

Nuclear New Build Renaissance, Decommissioning and Radiological Protection in the UK: Legal and Regulatory Framework

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Abstract

The “nuclear renaissance” in the United Kingdom (UK) has sparked both the development of new nuclear projects and the decommissioning of existing power stations. This simultaneous occurrence introduces significant legal and regulatory challenges to radiological protection and decommissioning. This paper critically analyses the existing legal and regulatory frameworks governing radiological protection and waste management during decommissioning in the UK. The study evaluates the effectiveness of international, regional, and national policies while considering national social and legal concerns. Finally, the paper concludes that the UK’s framework for radiological protection during decommissioning is reasonably effective, as demonstrated by improvements in regulatory structures, independent oversight and international collaboration.

Introduction

The resurgence in nuclear energy, often termed the ‘nuclear renaissance’, is driven by factors such as energy security, climate change mitigation and technological advancements such as small modular reactors (SMRs). This paper focuses on the UK, which is not only developing new nuclear projects but is also decommissioning a significant number of existing reactors. Effective waste management and the associated legal and regulatory provisions during decommissioning is crucial for safeguarding human health and the environment. The UK’s ‘nuclear renaissance’ comprises proposed initiatives to construct several nuclear power stations with the aim of bolstering energy security, achieving net-zero carbon emissions, and replacing aging nuclear power stations [1].

Hinckley Point C is under construction in Somerset and is expected to be operational by 2026–2027, with a capacity of 3.2 Gw. Sizewell C, with a capacity of 3.2 GW, has been approved and is in early development, aiming for completion in the early 2030s. Bradwell B has been proposed and is in the planning and assessment phases subject to approval and is expected to provide 2.2 GW of electricity. Prospective projects include Wylfa Newydd (Anglesey, Wales) and Moorside. Although the original plans for a large-scale nuclear project were temporarily halted, there is now a re-evaluation of the project, which includes the possibility of constructing new nuclear power stations equipped with advanced nuclear technology. Moorside (Cumbria, England) has the capacity to host both large reactors and SMRs, although the present focus of the project is to seek investment proposals. The government’s ambition for the ‘nuclear renaissance’ is to reach 24 GW of nuclear capacity by 2025, contributing to a quarter of the country’s electricity needs. If successful, these developments could provide the UK with a robust and low-carbon energy mix. For this reason, the legal and regulatory provisions for nuclear power station decommissioning is of paramount importance.

Indeed, the Chernobyl disaster in the former Soviet Union brought attention to the possible risks of nuclear power to the environment and human health [2]. Consequently, these risks are likely to persist for an extended period of time and are expected to continue into the future, posing a challenging legacy for future generations, especially with regards to radioactive waste, which is believed to retain its hazardous nature for several millennia.

This paper will explore the international legal framework for the waste management aspect of decommissioning, looking at the International Atomic Energy Agency, the Organisation for Economic Co-operation and Development (OECD) / Nuclear Energy Agency (NEA) specifically and their role in the safety of nuclear power stations decommissioning. The UK legal and regulatory infrastructure is then explored in detail. The chapter will conclude that the UK has pursued an innovative model for waste management capabilities, delivered through a robust legal and regulatory framework which can serve as a model for countries in pursuit of nuclear energy.

International Regulatory Framework

This section provides a critical overview of key international regulations and conventions that the UK is party to. The UK operates within a complex regulatory environment governed by international organizations such as the International Atomic Energy Agency (IAEA) and the Organisation for Economic Co-operation and Development (OECD)'s Nuclear Energy Agency (NEA). The IAEA plays a vital part in setting international standards, although its guidelines are considered 'soft law' with limited enforceability [3]. The Joint Convention on the Safety of Spent Fuel Management and Radioactive Waste Management (JC) attempts to establish a coherent approach but lacks strong enforcement mechanisms. Crucially, it is worth noting that while the IAEA legislation has the authority to create standards and guidelines, these requirements do not hold any legal weight in member states, including the UK. Viewing them as 'soft law' is challenging because they lack procedural tools to provide adequate governmental consent and authority [4]. The IAEA's guidelines, particularly those related to radiological protection and waste management, inform UK regulations despite their non-binding nature. This section reviews the relevant articles within IAEA statutes and discusses how the UK integrates these guidelines into its domestic legal framework.

The UK's adherence to the JC is central to its legal obligations. Despite being non-binding, the IAEA's safety standards influence the UK's regulatory framework, demonstrating their importance in shaping national policy. In addition, the International Commission on Radiological Protection (ICRP) plays an important role in shaping the principles and guidelines that influence radiological protection during decommissioning of nuclear power stations in the UK.

