becomes stratigraphy.

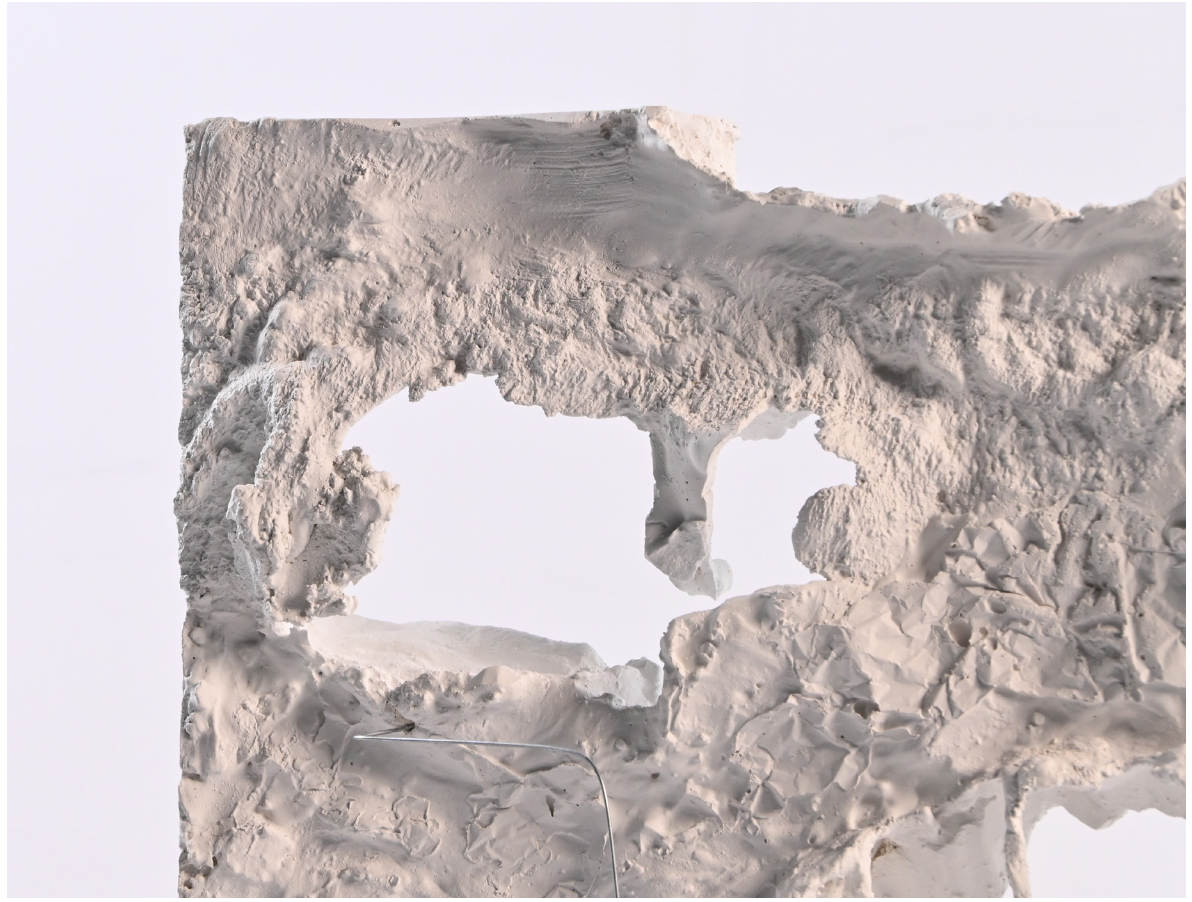
The last model of Modus Operandi (fig. 18) focused on the geological section of the territory, highlighting the coexistence of multiple timescales, bringing the idea of deep time. Matt Edgeworth (2021) argues that human activities have become massive enough to transform Earth's strata, operating on a geological timescale, as the nuclear material represents one of the few human-made substances that will persist on geological timescales surpassing civilisations, which makes humans a formidable Earth-system force (Spaulding, 2023).

Fig. 18. The deep time model situates the nuclear landscape within geological processes that far exceed human history. Formed by glaciation and the slow evolution of the terrain, the ground becomes both the foundation for nuclear infrastructure and the medium through which its responsibilities must endure.

Note 34
Human certainty appears small when measured against deep time.

Thus, the research focused on the idea of radioactive half – lives, remaining traceable across human, biological and geological domains despite the different understanding of timescales. Similar to Voltaire's Micromégas, human knowledge appears fragile because of the brevity of human existence; the impact of it extends across other timescales, altering them, allowing the presence of nuclear waste to be understood not as a residue but as an active participant, altering deep time.

Additionally, the INPP and Visaginas are of big interest in academic literature, specifically in the fields of nuclear studies, anthropology, and science and technology studies (Meyer & Sérandour, 2024). Through a scoping review of existing literature, the key concepts and social positions regarding the nuclear waste issue were identified.



Finally, the site visit was conducted to gather visual information and to collect the most recent data from Altra (INPP decommissioning organisation) and biological observation facilities.

Expected outputs for next quarter include analytical drawings, speculative sections, and representational models, following the timeframe set by a course guide. The planning follows a recursive structure: mapping informs design hypotheses, which are tested and re-mapped, gradually carving out a precise architectural argument. The end goal of the project is to provide a concrete, technically developed architectural proposal, operating as a continuous, daily reminder of responsibility within a post-nuclear territory, without relying on erasure or nostalgia.

Naturally Occurring Radioisotopes

Isotope	t1/2 = years	Notes
Carbon-14 (^{14}C)	5730	Cosmogenic; archaeology and environmental tracing
Potassium-40 (^{40}K)	1.25 billion	Primordial radionuclide
Uranium-235 (^{235}U)	704 million	Natural fissile isotope
Uranium-238 (^{238}U)Thorium-232	4.47 billion	Main natural uranium isotope
(^{232}Th)	14.0 billion	Primordial radionuclide
Radium-226 (^{226}Ra)	1600	Decay product of uranium

Artificially Produced Radioisotopes

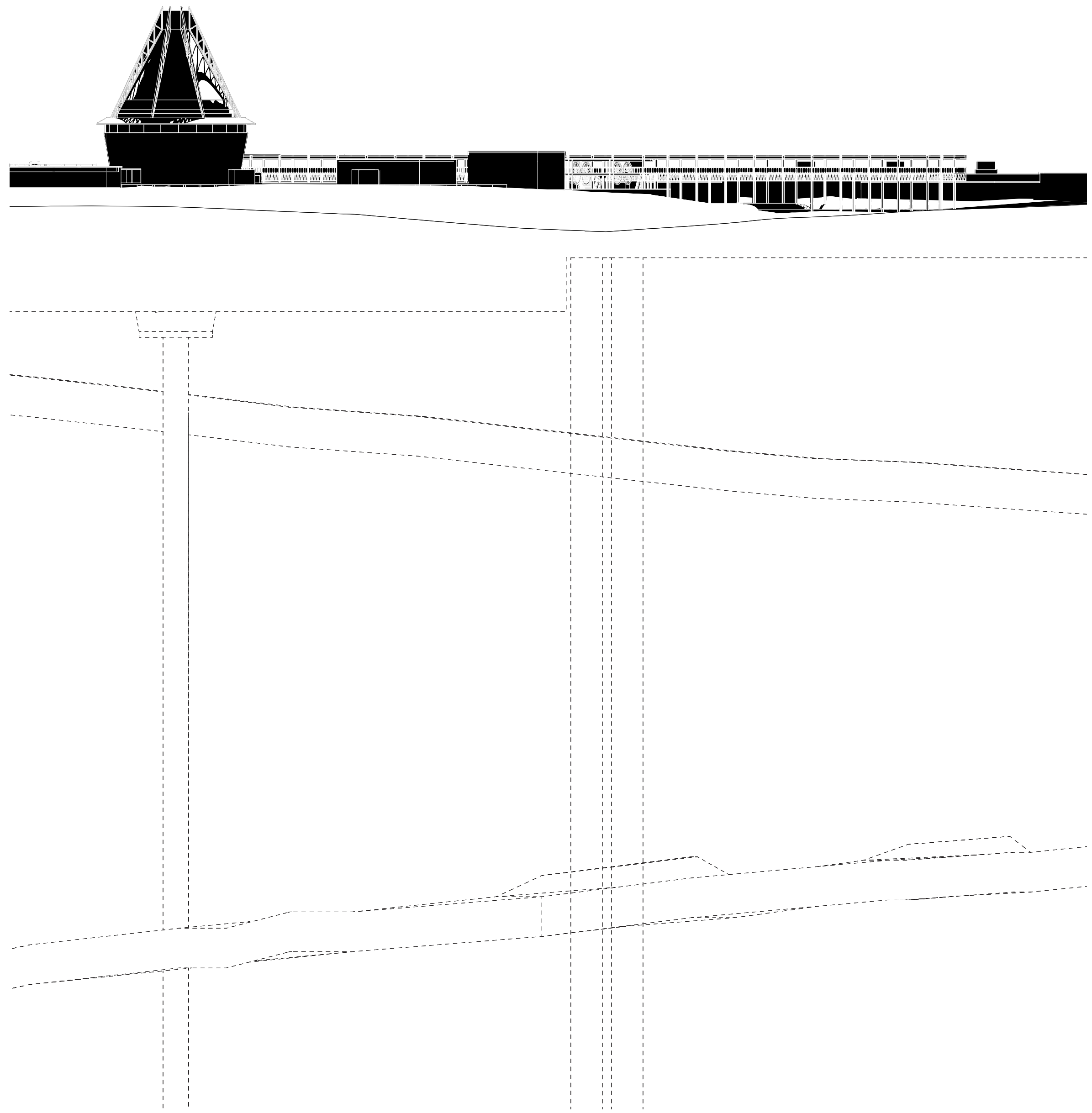
Isotope	t1/2 = years	Notes
Cobalt-60 (^{60}Co)	5.27 years	Industrial radiography and sterilization
Cesium-137 (^{137}Cs)	30.17 years	Industrial gauges and con-tamination legacy
Strontium-90 (^{90}Sr)	28.8 years	Fission product
Americium-241 (^{241}Am)	432 years	Smoke detectors and indus-trial gauges
Plutonium-238 (^{238}Pu)	87.7 years	Radioisotope power sys-tems
Plutonium-239 (^{239}Pu)	24,100 years	Nuclear fuel cycle and waste
Technetium-99 (^{99}Tc)	211,000 years	Long-lived fission product
Iodine-129 (^{129}I)	15.7 million years	Environmental tracer and waste management
Neptunium-237 (^{237}Np)	2.14 million years	Actinide in spent fuel

Research and design results

Note 34
Human certainty appears small when measured against deep time.

The Aftermath of megastructure pathology aims to rewrite the language of disappearance, often used to describe the landscapes of Ignalina Nuclear Power Plant. While decommissioning strategies are primarily concerned with dismantling and disposal, the investigation demonstrates the alternative heritage narratives to fading physical evidence of the nuclear industry's presence. The proposal has progressed into the new typology of nuclear sector industrial infrastructure, creating the thresholds for public domain and ritual in proximity with the highly technocratic environments, blurring the boundaries of secrecy (fig.19). It aims to challenge the conventional temporality of the built domain of the nuclear industry through the operational acknowledgement of different timescales. The proposal put forward a new approach to nuclear heritage and knowledge preservation through intangible and tangible indirect traces left by the former megastructure, which defined the territory as nuclear.

Fig. 19. The building dissolves into the terrain, becoming an extension of the landscape rather than an object upon it. Elevation



Territorialization

The territorialization of the project on the site is based upon the strategy of axes of utilisation, observation and exposure with multiple segregated accesses to the building to avoid cross-contamination and radioactive exposure (fig. 20).

