nuclear's wastelands part 6 – into the future

In the final part of a series of articles on the local and social legacies of nuclear energy, Andrew Blowers considers the issues raised by the long-term management of radioactive wastes and materials

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The abandoned landscape around the encased nuclear power station in the Chernobyl exclusion zone

'We don't inherit this land from our ancestors; we borrow it from our children.'
Attributed to Native American Chief Seattle, 1780-1866

Nuclear's wastelands are scattered around the world in places where nuclear activities, accidents or deliberate devastation have occurred. They are, at once, visible creations of dereliction, contamination, clean-up and restoration, and areas where radioactivity creates an invisible but pervasive risk. These areas are usually remote, distant from major population centres and, in some cases, constitute reservations deliberately sealed off to restrict access, like Hanford[1] in the US, or areas from which the population has been removed, as at Fukushima and Chernobyl. More typically they constitute nuclear oases where nuclear facilities and communities co-exist in a state of mutual dependency extending down the generations.

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The Aube storage centre – Centre de Stockage de l'Aube, operated by the French National Waste Management Agency (ANDRA)

These nuclear landscapes, some of which have been considered earlier in this series, are distinguished by their geographical isolation and their historical continuity, a perpetually reproducing pattern in time and space. They are places that manage the legacy from nuclear activities, comprising existing nuclear wastes and known future arisings. This legacy of nuclear power has created an environmental problem that is intractable and difficult enough to deal with. Wastes derived from new nuclear programmes will compound a problem that is, at least, determinable and potentially soluble to one that is indeterminable and, therefore, insoluble.

What is the problem?

By far the greatest volume of radioactive wastes (90%) is low level, accounting for 1% of the total radioactivity. Most of these wastes (over 80%) are managed in near-surface disposal facilities, such as the shallow repository at Drigg near Sellafield, or the Centre de Stockage de l'Aube in Eastern France. Intermediate-level wastes (ILW – 7% volume, 4% radioactivity) consist of resins, sludges, and fuel cladding; while the short-lived ILW can be managed through shallow disposal, the longer-lived ILW remain radioactive over long timescales and have to be managed in stores at nuclear sites or, as in the case of the graphite cores of redundant reactors as at Bradwell, UK, may be left in situ in so-called passive storage until the end of the century.

Higher-activity, heat-generating wastes are more difficult to manage. High-level wastes (HLW) are very radioactive, mainly fission products from reprocessing spent fuel and are held in liquid form and eventually vitrified for cooling and eventual disposal. In countries with a 'once through' nuclear cycle, spent fuel as waste is held in pools or dry casks, usually at power stations. In some countries, for instance France and the UK, spent fuel is considered potentially usable as recycled mixed-oxide fuel (MOX), although the volumes far exceed any conceivable future market. Similarly, there is far more plutonium in the UK than can possibly be needed for fuel or weapons, rising to 140 tonnes by 2020.

The important point here is that these highly active wastes and materials account for around 95% of the total activity in the inventory but a mere 4%, at most, of the volume. In countries with reprocessing, wastes from military operations have given rise to the most hazardous and intractable problems, such as the tanks at Hanford, the ponds and silos at Sellafield, and the widespread environmental pollution and contamination of villages and the Techa River created by the Mayak reprocessing plant near Ozersk in the Southern Urals in Russia. The problems of managing decommissioning and clean-up of existing nuclear facilities and known arisings of radioactive wastes is formidable indeed, without adding to the burden by creating wastes from new build.

What is the solution?

The favoured option for the long-term management of solid high- and intermediate-level wastes is deep geological disposal. The only deep repository opened so far is the Waste Isolation Pilot Plant (WIPP) facility at Carlsbad in New Mexico, USA, in

Paul DeRienzo/TRANSCEND Media Service

Inside the WIPP facility 26 miles from Carlsbad in New Mexico, USA – the only operating deep repository

a salt formation, dedicated to disposal of transuranic wastes from the US military programme but suspended from operation for three years (2014-17) because of a problem of radioactive release.

Progress towards disposal has been made in Finland, where the Onkalo project under the hard rock of the Baltic has approval and is under construction. Likewise, in Sweden a site has been approved for a similar project, but has been held up by concerns about corrosion of the copper canisters that contain the wastes.