The Joint Convention

Adopted in 1997, the Joint Convention marks a significant step toward international cooperation in nuclear safety. Article 24 of the JC focuses on operational radiation protection during decommissioning [5]. It emphasises the need to incorporate safety measures into the process in order to safeguard human health and the environment. The Article stipulates that decommissioning activities must be conducted within a controlled framework that encompasses safety evaluations and preventative measures to manage radioactive potential hazards. This entails the surveillance and reduction of radiation exposure and the adherence

to the ALARA principle. Further, it requires that suitable provisions be established for the handling of any radioactive waste produced during the decommissioning process, with a particular emphasis on ensuring radiological safety. The UK method incorporates key features such as the involvement of the Office for Nuclear Regulations (ONR). The ONR is tasked with overseeing safety, security and radiation protection during the decommissioning process. It guarantees that operators comply with rigorous safety standards and regulatory obligations. In addition, the Environmental Agencies oversee the regulation of environmental protection measures, assuring safe management of radioactive waste and compliance with legal restrictions for any releases into the environment. The UK's obligations under this convention include regular reporting and participation in peer review meetings. However, the lack of stringent enforcement mechanisms and the voluntary nature of compliance limit its effectiveness.

Current UK Legislative Framework

In addition to the Nuclear Installation Act 1965 (NIA 65), which lays the foundation for nuclear industry in the UK, the Radioactive Substances Act 1993 (RSA 93) is the current legislation for waste management aspects of decommissioning and is a devolved matter. The Act consolidated and replaced the 1960 Act and, subsequently, those made in the Environment Protection Act 1990. The Act controls the keeping of waste through authorisation and regulatory systems and also provides for public information held by enforcing authorities according to section 39 of the RSA 93. Enforcement and prohibition notices are issued by environment agencies in the respective regions. In Scotland, however, the Scottish Environmental Protection Agency (SEPA) uses its compliance assessment scheme to assess compliance with regulations and authorisations under the RSA 93. It is important to note that in the UK, the management of waste is based on the principles of radiological protection. These principles are derived from the standards and guidelines of the International Atomic Energy Agency (IAEA) and are used to guide domestic legislation and policy which flow down to inform domestic legislation and policies. The principles are enshrined in UK law and underpin the UK government's devolved policies on managing waste.

In this respect, the legislative framework for radioactive waste is assigned to devolved governments, set out in the Scotland Act 1998 (S Act 1), the Government of Wales Act 1998

(W Act 1998) and Northern Ireland Act 1998 (NI Act S1). Even so, the Radioactive Substances Act 1993 is the same across the nation. Chapter 1 (1) of the Environment Act 1995 (EA 95) provided for the establishment of the corporate body, known as the Environment Protection Agency (SEPA) in Scotland and as the Environment Agency in England and Wales, to provide for the transfer of functions such as waste management.

In this respect, waste management as a devolved matter aims to reform assignments of responsibilities across the country. This development has important implications for waste regulation, particularly to ensure compliance with legislation. This entails the transfer of some of the responsibilities from Westminster to the regional level and enables affected parties to review legislation. However, Scotland, as a devolved government, has no authority over nuclear power installations as a devolved competence, but it does have complete competence in environmental matters and planning. As a devolved power, the Scottish government has the power to block the installation of nuclear power stations in Scotland and is still against nuclear power. The main legal problem is that Scotland lacks authority over nuclear power installations, as a devolved state. The horizontal and vertical approaches present in the UK have the potential to cause compliance issues across legislation and regulatory instruments across various regions.

The Ionising Radiation Protection Regulations 2017

The Ionising Radiation Regulations 2017 (IRR 2017) have their roots in both international guidelines and earlier UK legislation. Early frameworks for radiation regulation and radioactive material management include the Radioactive Substances Act 1960 and the Ionising Radiation Regulations 1985, designed to regulate and manage radiation and to manage radioactive materials and restrict radiation exposure in the UK. The formulation of these regulations was based on extensive scientific research on radiation risk over the years, along with international and European initiatives to establish uniform safety standards.

The Ionising Radiation Regulations 1999 (IRP 1999) were the direct predecessor of the Ionising Radiation Regulations (IRR 2017). While the 1999 regulations provided a robust framework for radiation protection, advances in scientific understanding, changes in industry practices and the new Euratom Directive needed some revisions. Therefore, the impetus for the IRR

2017 was primarily the European Union's Basic Safety Standards Directive (Council Directive 2013/59/Euratom), which sought to standardise radiation protection legislation among EU member states. The directive incorporated revisions in scientific knowledge and executed new regulations for exposure, waste management and emergence preparedness. The UK, as a member of the EU at the time, was required to transpose this directive into national law. The IRR 2017 was introduced to fulfil this obligation and replace the previous IRP 1999.