The building is submerged in the ground and levelled with the landscape as a part of the earthworks strategy, making the architecture the active landscape agent. The heavy, thick concrete base becomes a new imposed, scarring brutalist landscape, while the surfacing metal and glass structures of the roof give the lighter idea of construction temporality. The concealment of the structure by previously "wandering" excavated soil mounts provides constructional advantages (lesser reliance on retaining walls), security and controlled access points, which pierce the landscape, creating the 8-10 meters and 5 meters deep ditches acting as the replacement to conventional fencing, covering nuclear landscapes.

Fig. 20. A layered reading of the site, revealing current infrastructures, planned developments, and the proposal as a new territorial framework. Site diagram, 1:5000, 594 x 841 mm.

Axes

The mentioned axes are defined through the relationship with the traces of megastructure and circulation around the site. The axis of utilization is layered with research laboratories facility and public domain, access; observation axis is spanning across the landscape in the form of 750 meters long pedestrian light structure bridge, connecting the water body on the site and the territory of necessary hydrogeological sample collection; axis of exposure consists of atomic garden green house and the orchestra tower which operates as nuclear waste dispatch shaft with access only through the building.

Taking the existing condition of looming burden and presence of nuclear waste, the Aftermath proposes the deep repository and encapsulation approach based on the preferred immediate dismantling strategy selected by the government structures due to technical and financial reasons (fig. 21). The encapsulation plant ensures safe transfer of the nuclear waste into the new canisters and dispatch to the deep geological repository (fig. 25).

Fig. 21. Main programmatic elements and their organization within the territorial framework. Site plan, 1:2000, 420 × 594 mm.

Encapsulation

The encapsulation plant (fig. 22) is a recent concept of nuclear management system with only 2 projects in development by Posiva Oy in Finland and Forsmark in Sweden. It operates as a mechanism translating human consequences to the timescale of geological time. Territorially, the project is displaced from the axis of utilisation due to the required demolition of the mechanism once the operational purpose is completed, following safety protocols. This strategy of displacement was introduced for the long-term spatial acknowledgement of the absence of an encapsulation plant in the future. The void left behind the plant (fig. 23,24) becomes the confrontation point of the axes of utilisation and observation - another typology of nuclear landscape.

Fig. 22. Spatial sequence of the encapsulation process, illustrating the route of nuclear fuel toward the geological repository. Encapsualtion plant floor plan, worm-eye view, 1:300, 594 x 841 mm.

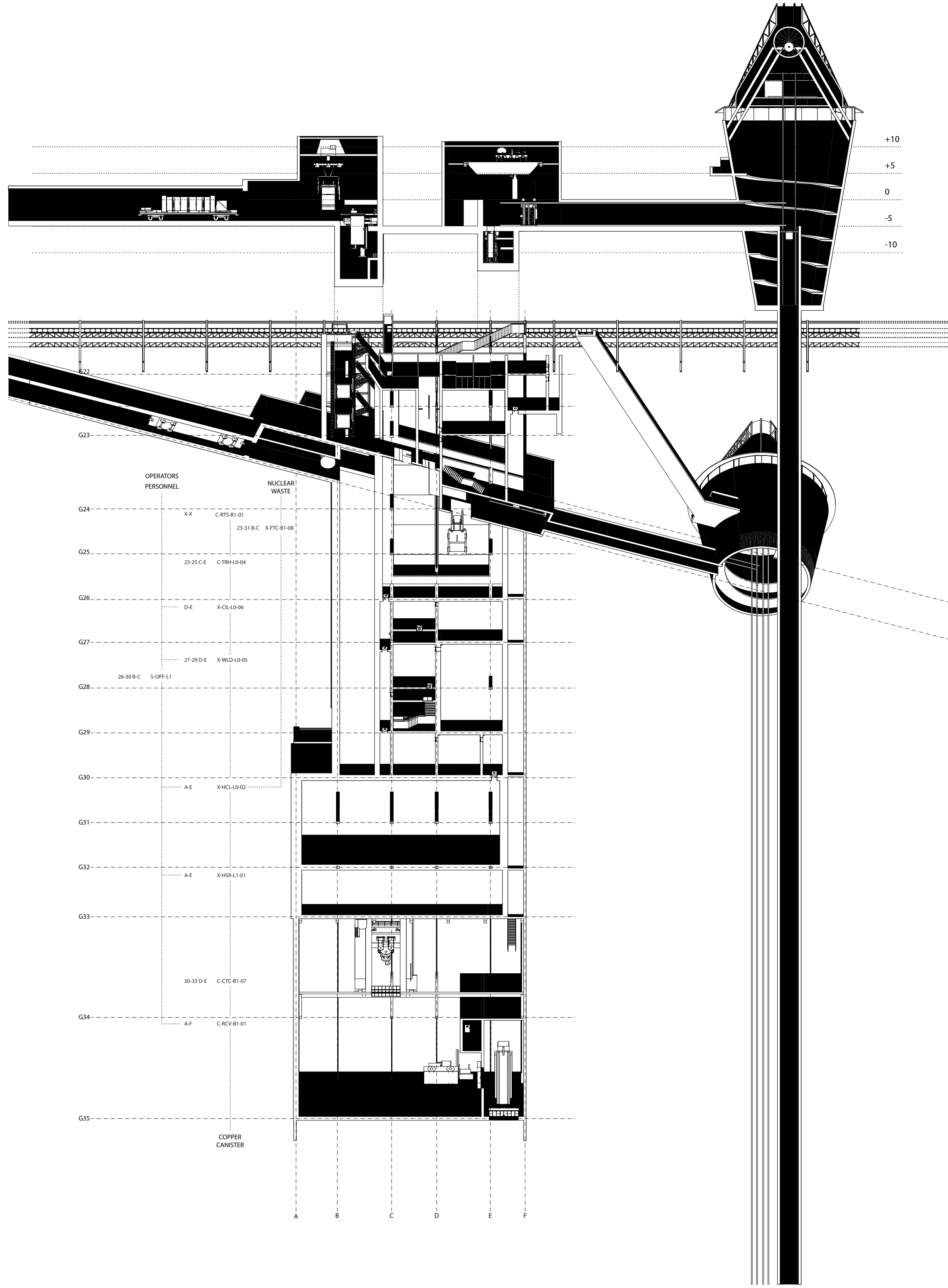


Fig. 23, 24. The architecture is designed around an inevitable disappearance. Designed for a function that will eventually cease to exist, the encapsulation plant anticipates its own obsolescence. Rather than resisting this condition, the project incorporates absence as an active design principle, allowing the memory of operation to persist through traces, rituals and transformed spatial relationships.

Geological Orchestra Tower

The deepest temporal horizon addressed by the proposal is geological time. Positioned above the deep repository shaft, the orchestra tower is the centrepiece of the project, slightly displaced from the overall composition. Its location was coordinated with the tunnel connecting the surface with the underground repository facilities. It becomes the most important threshold of public and technocratic presence (fig. 25).

Technically, the operation represents a routine stage within repository management. Architecturally, however, it becomes a tool of ritualisation. Twice per month, as documented by Posiva Oy, the shaft will dispatch the canister of nuclear waste with a unique composition of isotopes and radionuclides. The copper canister of 1.05 meters in diameter and 4.5 meters tall will be loaded by the machine onto the lift mechanism. The lift tool is designed using the vertical shaft sinking machine (VSM) used for the construction of this unique dimension shaft to become part of the physical traces documenting the presence or absence.

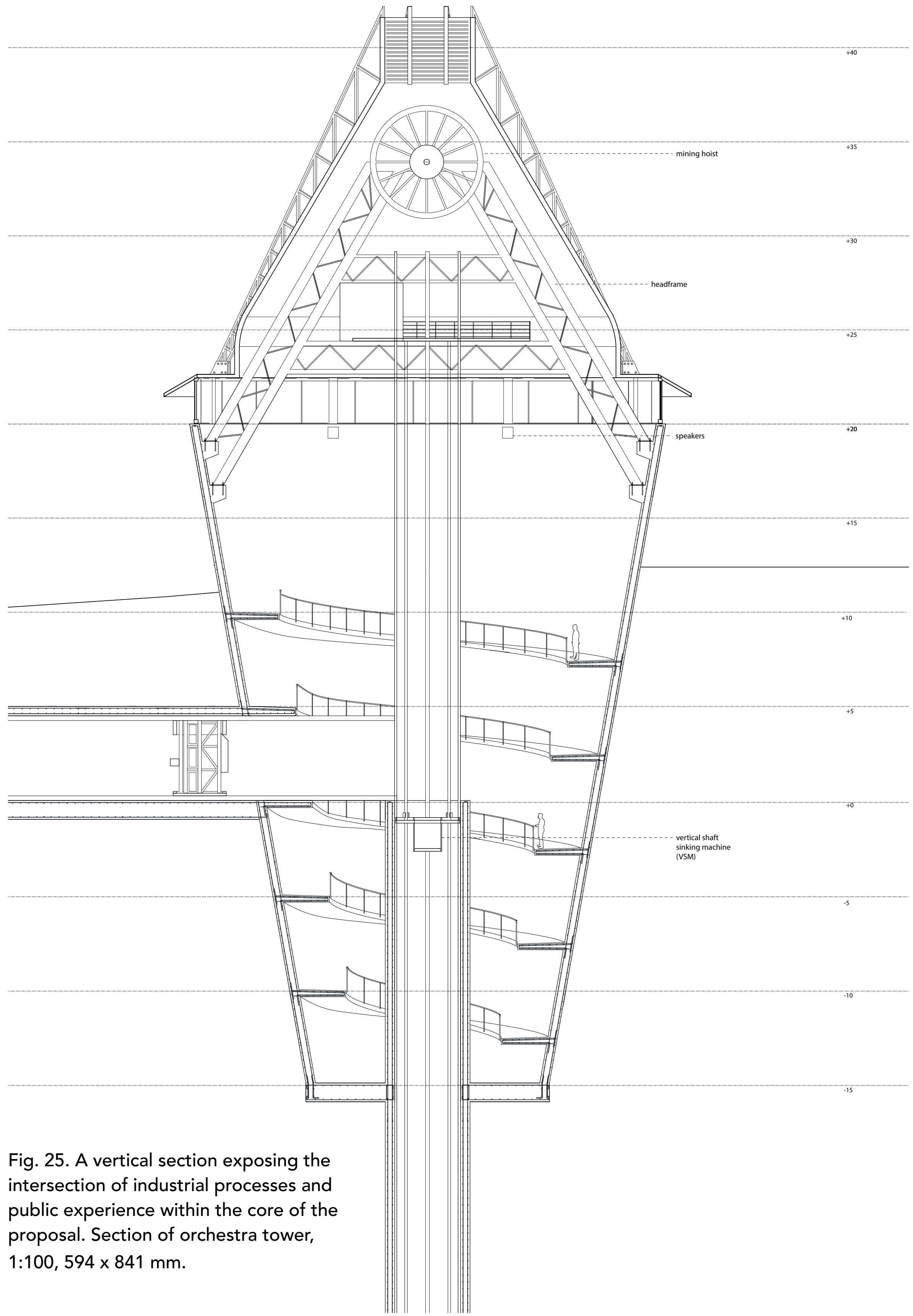


Fig. 25. A vertical section exposing the intersection of industrial processes and public experience within the core of the proposal. Section of orchestra tower, 1:100, 594 x 841 mm.

Previously, during the encapsulation process, the scientists would collect the samples of radionuclides from the canister to convert them into sounds using the radioactive orchestra technology, which reads the half-life of radioactive decay as notes to produce a soundscape. Such a soundscape becomes the accompaniment for the burial, documenting the composition of fuel through gamma radiation in case of a necessary retrieval procedure. It allows us to hear the nucleus of the atom undergoing the decay process, which will last for the next 100 000 years, defining the geological timescale.