Elsewhere, at Bure in France, Projet Cigéo, an underground laboratory, has been constructed as a prelude to possibly achieving a full-scale repository. In Germany the salt mine intended for a repository at Gorleben has been closed while a fresh search begins. In the UK, too, where a prospective site near Sellafield failed to gain public support, a new siting process has begun; and in the USA the wheel has come full circle back to Yucca Mountain, but may keep spinning as the conflict over the site is mired in political, regulatory and legal conflicts.

Among the other major producers of nuclear waste, Russia is planning an underground laboratory at Krasnoyarsk in Central Siberia, China is investigating sites in Gansu province in the north west of the country, Japan has initiated a repository siting process, and South Korea is at an early stage of planning.

The concept for deep disposal has to demonstrate that the waste containers, the engineered barrier and the host rock (hard, salt or clay) will isolate the wastes from the environment for hundreds of thousands of years. That is a heroic challenge for scientists and engineers and is a major barrier to progress. A site for a repository not only has to satisfy scientific criteria, it also has to achieve social acceptability. Attempts to land a site without public approval or consultation were rebuffed during the 1980s, as in Eastern England, in Sweden, in France and, most significantly, at Gorleben in Germany as communities confronted the nuclear industry.[2]

In response, most countries turned to site selection processes based on community consent (voluntarism), partnership and a recognition of the need for compensation for the burden of risk taken on by communities hosting a locally unwanted national facility. In those countries, like Sweden and France, where geologically suitable sites were identified and communities were invited to volunteer, there was a successful outcome, and Osthammer (Sweden) and Bure (France) emerged on the basis of elimination. In Germany, the US and the UK, where a 'white map' approach was recommended, the process was either not pursued (US), abandoned and a new process initiated (Germany), or was attempted but failed to proceed, as in the UK, where a revised approach has now begun.[3] But, as the government in the UK observes, 'Finding a suitable location for a geological disposal facility is a complex, long-term process that will take many years'.[4]

Periphery and inequality

While deep disposal is presently favoured as the best approach for the long-term management of long-lived, highly radioactive wastes, alternatives may come into the reckoning, and, in the interim, storage is the only available solution. Although every effort is made to find communities willing to host a repository, it is accepted that, for a long time to come, wastes will be managed in what I have called in this series 'peripheral communities'.

These are geographically isolated, relatively insulated communities. They are defined by their economic dependence on nuclear activities and are distinguished socially by their realistic acceptance, resilience and adaptation to their role. This expression of what has been called a 'nuclear culture' has been described earlier in the series in the long established contexts of Hanford and Sellafield. Politically, these peripheral communities are subordinated as they exert relatively little control as decisions affecting their wellbeing and welfare are taken elsewhere. These geographical, economic, cultural and political conditions combine to produce a pattern of social and spatial inequality.

This pattern is a product of a process of 'peripheralisation', whereby unequal power relations exert a pull that confirms and confines the nuclear legacy in existing locations and a push that generally repels the industry from colonising new ones. There is consequently an association of peripherality and inequality, separating and defining nuclear communities.

The inequality experienced by nuclear communities is differentiated by three characteristics. One is the specific *cause* of inequality, deriving from the physical proximity of a community to an activity that instils that peculiar fear and stigma associated with living in landscapes of nuclear risk. The second is the particular *nature* of the inequality, which is not manifested in poverty or relative deprivation but, rather, in a cultural awareness of separation,

Bellona. Inset photo: Ecodefense

Administration buildings at the Fissile Material Storage Facility (FMSF) at Mayak – Russia's only operational facility for reprocessing spent nuclear fuel from VVER-440 type reactors and spent fuel from nuclear submarines, as well as fuel imported from other countries. Inset: An aged radiation sign on the banks of the Techa River – the Mayak nuclear complex dumped 2.68 billion cubic feet of highly radioactive waste into the river from 1949 to 1956

powerlessness and exclusion. These two characteristics are mediated and moderated by the relative economic prosperity and political leverage that endows these communities with the power to ensure their sustainability and survival.

A third distinguishing feature of these peripheral communities is their *persistence* over time. Peripheral communities associated with other activities such as mining and some heavy and hazardous industries are evanescent, with a lifecycle of growth and decline and, ultimately, death once the resource runs out or the activity is closed down. Nuclear communities, especially those like Hanford, Sellafield and La Hague, never die but continue so long as the legacy of wastes must be managed. Thus the process of management and clean-up of the legacy of nuclear power is a process that persists long after production ceases. The intra-generational inequality that already distinguishes these peripheral communities persists down the generations as a spatial pattern of inter-generational inequality.