In that aspect, the IRR 2017 incorporated the latest requirements for the Euratom Directive, aligning UK law with updated international best practices and ensuring continued compliance with the European legal framework. The IRR 2017 offers comprehensive guidelines on dose limits, a regulated approach that customises safety measures according to the level of risk and enhanced provisions for safeguarding workers, the public and the environment. Although the UK is no longer a member of the EU, the IRR 2017 remains in force, reflecting the UK's commitment to radiation protection and ensuring that safety measures are updated.

The IRR 2017 regulation 8 (1-4) requires radiation risk assessment. The implementation of these rules does not conflict with the provisions of regulation 3 of the Management of Health and Safety at Work Regulations 1999. The IRR 2017 also requires restriction of exposure according to Regulation 9, personal protective equipment (PPE) (Regulation 10) and dose limitation (Regulation 12). In addition to these regulations, there is a requirement for contingency plans according to Regulation 13 and also the need for a radiation protection advisor (Regulation 14).

The Role of the ICRP in Decommissioning in the UK

While the ICRP does not directly regulate nuclear decommissioning in the UK, its guidelines are foundational to the country's regulatory framework. The ONR, EA, and other regulatory bodies apply ICRP principles in the oversight of decommissioning activities, ensuring that radiological protection for workers, the public and the environment aligns with international best practices. As an independent, non-governmental organisation, the ICRP establishes radiological protection principles that are applied globally, focusing on areas such as exposure limits, safety standards and dose management. Its fundamental principles applied to decommissioning include justification, optimisation and dose limitation.

The UK Regulatory Framework

The UK's regulatory framework is anchored by the Nuclear Installations Act 1965, the Energy Act 2004 and the Environmental Permitting Regulations. The Nuclear Decommissioning Authority (NDA), established under the Energy Act 2004, oversees waste management during decommissioning. This section discusses how the UK regulations incorporate international guidelines while addressing national concerns, particularly in waste management.

The Nuclear Decommissioning Authority (NDA)

The creation of the Nuclear Decommissioning Authority (NDA) under the Energy Act 2004 (EA 2004) revealed positive shifts towards decommissioning. However, the establishment of the EN04 also signalled the government's commitment to phase out nuclear power stations, as highlighted in the white paper of 2006. The NDA's responsibilities include site management, strategic oversight and stakeholder engagement across 17 nuclear sites in the UK according to sections 1–7 of the EA 2004. Additionally, it is responsible for evaluation of the socioeconomic effects on nearby communities surrounding the decommissioning sites and facilitating local development.

When the NDA was initially set up, it adopted a model that involved parent body organisations (PBOs) to manage the day-to-day operations of specific nuclear sites. The PBO model was based on the principle of outsourcing management to private sector consortia with specialised expertise in nuclear operations. In this aspect, the NDA remained the owner of the sites and held strategic oversight, while PBOs were contracted to operate on the sites. PBOs were private companies or consortia awarded contracts through competitive bidding to management Site Licence Companies (SLCs), which directly handled operations at individual nuclear sites. PBOs were responsible for delivering decommissioning plans, managing budgets and meeting performance targets. Their contracts included financial incentives based on successful performance. The multi-layered structure of the NDA overseeing PBOs, which in turn managed the SLCs, created complex and sometimes inefficient management chains and as a result there were challenges in aligning the objectives of private sector PBOs with public sector priorities, leading to conflicts of interest and governance issues.

The model came under scrutiny from government auditors, including the National Audit Office (NAO), which highlighted significant shortcomings in performance and value for money with the model. In 2015, the UK government and the NDA terminated the PBO model at Sellafield and transitioned to a more direct management approach. Thereafter, the NDA adopted a direct management model for the site, creating Sellafield Ltd. as a wholly owned subsidiary of the NDA. The change allowed for more streamline decision-making and better alignment with public sector goals and better safety measures.

Nonetheless, waste management under the current regime remains regulated under the liability regime until ONR has given notice in writing to the operate holding the nuclear site licence when, in its opinion, 'there has ceased to be any danger from ionising radiations from anything on the site'. The Energy Act 2023 states that any radioactive waste remaining at the site and any further site monitoring should continue to be regulated by the relevant environmental agencies, who would continue to regulate the site until the RSR environmental permit was able to surrender.

Regulatory Regimes

Office for Nuclear Regulations

How regulations are implemented and enforced, and how compliance is ensured and promoted, are critical determinants of whether a regulatory system is working as intended. In this respect, in addition to regulating nuclear safety, through site licensing, the independent public cooperation Office for Nuclear Regulations (ONR), established by Part 3 of the Energy Act 2013 (EA 13)'s purpose, is outlined in Sections 67 and 69 of the Act. It also regulates conventional health and safety law on nuclear-licensed sites. Some of these purposes are covered by the purposes of the Health and Safety Executive, as set out in section 1 of the Health and Safety at Work Act 1974. Section 68 (1A) of the Energy Act 2013 states that the ONR is responsible for enforcing statutory provisions relating to waste management. Part 1 of Schedule 8 gives the ONR the power to appoint inspectors to ensure that activities are carried out according to specified regulations. Paragraph 5 allows for remedial action to be sought in accordance with the improvement and prohibition notices.