Fig. 26. Exterior render of orchestra tower shows a concrete geological plinth supporting lightweight steel structures above. It establishes a dialogue between permanence and adaptation, containment and occupation. Both structures shield the contemporary hearth - hidden nuclear processes and repositories that continue to organise the territory.

Atomic greenhouse

"It is not enough to take this weapon out of the hands of the soldiers. It must be put into the hands of those who will know how to strip its military casing and adapt it to the arts of peace."
- President Eisenhower in a 1953 speech titled Atoms for Peace.

At the same time, one needs to consider the biological timescale manifested through the second threshold of a high control environment - the atomic greenhouse (fig. 27). The concept is based on the practice originating from the 1950s as a part of the "atoms for peace" movement (Youssef, 2019). Gamma gardens use Cobalt – 60, a byproduct of power plants and nuclear waste, which is being emitted in the atmosphere. It is used to test the irradiation effect on plant life. The goal of this facility is to create a mutation of the native to the site plants, to develop the biological marker of contamination and nuclear landscapes.

The products of the facility will cover the NSDF territory above the landscape corridor, like melanised fungi species in the Chornobyl reactor (Dadachova & Casadevall, 2008) (fig. 29)

The objective of the garden is not agricultural productivity but observation. The greenhouse creates a controlled zone of exclusion and biological accelerated evolution, confronting the biological timescale of adaptation by making it visible. It operated the cobalt-60 slug to irradiate the field remotely, and when not in use, put it to rest in the lead vault container underground. Access to the greenhouse is ensured through multiple buffer zone underground spaces to ensure safety measures. The plan of the greenhouse itself is structured into 3 radial zones, with the closest zone being the most vulnerable to radiation, usually causing the death of plants, highlighting the condition of mediated proximity (fig. 27). The visitors have a chance to observe the facility through the window with heavily shielded multi-layered viewing panels.

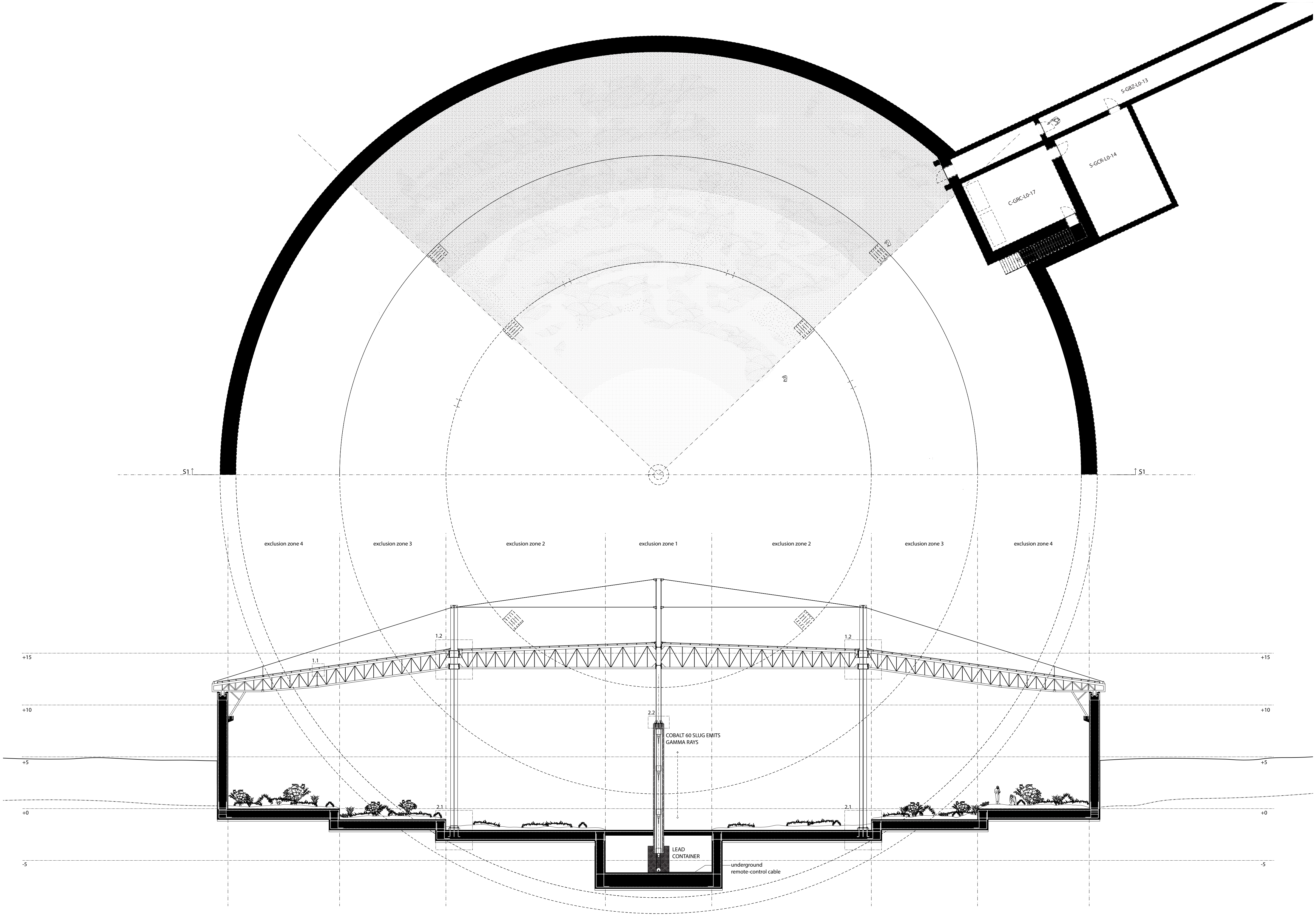


Fig. 27. Spatial arrangement of the greenhouse, highlighting the controlled zones of irradiation.
Atomic greenhouse section, 1:150, 594 x 841 mm.

Fig. 28. Nuclear landscape seeking neutrality, however unavailable for occupation and interaction. It requires constant observation.

Fig. 29. The selected plant species respond to altered environmental conditions and make otherwise invisible contamination legible.

Fig. 30. The greenhouse is organised around a central cobalt-60 source, transforming the irradiation apparatus into both a scientific instrument and a structural column. The radial steel truss roof extends from this central element, translating the invisible geometry of radiation into architectural form. The project expands the legacy of the Atomic Garden by making processes of mutation, observation and stewardship visible within a publicly accessible environment. Structural zoomed in view of the atomic greenhouse section, 1:150, 594 x 841 mm.

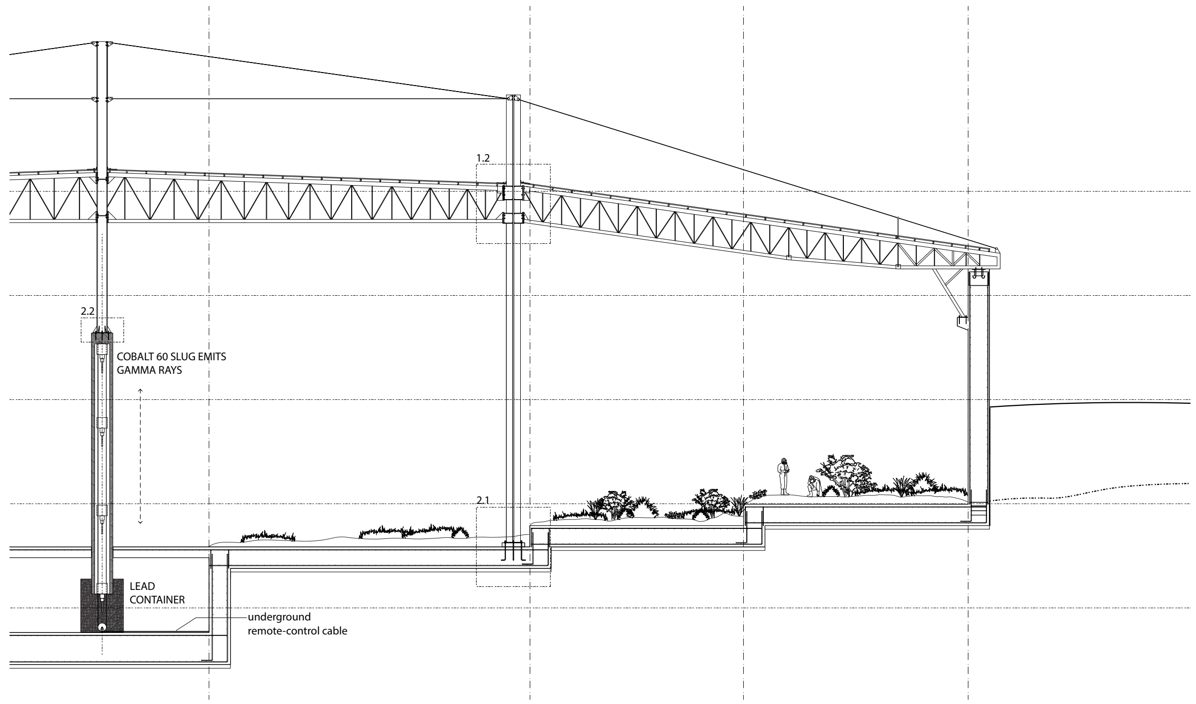
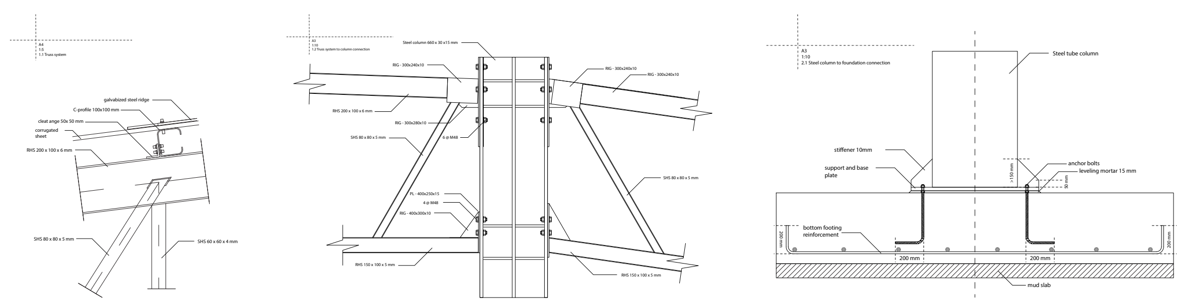


Fig. 31. Details 1.1, 1.2, 2.1 1:5, 1:10, 210 x 297 mm, 297 × 420 mm.