It is the inter-generational aspect, the knowledge that radioactivity poses risk to environments and human health for periods extending well beyond our comprehension, that has prevailed on governments to ensure, at least in principle, that the legacy is safely and securely managed. Hence the International Atomic Energy Agency (IAEA) has pronounced a principle of inter-generational equity, couched in a phrase of anthropocentric sustainability: 'Radioactive waste shall be managed in such a way that will not impose undue burdens on future generations.'[5] The focus on human impact is reiterated in the principle that 'predicted impacts on the health of future generations will not be greater than relevant levels of impact that are acceptable today'. There is a strong strain of stewardship in these pronouncements, a requirement to ensure a continuing presence, a 'duty to preserve this physical world in such a state that the condition for that presence remains intact'.[6]

Storage or disposal? Is that the question?

The difficulty lies in translating these principles of sustainability into processes of radioactive waste management. Seemingly, there is presently a choice between long-term storage and early disposal of wastes. The concepts of responsibility and timescales are the determining factors in making the choice; the question is: for how long should we take responsibility?

There are two approaches to this question. One, based on the idea of *diminishing responsibility*, favours early disposal, the removal of wastes indefinitely from the accessible environment in a secure containment for hundreds of thousands of years. This relieves future generations of the costs, effort and risks of managing the legacy. The near-term risks of disposal may be mitigated by retrievability and, later, by some form of information transfer, but, over the longer term, responsibility is surrendered and the future is left to itself. Ultimately risks cannot be entirely eliminated, but at such long timescales social and physical conditions are unknowable.

The other approach appeals to the idea of *continuing responsibility* and advocates long-term storage as the appropriate method for managing long-lived highly active wastes. Unlike disposal, storage cannot be seen as a permanent solution, neither can it be regarded as an 'interim' solution on the way to a permanent solution. It is, rather, a recognition that it is the appropriate method for the foreseeable future, beyond which other solutions, including disposal, may exist. It implies that we have a continuing responsibility to account for the impact of our actions, but one that is passed on to future generations, who will be presented with the knowledge and resources to manage the risks. While there is a transfer of some of the burden of management, the future will retain the flexibility for decision-making in a context of what might be termed a 'continuing present'.

In passing, it is worth noting that retrievability and reversibility have been proposed as a kind of middle-way hybrid solution. France favours reversible disposal, while Germany has adopted the concept of a 'final repository mine with reversibility'. While such an approach may assuage public anxiety, reversibility is relative, and in practice increasingly difficult to achieve as disposal proceeds. In any case, 'early' disposal is unlikely to be completed for a century at least, leaving ample time for future generations to consider whether or not it is safe to proceed.

These theoretical positions underlie the different approaches to responsibility and timescales that are being pursued. While, in the present state of knowledge, almost all countries envisage disposal at some future time as the final stage, there are variations in the disposal concepts, geology, inventory, timescales and decision-making. In order to achieve a suitable and acceptable site, many countries, as observed earlier, have adopted a devolved approach to decision-making for a national facility. In nearly every case, Finland excepted, progress has been necessarily slow, although, in view of the timescales and complexities, a trans-generational and interminable process is inevitable.

In theoretical terms of timescales and responsibility, then, long-term storage and disposal are different approaches. However, policy-makers favouring disposal have tended to see storage as a complementary approach, a prelude to disposal, hence the use of the term *interim* rather than *long-term* storage. The UK's Committee on Radioactive Waste Management recognised the relationship in pronouncing that 'A robust programme of interim storage must play an integral part in the long-term management strategy'.[7]

Storage is, plainly, an inter-generational issue. At Hanford and Sellafield the task of nuclear decommissioning and waste management is hugely complex and will take decades to complete (in the case of Sellafield at a cost of £70 billion and taking over a hundred years). Elsewhere, there are a myriad of sites, large and small, where redundant

Bechtel National Inc.

The Waste Treatment and Immobilization Plant (WTP) being designed and constructed by Bechtel National for the US Department of Energy at Hanford in Washington State, USA. When complete, the WTP will be the world's largest radioactive waste treatment plant

EDF

Work on site in building the new nuclear reactor at Hinkley Point

nuclear facilities will be left in situ with no firm plans for ultimate removal. Spent fuel is accumulating at reactor sites around the world, left in storage ponds or in dry stores. Even if repositories become available, it will be decades before they will accommodate all these wastes, if at all.