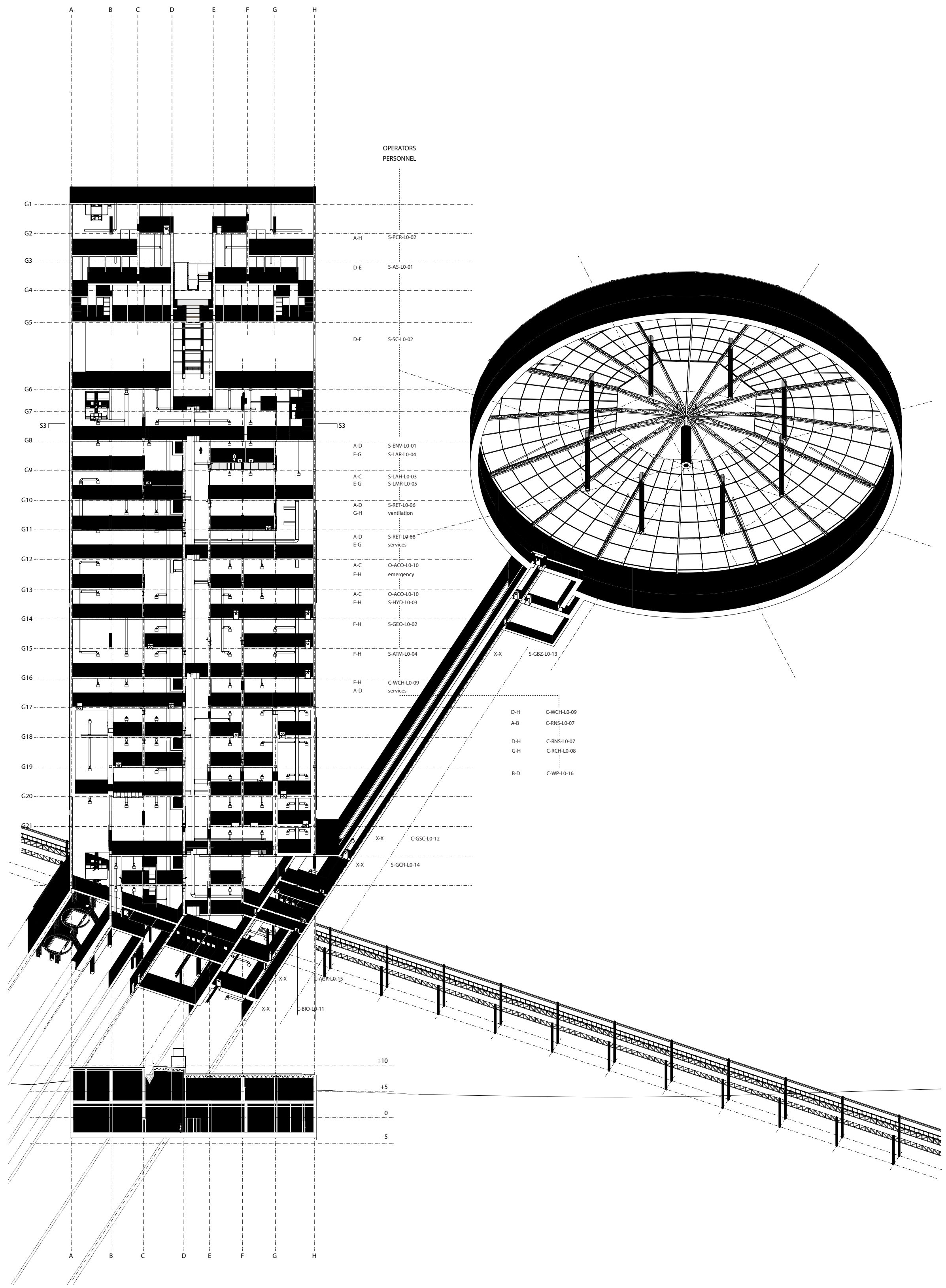


Corridor

The third timescale is addressed by human time, as human continuity depends on social institutions capable of transmitting knowledge. The publicly accessible domain of the project becomes the space in between institutional expertise and social memory, protecting collective memory and communicating invisible responsibilities into spatial experiences. It is placed above the supporting research laboratories, which are placed on the in-ground level of the utilisation, becoming a long-term defining agent of the landscape (fig. 32, 35).

The concept behind it draws upon the work of Bruno Latour and Steve Woolgar in “Laboratory Life” and Glison and Thompson in “The Architecture of Science”. Both works challenge the assumption that scientific knowledge exists independently of the environments in which it is produced. Knowledge emerges through interactions between instruments, procedures, observations, social relations and spatial arrangements; thus, laboratories not just contain science but construct it.

Fig. 32. The worm’s-eye oblique visualises the building as a response to forces emerging from the repository beneath. White illuminated walls communicate the presence of irradiation and invisible processes originating underground, while darker structural elements act as shields, thresholds and zones of mediation. Research center floor plan 0, worm-eye view 1:300, 594 x 841 mm



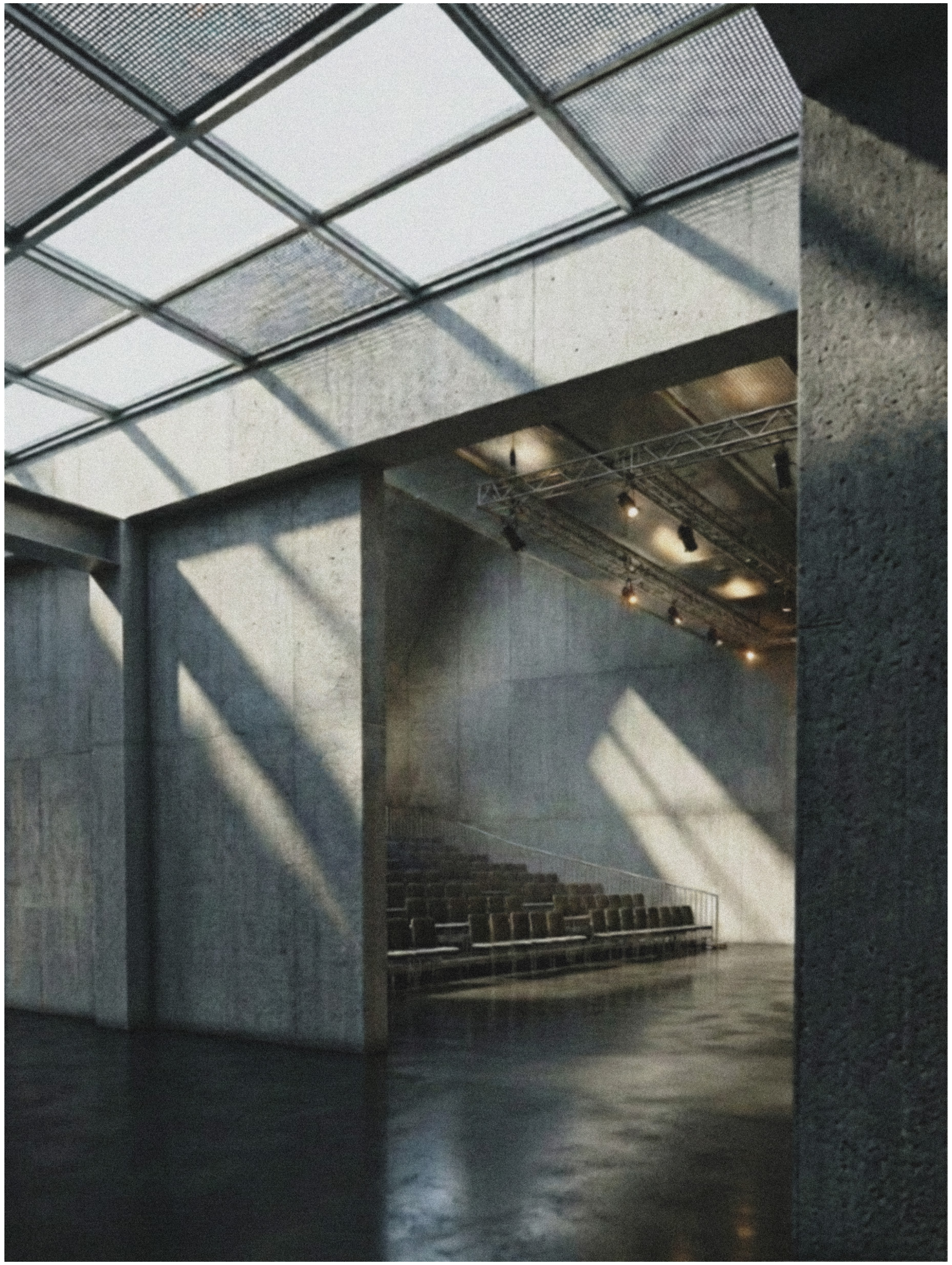
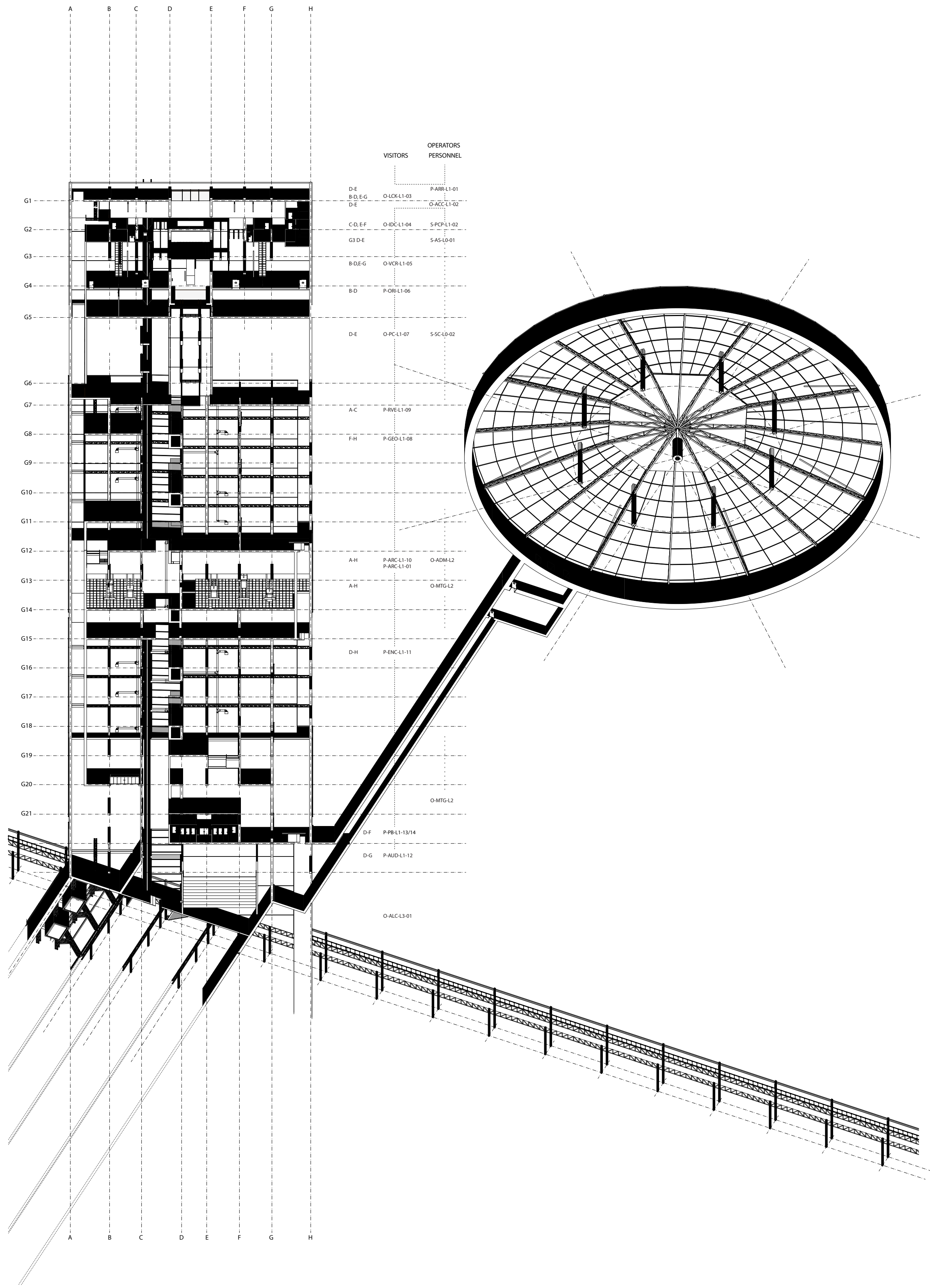


Fig. 33. An interior view of auditorium - P-AUD-L1-12

Fig. 34. An interior view of the corridor between geological and repository voids exhibitions - P-RVE-L1-0, P-GEO-L1-08

Fig. 35. Visitor and worker routes (documented in a diagram along the floor plan) are organised as parallel yet interconnected trajectories, negotiating thresholds between observation, supervision and control. The structural grid becomes an instrument of orientation, navigation of the spaces mentioned. Spatial organization and connectivity of the research center Level 1. Research center floor plan 1, worm-eye view 1:300, 594 x 841 mm

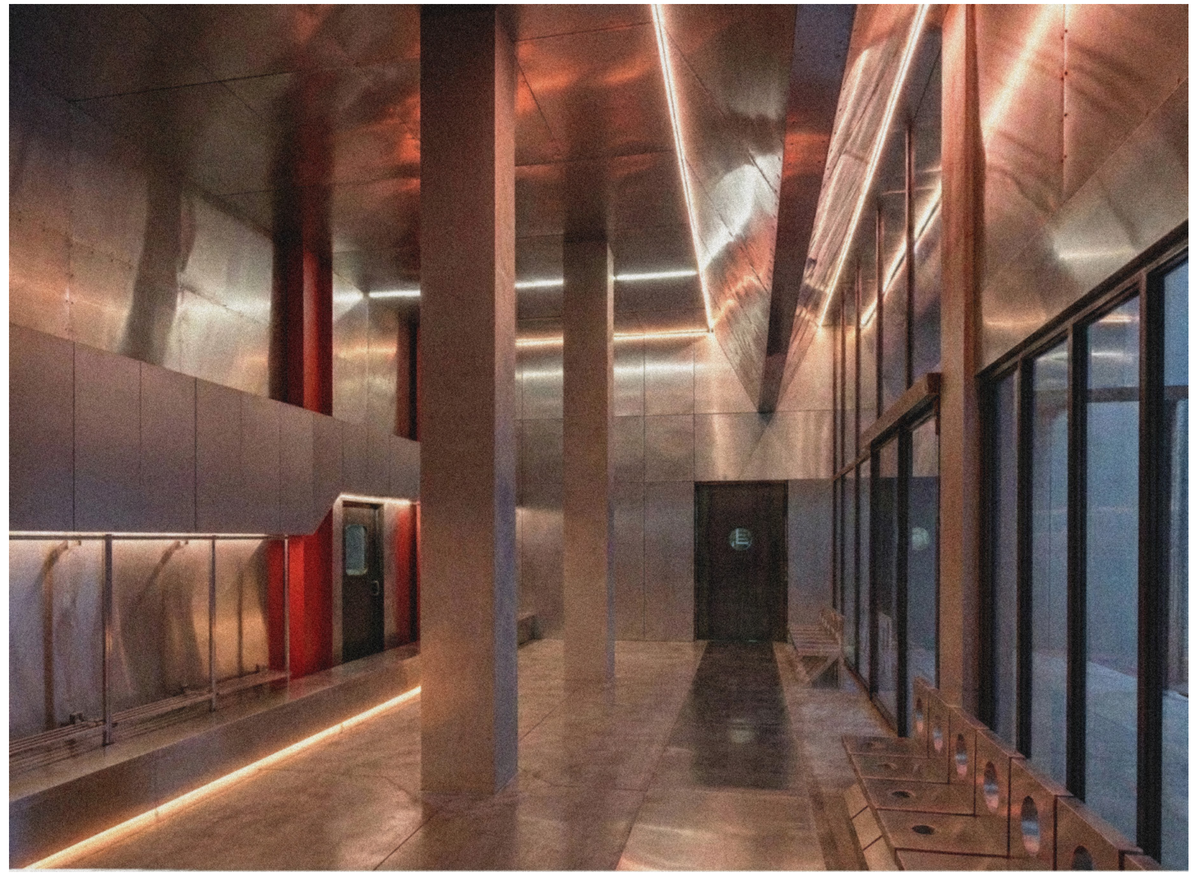


Consequently, the hierarchy of safety buffer zones and the particular ritual of nuclear safety routine required to enter the research centre support the meaningful preservation of the knowledge through interpretation, verification and reproduction of it (fig. 36, 37). Therefore, the proposal rejects the image of the repository as a final act of burial by producing the continuously inhabited institution supporting active processes of the defined landscape.

The utilisation axis hosts the publicly accessible domain of the project. It becomes the space between institutional expertise and social memory, protecting collective memory and communicating invisible responsibilities into spatial experiences.

Fig. 36. Render of visitor changing room view as they enter the facility.

Fig. 37. Diagram of distribution of air pressure zones and ventilation flows according to safety classification.



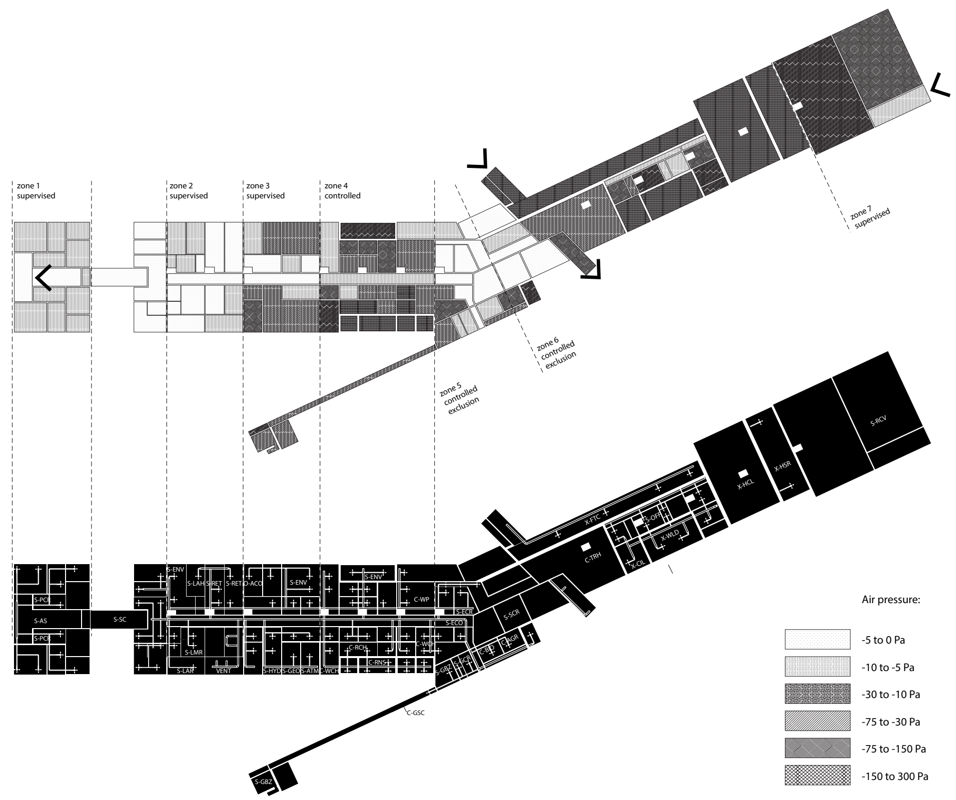


Fig. 38. The building is organised as a sequence of controlled thresholds where spatialization and distances fuction as shielding material. Accessibility is negotiated through a gradient of proximity, responsibility and control. The resulting itinerary guides occupants through layers of Public, Observed, Supervised, Controlled and Exclusion spaces, reflecting the operational logic of the nuclear industry. Radiation produces its own spatial hierarchy, organising the building from publicly accessible domains to highly restricted environments. 297 × 420 mm.

Fig. 39. The atomic garden, orchestra tower and landscape corridor operate as negotiated threshold spaces where distinct accessibility regimes overlap. Spatial hierarchy produced by radiation, responsibility and safety is temporarily exposed and made legible to diverse occupants.

arrival hall
P-ARR-L1-01

access control
O-ACC-L1-02

visitors lockers
O-LCK-L1-03

identification checkpoint
O-IDC-L1-04

visitor change room
O-VCR-L1-05

orientation room
P-ORI-L1-06

public corridor
O-PC-L1-07

geological exhibition
P-GEO-L1-08

repository voids exhibition
P-RVE-L1-09

archive
P-ARC-L1-10
P-ARC-L1-01

encapsulation exhibition
P-ENC-L1-11

administration
O-ADM-L2-02/3/4/5/6/7

meeting room (s)
O-MTG-L2-09/10/11/12/13/14/15/16

auditorium
P-AUD-L1-12

orchestra shaft tower
O-SFT-L2

greenhouse corridor
S-GHC-L1-03

landscapre corridor
O-ALC-L3-01

public bathroom
P-PB-L1-13/14

personnel checkpoint
S-PCP-L1-02

staff stair
S-AS-L0-01

personnel change room
S-PCR-L0-02

staff corridor
S-SC-L0-02

laboratory archive
S-LAH-L0-03

laboratory administration
S-LAR-L0-04

laboratory meeting room
S-LMR-L0-05

laboratories:
S/C- - L0 -

S-ENV-L0-01	environmental monitoring
S-GEO-L0-02	geotechnical
S-HYD-L0-03	hydrochemistry
S-ATM-L0-04	atmospheric monitoring
S-RET-L0-06	retrievability
O-ACO-L0-10	acoustic monitoring
S-GBZ-L0-13	greenhouse buffer zone
S-GCR-L0-14	greenhouse change room
C-RNS-L0-07	radionuclide sampling
C-RCH-L0-08	radiochemistry
C-WCH-L0-09	waste characterization
C-BIO-L0-11	biological response
C-GSC-L0-12	greenhouse service corridor
C-AGR-L0-15	accelerated growth
C-WP-L0-16	waste processing room

encapsulation corridor
S-ECO-L0-01

encapsulation change room
S-ECR-L0-02

security control room
S-SCR-L0-03

transfer hall
C-TRH-L0-04

receiving hall
C-RCV-B1-01

canister transfer corridor
C-CTC-B1-07

operations offices
S-OFF-L1-02/03/04/05/06/06/08

repository transfer shaft
C-RTS-B1-01

hot cell
X-HCL-L0-02

hot cell service room
X-HSR-L1-01

closure welding cell
X-WLD-L0-05

canister integrity laboratory
X-CIL-L0-06

fuel transfer corridor
X-FTC-B1-08

atomic greenhouse
X-ACG-B1-09

Air pressure:	Code:	Access Level:
-5 to 0 Pa	P	Public
-30 to -10 Pa	O	Observed
-75 to -30 Pa	S	Supervised
-75 to -150 Pa	C	Controlled
-150 to 300 Pa	X	Exclusion