The notion of these wastes being neatly managed, packaged and transferred to a welcoming and pristine repository there to be entombed for ever, as envisaged in a host of glossy brochures and alluring videos, is fanciful. A more likely outcome is a proliferation of waste stores in peripheral locations in deteriorating conditions as a declining nuclear industry moves from production to decommissioning to waste and clean-up. With or without repositories, the present and foreseeable future management of radioactive waste is interim, indefinite storage.

What future for new build?

The legacy of nuclear waste bequeathed by past and present generations from the generation of nuclear power and development of nuclear weapons requires continuing management in the future. It is as necessary as it is inevitable. The creation of further wastes from new nuclear energy is neither necessary nor inevitable. Nuclear's moment, certainly in the West, has passed, although it lingers on in some countries, including the UK, on the basis that it is a necessary part of the energy mix and provides low-carbon energy necessary to combat climate change.

At best this is a transitional argument, since alternative and cheaper forms of renewable energy production and storage capable of providing base load power and displacing fossil fuel generation are becoming available. In any case, nuclear energy is proving too costly and inflexible and ultimately outmoded, locking in an expensive source of supply far into the future.

Nuclear energy is also problematic on grounds of safety, security and waste. Safety and security may be compromised by routine, accidental, or deliberate releases of radioactivity. Charles Perrow has argued from evidence that accidents are 'normal' in complex systems like nuclear plants, where 'multiple and unexpected interactions of failures are inevitable'.[8]

But the most inescapable consequence of nuclear power is the enduring legacy of long-lived highly active wastes that create and sustain nuclear's wastelands and the peripheral communities around them. Of all the issues in the debate over nuclear power, including need, cost, safety and security, it is the creation of nuclear waste that provokes the most compelling argument against new build.

New build introduces potentially unmanageable problems. The scale and nature of the existing and committed waste arisings is broadly known and, to that extent, it is possible to plan for its future management, whether by storage, disposal or some alternative method. By contrast, the scale of the inventory arising from a new build programme is unpredictable. Above all, new build introduces new problems of timescale and responsibility. As CoRWM puts it:

> *'New build wastes would extend the time-scales for implementation, possibly for very long but essentially unknowable future periods. Further,*

Peter Headford

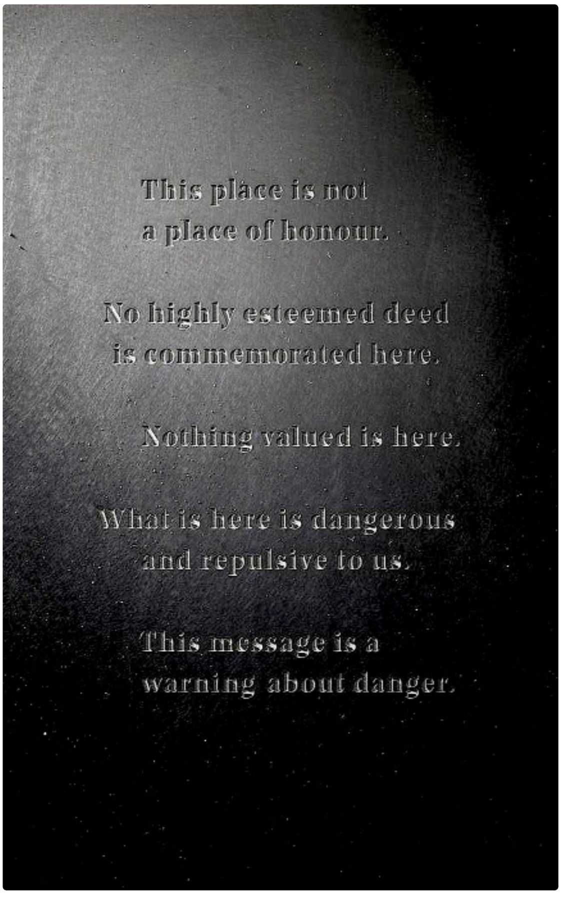
the political and ethical issues raised by the creation of more wastes are quite different from those relating to committed – and therefore unavoidable – wastes.'[9]

In the UK, the eight sites nominated or under development for new build are scattered around the coast of England and Wales. Of these, six sites are at various stages in the development of new nuclear stations. One (Hinkley Point) is under construction; two (Wylfa and Sizewell) are at the permitting stage but not yet committed; one (Bradwell) is at a very early stage in the assessment process; and one (Oldbury) has yet to begin the process. It is uncertain when or whether all, or indeed any, of these will eventually begin generating, but, if they do, they will also become storage sites for spent fuel and other active wastes.