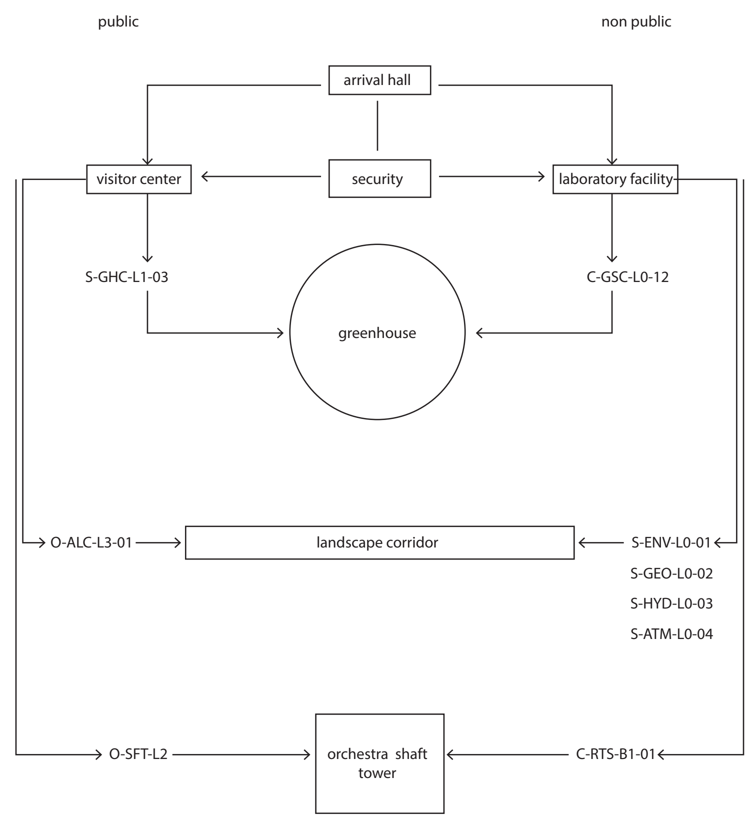
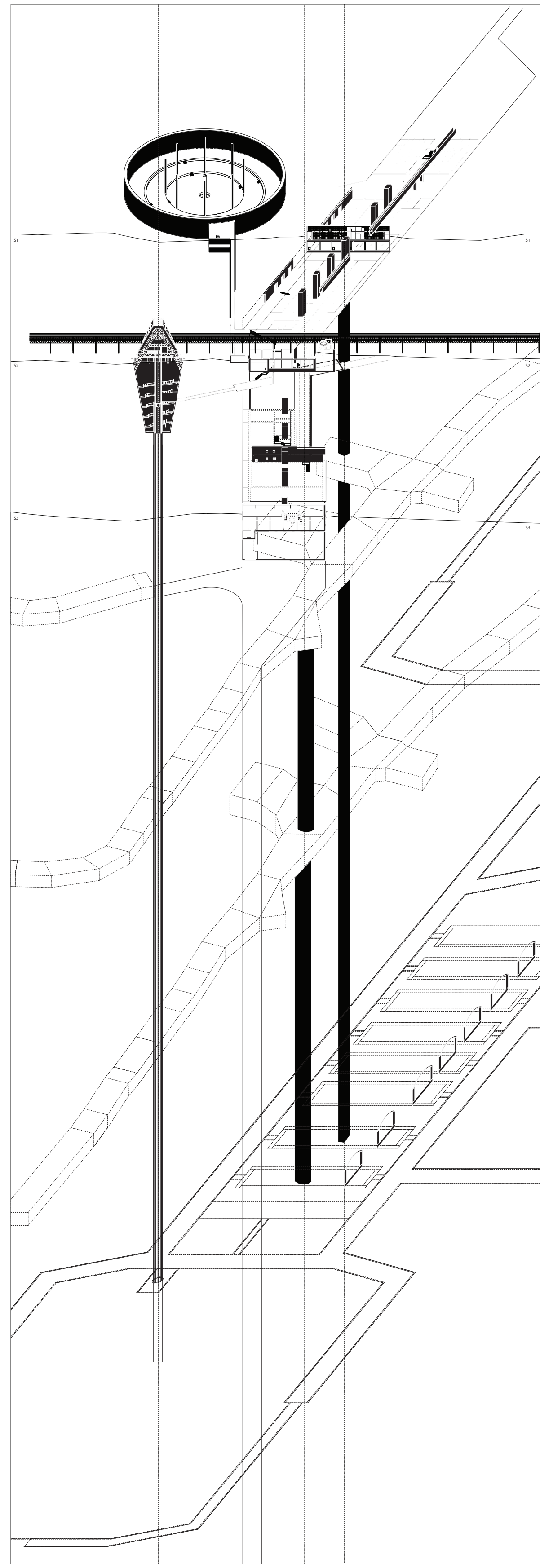


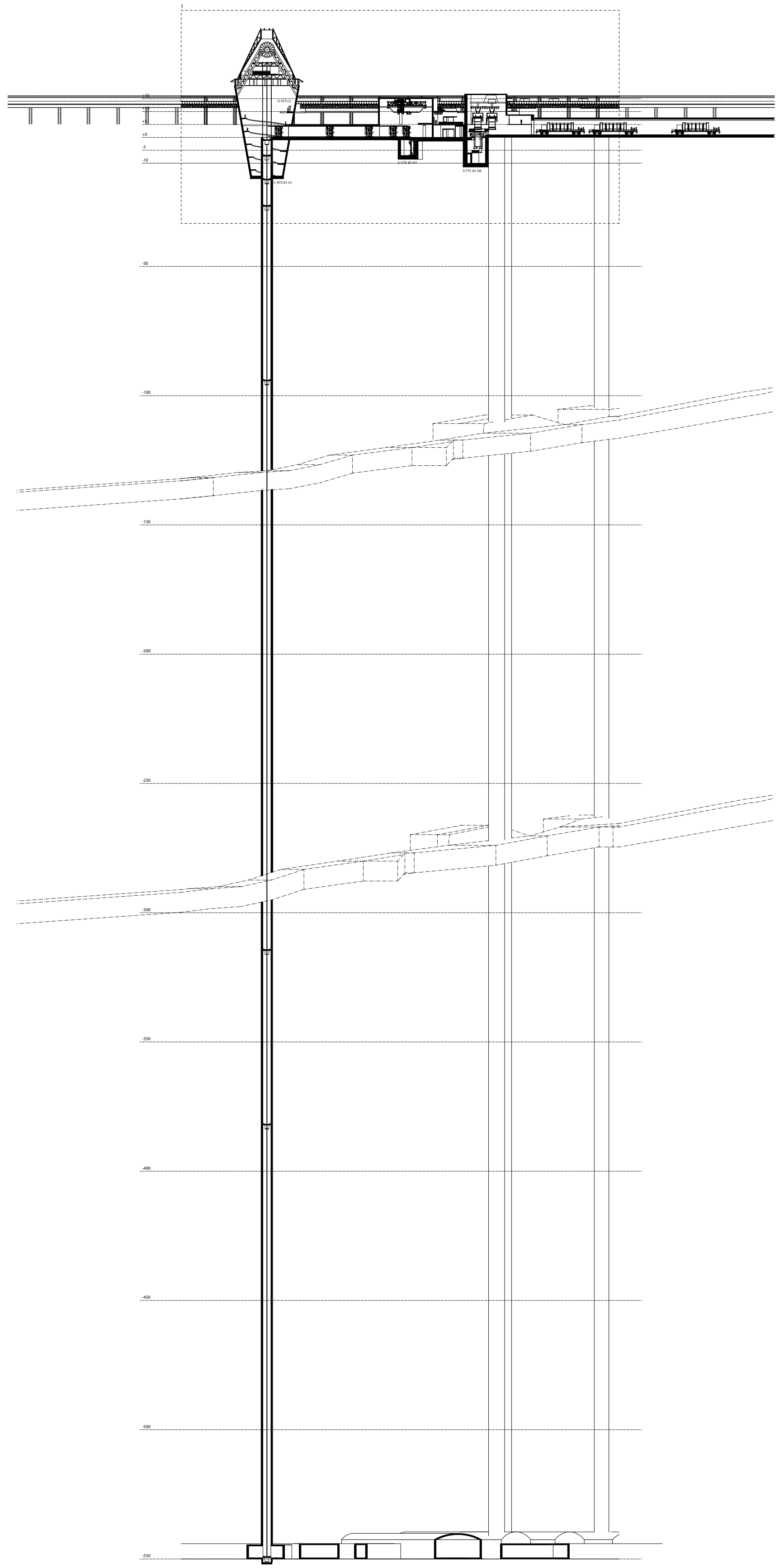
Fig. 40. The corridor acts as a continuous viewing apparatus through which the post-nuclear territory can be experienced and interpreted. It is linking laboratories, observation points, sample collection points and public spaces, it transforms movement into supervision and gradual exposure to the landscape of traces.



The project concludes that the primary challenge of post – nuclear territories is neither contamination nor waste itself but continuity. The proposal shifts the focus of preservation away from objects and towards interpretation and processes as a method of operation. Rather than erasing traces through decommissioning or preserving them through nostalgia, the proposal establishes an institution that mediates between human, biological and geological timescales.

It attempts to preserve the capacity to understand the consequences of the megastructural pathologies. Ultimately, the project argues that the future of nuclear heritage lies in the preservation of knowledge systems. The institution, positioned as a mediator between geological permanence and human impermanence, ensures the survival of the collective capacity to respond to the presence of nuclear waste as the most burdening trace.

Fig. 41. The section reveals the vertical relationship between the architectural intervention and the geological repository beneath. Section, 1:500, 594 x 1400 mm.



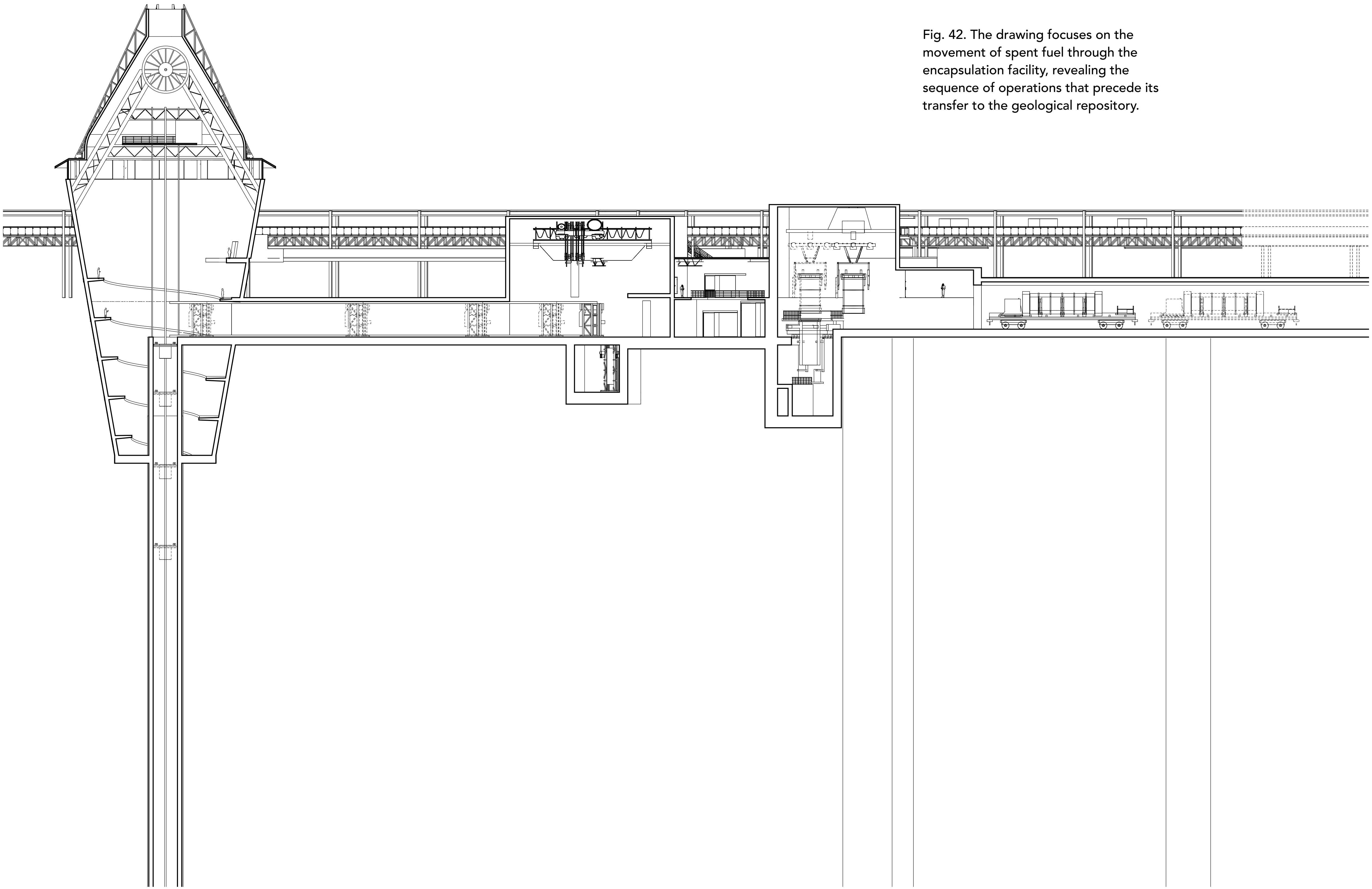


Fig. 42. The drawing focuses on the movement of spent fuel through the encapsulation facility, revealing the sequence of operations that precede its transfer to the geological repository.

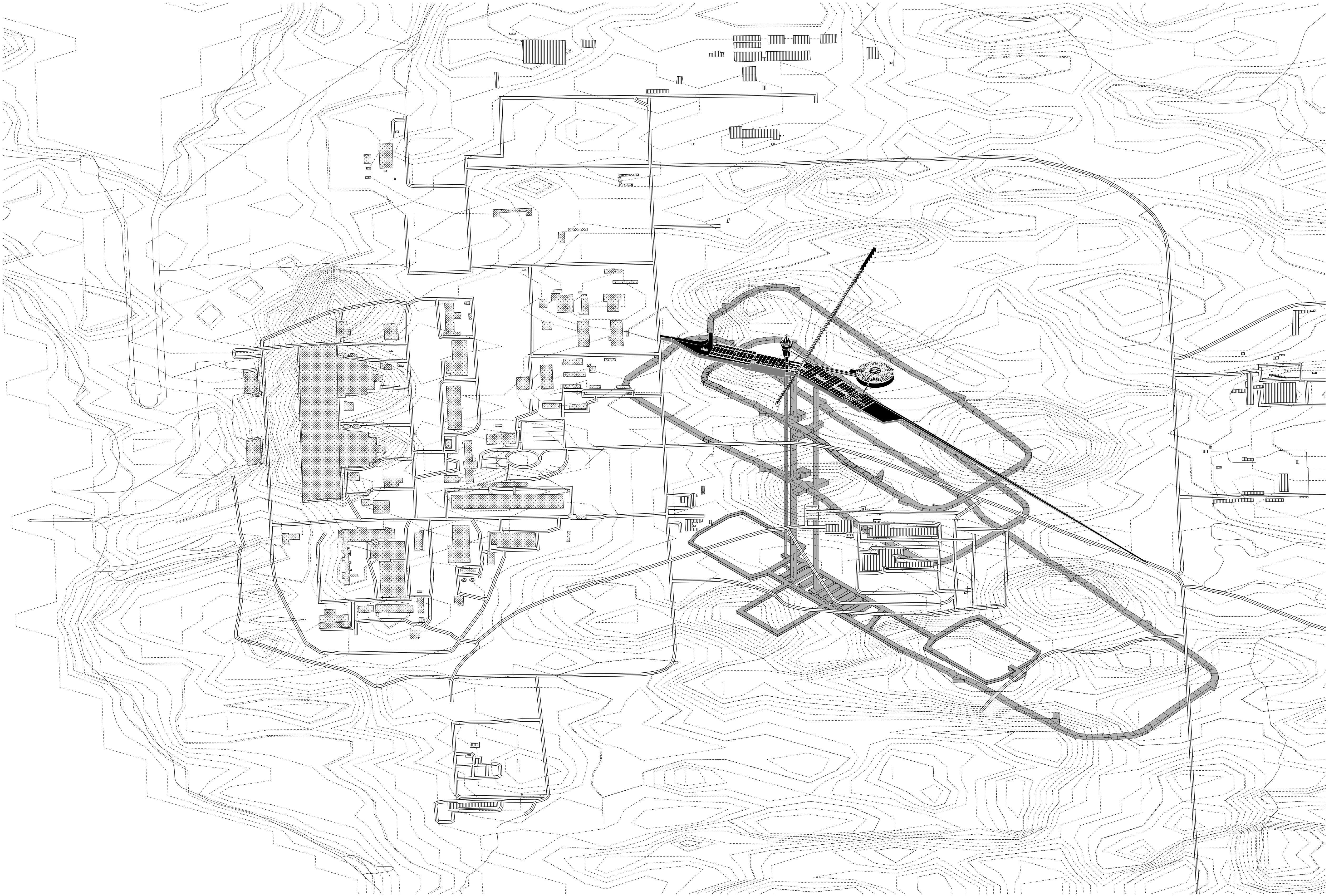


Fig. 43. X-ray axonometric view of the site, 1:5000, 420 × 594 mm.

Conclusion

The research demonstrates that when a nuclear megastructure retreats, the territory cannot be returned to neutrality - it is forever defined as nuclear through the traces left behind. Radioactive matter, altered landscapes, institutional knowledge, tailored infrastructures, and social stigmatisation continue to shape territory long after the mother body ceases to exist. Current decommissioning strategies follow the strict, purely technical protocol of safety. Thus, they handle only a small amount of physical burdening traces through containment and concealing, reducing such to technical problems rather than cultural and spatial conditions.

The project argues that architecture can operate as a framework consisting of multiple timescales, in which the intangible traces can be acknowledged and embodied as a part of the nuclear industrial heritage. Such a system would focus on processes, rituals, observations and systems of knowledge instead of physical artefacts, allowing future generations to understand and interpret the presence and absence of nuclear (heritage).

The Aftermath demonstrates that architectural space can mediate between institutional secrecy and public exposure, though established controlled thresholds bridge scientific/technical operations and public access without eliminating the reality of risk. The thresholds provide a ritualistic narrative for the invisible responsibilities while maintaining necessary safety boundaries.

Finally, the project acknowledges the liminality of the territory as a condition to operate within, existing in between presence and absence. Architecture uses this condition to negotiate relationships between society, technology and long-term consequences.

Implications and recommendations

The proposed design is an experiment, embodying the alternative architectural approach to nuclear heritage with the premise that nuclear heritage is deeply embedded within long-term environmental and institutional processes. The project translates theoretical discussions surrounding it, memory and long-term responsibility into an architectural framework. Rather than treating decommissioning as the end of the technological landscape, it denies the possible neutrality and proposes architectural intervention as a continuous mediator within it. The design, therefore, becomes a test of how architecture can engage with conditions of absence, uncertainty, and temporal scales that exceed conventional design horizons.

The design explores continuity of knowledge through integration of public and scientific domains, creating the ritualisation of technical processes, avoiding reliance on static or nostalgic representations. It suggests the engagement of architecture with invisible conditions, intangible traces unfolding across human, biological and geological timescales.

At the same time, the project reveals limitations inherent to working with the nuclear sector. While the proposal seeks to challenge existing approaches to decommissioning and heritage, many of its spatial, technical and operational decisions remain conditioned by contemporary nuclear safety standards, regulatory frameworks and engineering requirements, limitations based on equipment/machinery design. As a result, the intervention is constrained by the same institutional standards it claims to critically examine; thus, a more radical interpretation of the theoretical framework might have questioned these operational assumptions further and explored forms of engagement less dependent on existing industry protocols. However, by accepting the tension of the practical environment, it demonstrates the possibilities and limitations of architecture confronting highly regulated technological landscapes.

Reflection

The development of the project evolved through the cycles of testing, reflections and reinterpretations following the narrative of heritage and exploring the physical limitations and boundaries set by the industry standards. It was calibrated between research and design, where architectural propositions were repeatedly tested against theoretical arguments and technical realities.

It began with the study of scientific and anthropological research available for the territory, identifying the strong disconnect. This highlighted the dilemma of nuclear heritage - a tension between the inevitable loss of material traces and their enduring presence. The most valuable approach, which helped to bridge this disconnect, appeared to be the mapping (Q1), as it revealed the relationships that were not immediately visible within conventional site analysis and, as a result, defined the site. Because many of the defining characteristics of post-nuclear landscapes are invisible, intangible, or unfold over geological timescales, conventional architectural analysis alone could not fully address the complexity of the site.

Research papers on nuclear heritage, decommissioning strategies, geology, radiation, and science and technology studies became an extension of the site itself, providing access to processes that cannot be directly observed. Theoretical concepts were therefore not treated as background references but as active design tools.

At the same time, this way of working presented limitations. The strong dependence on theoretical discourse occasionally created the risk that the project would become an illustration of academic concepts rather than an autonomous architectural proposition. Similarly, the need to engage with existing nuclear safety standards and engineering practices constrained some of the more speculative ambitions of the design. In retrospect, a more radical exploration could have temporarily detached itself further from established industry protocols before negotiating their reintroduction.

Nevertheless, these tensions became a valuable outcome of the process itself. They revealed that designing for post-nuclear territories requires architecture to operate beyond its traditional disciplinary boundaries and engage with scientific knowledge, institutional structures, and long-term environmental processes, negotiating complex relationships between society, technology and deep time.

Acknowledgements

This thesis marks a culmination of a long process of exploration rooted in personal curiosity regarding one's past. Working within the place of my birth and upbringing became a unique process of self-reflection and discovery, allowing me to reconnect with familiar places through a new lens.

I would like to express my sincere gratitude to my family and friends supporting me throughout this journey with patience and encouragement, providing rational insight or emotional vulnerability during the periods of doubt and moments of challenge.

I am deeply grateful to my mentors and tutors for the guidance and critical insight they provided. Their feedback broadened the horizons of my curiosity, pushing the project beyond its initial boundaries and helping a lot to shape its final form.

My thanks also extend to the researchers and professionals, whose expertise and dedication made it possible to have a strong base of knowledge and propose this bridge of architectural speculation. Their work made it possible to read the realities of nuclear landscapes.

This work is dedicated to all who are interested in nuclear time and consider themselves nuclear humans; to those who seek understanding in presence and absence and engage with questions that extend far beyond a single human lifetime.

BIBLIOGRAPHY

2012 m. Lietuvos Respublikos Seimo rinkimai ir referendumas dėl naujos atominės elektrinės statybos Lietuvos Respublikoje. (2012, October 18). vrk.lt. https://www.vrk.lt/statiniai/puslapiai/2012_seimo_rinkimai/output_lt/referendumas/referendumas.html

Ahmad, S., Chang, B., Lian, C., Raza, S. A., & Wang, M. (2023). Design and development study of gradient composite shielding material for nuclear radiation. *Nuclear Engineering and Design, 414,* 112517. https://doi.org/10.1016/j.nucengdes.2023.112517

Adlienė, D., Rääf, C., Magnusson, Å., Behring, J., Zakaria, M., Adlys, G., Skog, G., Stenström, K., & Mattsson, S. (2006). Assessment of the environmental contamination with long-lived radionuclides around an operating RBMK reactor station. *Journal of Environmental Radioactivity, 90(1)*, 68–77. https://doi.org/10.1016/j.jenvrad.2006.06.004

Babilas, E., Dokucajev, P., Janulevičius, D., Markelov, A., Pabarčius, R., Rimkevičius, S., Ušpuras, E., & Vaišnoras, M. (2018). Innovative technologies for spent fuel safe management at Ignalina channel-type reactors. *Nuclear Engineering and Technology, 50(3),* 504–511. https://doi.org/10.1016/j.net.2018.01.011

Baločkaitė, R., & Rinkevičius, L. (2008). Sovietinės modernybės virsmas: nuo Černobylio bei Ignalinos iki Žaliųjų judėjimo ir Sąjūdžio. *Sociologija Mintis Ir Veiksmas, 22,* 20–40. https://doi.org/10.15388/socmintvei.2008.2.6056

Baltrūnas, V., Švedas, K., & Pukelytė, V. (2006). Palaeogeography of South Lithuania during the last ice age. *Sedimentary Geology, 193*(1–4), 221–231. https://doi.org/10.1016/j.sedgeo.2005.09.024

Bunge, W. (1988). *Nuclear War Atlas.* Wiley-Blackwell.