Once again, existing locations are being asked (or rather not being asked) to take on an indeterminable burden for an indeterminate period. It is currently assumed that a repository may be available to take legacy intermediate-level wastes by 2040 and high-level wastes/spent fuel by around 2075, with completion of disposal of legacy wastes by around 2130.[10] Therefore disposal of new build wastes would not even begin until well into the next century.

There are sound reasons for doubting these assumptions. It seems implausible, for reasons stated earlier, that a repository could be operating by 2040 or that there would be available capacity to take new build wastes for a substantial new build programme. The timescales are simply too long and, consequently, 'any statement at all about the impacts of current actions and about obligations of current societies towards the future eventually become meaningless'.[11] It is quite conceivable that the wastes will remain stored on vulnerable coastal sites in deteriorating conditions indefinitely.

The UK Government's claim that 'effective arrangements… will exist to manage and dispose of the waste' that will be produced from new nuclear power stations[12] is truly insupportable. There is neither an agreed disposal concept nor an acceptable site in prospect. A deep repository may not materialise for decades, if at all. But at least the search for a repository is based on the principles of voluntarism, partnership, and compensation. By contrast, community consent and participation have not even been sought, nor compensation offered to communities at the peripheral sites where long-



term storage of highly active wastes from new build will have to be managed for at least the next century.

It is an approach that is unethical and unacceptable; it is also unnecessary. There is no long-term solution realistically in prospect and, for that reason alone, there can be no justification for any further nuclear development. For the time being, the pragmatic solution is already present in the safe and secure storage of the nuclear legacy where it already is. Without the pressure of finding a solution to justify a new build programme, the search for a repository can proceed in a measured way to ensure that the components – suitable geology, a safe disposal method, and an acceptable site – can be successfully integrated. In the meantime, and for the foreseeable future, peripheral communities in nuclear's wastelands around the world will live with the legacy.

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Notes

1 Hanford is the subject of the second article in this series – A Blowers: 'Nuclear's wastelands. Part 2 – Hanford, the nuclear frontier'. *Town & Country Planning*, 2017, Vol. 86, Sept., 364-69

2 The conflict over the Gorleben site is described in the fifth article in the series – A Blowers: 'Nuclear's wastelands. Part 5 – Gorleben, the power of the periphery'. *Town & Country Planning*, 2018, Vol. 87, May/Jun., 364-69, 231-37

3 The various attempts at site selection in France, the UK and Germany are discussed in earlier articles in the series

4 *Consultation: Working with Communities. Implementing Geological Disposal*. Department for Business, Energy and Industrial Strategy, Jan. 2018, p. 22. www.gov.uk/government/consultations/working-with-communities-implementing-geological-disposal

5 Principle 5: 'Burdens on future generations', in *Principles of Radioactive Waste Management: Safety Fundamentals*. IAEA Safety Series No. 111-F. International Atomic Energy Agency, 1995

6 H Jonas: *The Imperative of Responsibility: In Search of an Ethics for the Technological Age*. University of Chicago Press, 1984, p.10

7 *Managing our Radioactive Waste Safely. CoRWM's Recommendations to Government*. CoRWM Doc 700. Committee on Radioactive Waste Management (CoRWM), Jul. 2006, p.13. www.gov.uk/government/publications/managing-our-radioactive-waste-safely-corwm-doc-700

8 C Perrow: *Normal Accidents: Living with High-Risk Technologies*. Updated edition. Princeton University Press, 1999 (first published by Basic Books, 1984)

9 *Managing our Radioactive Waste Safely* (see note 7), p.13

10 *National Policy Statement for Nuclear Power Generation (EN-6), Vol. II of II – Annexes*. Department of Energy and Climate Change, Jun. 2011. p.16. www.gov.uk/government/publications/national-policy-statements-for-energy-infrastructure

11 *The Environmental and Ethical Basis of Geological Disposal*. Nuclear Energy Agency/Organisation for Economic Cooperation and Development, 2006, p.21

12 *National Policy Statement for Nuclear Power Generation (EN-6), Vol. II of II – Annexes* (see note 10), p.13