Cicenaite, G. (2021, May 1). *Lithuania's "Nuclear" Town in a Global World. Local Millennials' Perceptions of Visaginas after the Closure of the Ignalina Nuclear Power Plant*. http://hdl.handle.net/1946/38133

Dadachova, E., & Casadevall, A. (2008). Ionizing radiation: how fungi cope, adapt, and exploit with the help of melanin. *Current Opinion in Microbiology, 11(6),* 525–531. https://doi.org/10.1016/j.mib.2008.09.013

D'Auria, F., Gabaraev, B., Soloviev, S., Novoselsky, O., Moskalev, A., Uspuras, E., Galassi, G., Parisi, C., Petrov, A., Radkevich, V., Parafilo, L., & Kryuchkov, D. (2007). Deterministic accident analysis for RBMK. *Nuclear Engineering and Design, 238(4)*, 975–1001. https://doi.org/10.1016/j.nucengdes.2007.03.006

Dawney, L. (2019). Decommissioned places: Ruins, endurance and care at the end of the first nuclear age. *Transactions of the Institute of British Geographers, 45(1),* 33–49. https://doi.org/10.1111/tran.12334

Dovydaitytė, L., & Denisenko, O. (2025). Nuclear urbanity as heritage. *Urban History,* 1–17. https://doi.org/10.1017/s0963926825100382

Edgeworth, M. (2021). Transgressing Time: Archaeological evidence in/of the anthropocene. *Annual Review of Anthropology, 50(1),* 93–108. https://doi.org/10.1146/annurev-anthro-101819-110118

Fulli, G. (2016). Electricity security: models and methods for supporting the policy decision making in the European Union. In *PORTO Publications Open Repository TOrino (Politecnico di Torino).* https://doi.org/10.13140/rg.2.1.3020.5683

Gaigalis, V., Markevicius, A., Skema, R., & Savickas, J. (2015). Sustainable energy strategy of Lithuanian Ignalina Nuclear Power Plant region for 2012–2035 as a chance for regional development. *Renewable and Sustainable Energy Reviews, 51,* 1680–1696. https://doi.org/10.1016/j.rser.2015.07.047

Guobytė, R., & Satkūnas, J. (2011). Pleistocene glaciations in Lithuania. In *Developments in quaternary science* (pp. 231–246). https://doi.org/10.1016/b978-0-444-53447-7.00019-2

Goulding, C., Saren, M., & Pressey, A. (2018). 'Presence' and 'absence' in themed heritage. *Annals of Tourism Research*, 71, 25–38. https://doi.org/10.1016/j.annals.2018.05.001

Harrison, R. (2012). *Heritage*. https://doi.org/10.4324/9780203108857

Jakimavičiūtė-Maselienė, V. (2007). Safety assessment of the low and intermediate level radioactive waste near-surface repository for Stabatiškė site (Lithuania). *Lithuanian Journal of Physics, 47(4)*, 503–512. https://doi.org/10.3952/lithjphys.47420

Kim, H., Park, C., & Kwon, O. J. (2016). Conceptual design of the space disposal system for the highly radioactive component of the nuclear waste. *Energy, 115,* 155–168. https://doi.org/10.1016/j.energy.2016.09.012

Kirk, J., Clayton, R., Banford, A., & Stamford, L. (2025). Environmental impacts of decommissioning a nuclear power plant: A life cycle assessment of a Magnox site. *Environmental Impact Assessment Review, 113,* 107880. https://doi.org/10.1016/j.eiar.2025.107880

Ktalley. (2024, October 7). *Strategic stability in the third nuclear age - Atlantic Council.* Atlantic Council. https://www.atlanticcouncil.org/in-depth-research-reports/issue-brief/strategic-stability-in-the-third-nuclear-age/

Lehtonen, M. (2021). NEA framing nuclear megaproject "Pathologies": Vices of the modern Western society? *Nuclear Technology, 207(9),* 1329–1350. https://doi.org/10.1080/00295450.2021.1885952

Libretexts. (2023, April 3). 8.3: *Half-life of radioisotopes.* Chemistry LibreTexts. https://chem.libretexts.org/Bookshelves/Introductory_Chemistry/Introduction_to_General_Chemistry_(Malik)/08%3A_Nuclear_chemistry/8.03%3A_Half-life_of_radioisotopes

Liubimau, S. (2021). *Re-Tooling knowledge infrastructures in a nuclear town.*

Lukšienė, B., Marčiulionienė, D., Rožkov, A., Gudelis, A., Holm, E., & Galvonaitė, A. (2012). Distribution of artificial gamma-ray emitting radionuclide activity concentration in the top soil in the vicinity of the Ignalina Nuclear Power Plant and other regions in Lithuania. *The Science of the Total Environment, 439,* 96–105. https://doi.org/10.1016/j.scitotenv.2012.09.012

Maëva, L. (2017). Micromégas - Voltaire, 1752. *Docs.school Publications.* https://www.pimido.com/philosophie-et-litterature/litterature/fiche-de-lecture/micromegas-voltaire-1752-592947.html

Marčiulionienė, D., Mažeika, J., Lukšienė, B., Jefanova, O., Mikalauskienė, R., & Paškauskas, R. (2015). Anthropogenic radionuclide fluxes and distribution in bottom sediments of the cooling basin of the Ignalina Nuclear Power Plant. *Journal of Environmental Radioactivity, 145,* 48–57. https://doi.org/10.1016/j.jenvrad.2015.03.007

Marčiulionienė, D., Montvydienė, D., Kazlauskienė, N., & Kesminas, V. (2011). CHANGES IN MACROPHYTES AND FISH COMMUNITIES IN THE COOLER OF IGNALINA NUCLEAR POWER PLANT (1988–2008) / MAKROFITŲ IR ŽUVŲ RŪŠINĖ KAITA DRŪKŠIŲ EŽERE – IGNALINOS ATOMINĖS ELEKTRINĖS AUŠINIMO BASEINE (1988–2008). *Journal of Environmental Engineering and Landscape Management, 19(1)*, 21–33. https://doi.org/10.3846/16486897.2011.557273

Marciulioniene, D., Petkeviciute, D., Jasiulionis, R., Gudelis, A., & Mazeika, J. (1998). *Bioaccumulation of radionuclides in Lake Druksiai, the cooling basin for the Ignalina nuclear power plant, Lithuania.* INIS – International Nuclear Information System. https://inis.iaea.org/records/byc4p-pqd46

Mazeika, J., Petrosius, R., & Pukiene, R. (2007). Carbon-14 in tree rings in the vicinity of Ignalina Nuclear Power Plant, Lithuania. *Geochronometria*, 28, 31–37. https://doi.org/10.2478/v10003-007-0025-y

Meyer, T., & Sérandour, A. (2024). Placing the intangible: Space, nuclear power and social sciences. *Energy Research & Social Science, 115*, 103611. https://doi.org/10.1016/j.erss.2024.103611

Motiejunas, S. (2004). Identification of candidate sites for a near surface repository for radioactive waste. In *Radioactive Waste Management Agency, Vilnius (Lithuania); Geological Survey of Lithuania, Vilnius (Lithuania); Institute of Geology and Geography, Vilnius (Lithuania); Lithuanian Energy Institute, Kaunas (Lithuania).* https://www.osti.gov/etdeweb/biblio/20711863

Musch, S. (2016a). THE ATOMIC PRIESTHOOD AND NUCLEAR WASTE MANAGEMENT: RELIGION, SCI-FI LITERATURE, AND THE END OF OUR CIVILIZATION. *Zygon®*, 51(3). https://doi.org/10.1111/zygo.12268

Nash, K. L., & Lumetta, G. J. (2011). *Advanced separation techniques for nuclear fuel reprocessing and radioactive waste treatment.* Woodhead Publishing.

Naylor, J. L. (2019). The third nuclear age. *Comparative Strategy, 38(4),* 276–288. https://doi.org/10.1080/01495933.2019.1633185

Nuclear Decommissioning (Lithuania). (n.d.). European Commission. https://commission.europa.eu/funding-tenders/find-funding/eu-funding-programmes/nuclear-decommissioning-lithuania_en

Past. (2019, November 1). Nuclear Aesthetics Research Network. https://nuclearaesthetics.wordpress.com/past/

Posiva - Long-term safety. (n.d.). https://www.posiva.fi/en/index/finaldisposal/long-termsafety.html

Poškas, P., Ragaišis, V., Šmaižys, A., Sirvydas, A., Šimonis, A., Narkūnas, E., & LEI, Nuclear Engineering Laboratory. (2025). *CUMULATIVE ENVIRONMENTAL IMPACT ASSESSMENT OF THE DECOMMISSIONING PROCESS OF THE IGNALINA NPP.* https://sgav.dk/Media/639004301990913045/Ignalina%20NPP%20decom.%20EIA%20report%20summary_202511_En.pdf

RADIOACTIVE ORCHESTRA: RADIOACTIVE ORCHESTRA FEAT. AXEL BOMAN — STUDIO BARNHUS. (n.d.). STUDIO BARNHUS. https://studiobarnhus.com/barnradioactive001

Radioisotopes in industry - World Nuclear Association. (n.d.). https://world-nuclear.org/information-library/non-power-nuclear-applications/radioisotopes-research/radioisotopes-in-industry

Ross, L. M. (2023). Nuclear Cultural Heritage: From Energy Past to heritage future. *Heritage & Society, 17(2),* 296–315. https://doi.org/10.1080/2159032x.2023.2266644

Sandberg Instituut. (n.d.). *Sandberg instituut.* https://www.sandberg.nl/students/naomi-hubert/work/future-crystals-of-the-anthropocene

Semper, G. (2011). *The four elements of architecture and other writings.* Cambridge University Press.

Sheng, J., Choi, K., & Song, M. (2001). Vitrification of liquid waste from nuclear power plants. *Journal of Nuclear Materials, 297(1),* 7–13. https://doi.org/10.1016/s0022-3115(01)00598-0

Spaulding, D. (2023, November 1). *The Anthropocene as a nuclear age.* The Equation. https://blog.ucs.org/dylan-spaulding/the-anthropocene-as-a-nuclear-age/

Tsvetkov, P. (2011). Nuclear Power - operation, safety and environment. *In InTech eBooks.* https://doi.org/10.5772/987

Unokiwedi, O. P., Gao, J., Bethune, T., & Awolayo, A. N. (2025). Deep geological repositories — A review of design concepts, near-field evolution, and their implications for nuclear waste containment. *Journal of Environmental Radioactivity, 289,* 107750. https://doi.org/10.1016/j.jenvrad.2025.107750

Vaitiekūnas, P., Katinas, V., & Markevičius, A. (2004). SIMULATION OF CONDUCTIVE-CONVECTIVE HEAT TRANSFER IN a NATURAL BASIN. *Journal of Environmental Engineering and Landscape Management, 12(2)*, 58–62. https://doi.org/10.3846/16486897.2004.9636818

Valiuškevičius, G., & Ignatavicius, G. (2021). LIETUVOS GAMTINĖ APLINKA, BŪKLĖ, PROCESAI IR RAIDA. *Vu-lt.* https://www.academia.edu/36008141/LIETUVOS_GAMTIN%C4%96_APLINKA_B%C5%AAKL%C4%96_PROCESAI_IR_RAIDA

Verma, A. (2021). The nuclear, Humanities, and social science nexus: Challenges and opportunities for speaking across the disciplinary divides. *Nuclear Technology, 207(9),* iii–xv. https://doi.org/10.1080/00295450.2021.1941663

Weinberg, A. M. (1972). Social institutions and nuclear energy. *Science, 177(*4043), 27–34. https://doi.org/10.1126/science.177.4043.27

Widuto, A. & European Parliamentary Research Service. (2026). Nuclear decommissioning assistance programme of the Ignalina nuclear power plant in Lithuania. *In EU Legislation in Progress* (Report PE 782.642). https://www.europarl.europa.eu/RegData/etudes/BRIE/2026/782642/EPRS_BRI(2026)782642_EN.pdf

Yim, M., & Caron, F. (2005). Life cycle and management of carbon-14 from nuclear power generation. *Progress in Nuclear Energy, 48(1),* 2–36. https://doi.org/10.1016/j.pnucene.2005.04.002

Youssef, S. (2019, July 12). *Atom in the Garden of Eden - 99% invisible*. 99% Invisible. https://99percentinvisible.org/episode/atom-garden-eden/