The ONR applies the ALARA (as low as reasonably achievable) principle throughout the decommissioning of nuclear power stations in the UK. The ALARA principle is a foundation of radiation protection and involves minimising radiation exposure to workers, the public and the environment to levels as low as reasonably achievable, taking into account social, technical and economic factors. In this case, the ONR's duty is to provide detailed guidance and sets expectations for operators to follow the ALARA principle during the decommissioning cycle. The ONR's regulations require that nuclear licenses demonstrate how they will implement ALARA in their decommissioning strategies, ensuring that radiological risks are minimised. Before decommissioning can start, operators are required to submit detailed decommissioning plans to the ONR stating how exposure will be reduced according to the ALARA principle. The ONR requires operators to use appropriate technologies, safety protocols and protective equipment to reduce radiation doses to workers. The ONR also ensures that operators optimise protection by considering alternative methods, tools and strategies that could further reduce exposure while still being practical and cost-effective. For example, the use of remote-controlled equipment as an option. The ONR plays a vital role in ensuring that the ALARA principle is embedded in the lifecycle of nuclear power station decommissioning in the UK. Through comprehensive regulatory oversight, planning, monitoring and continuous review, the ONR ensures that radiation exposures are minimised to protect workers, the public and the environment, while balancing practical and economic factors. This approach aligns with international best practices and reinforces the UK's commitment to safe and responsible waste management aspects of nuclear decommissioning.

Legal sanctions for non-compliance for licence conditions or the avoidance of a licence has been based on a combination of criminal penalties and administrative sanctions, such as the revocation of a licence. However, the concept of civil penalties is not well developed in the UK, as argued by Macrory.¹ In many areas, the ONR, as the regulator, has powers under EA 13 to provide various forms of enforcement, such as warnings, letters, notices and information, and improvement and prohibition notices. From a viewpoint of waste management, this type of legal structure is effective. Social-legal structure studies of pollution control authorities

¹ Richard Macrory, *Regulating a Risky Environment* (2002) in *Regulation, Enforcement and Governance in Environmental Law*, (Hart 2014).

have shown the extent to which the emphasis on smooth environmental administration rather than law enforcement as such has encouraged a non-confrontational relationship between regulators and those they regulate, such as the operators. Furthermore, in making these points, it should be recognised that close links between regulators and operators can be mutually beneficial and serve safety interests by encouraging effective regulation in the highly specialised and technical area of waste management. However, it must also be acknowledged that overly close relationships and competing interests with the regulatory system can pose significant risks and lead to regulatory failures, as was the case with the Fukushima Daiichi accident.

In this regard, while the ONR has the power to revoke licences, it rarely does so, or in extreme cases seek an injunction, but enforcement actions of the ONR are rarely escalated. In implementing the regulatory system, their options are to serve warnings, letters, notices with information, or improvement and prohibition notices. As an example, an improvement notice at the Wylfa site on Anglesey was issued for failing to manage asbestos-containing material at the site. In this case, the ONR determined that the improvement notice was necessary to ensure the operator, Magnox Ltd., took timely action to ensure the required legal standards were met. In this case, an improvement notice was issued on 01 March 2024 to Nuclear Restoration Services (formerly Magnox Ltd.) for shortfalls in arrangements of storing alkali metals at its Dounreay site.

Control mechanisms to monitor the implementation of the law are weak, for example, on 01 March 2024, the ONR issued improvement notices to Dounreay Nuclear Power Station under the HSWA74, sections 2 (1) and 3 (1), the NI65, Nuclear Site Licence Condition 4 (2) and the Control of Substances Hazardous to Health Regulations 2002 (COSHH) Regulations 7 (3) and (4). Nonetheless, the implementation of the HSWA 1974 illustrates the UK's commitment to mandating that employers take responsibility for the well-being and protection of their workers.

Health and Safety at Work Act 1974

The Health and Safety at Work (HSAW 1974) was designed to protect workers at nuclear sites during the management of waste. The control of potential worker exposure resulting from waste management at nuclear power stations is the focus for the legislation. To this effect, the provisions under the HSWA 1974 is that an employer is required to ensure as far as is reasonably practical that he does not cause harm either to his employees or to other people either on or off the site by providing a clear allocation of responsibilities to the bodies involved in the different steps of radioactive waste management. Importantly, the provisions made under the Nuclear Installation Act 1965 in respect of both licensing and inspecting prescribed nuclear installations are subject to the regulation and enforcement regime of the HSWA1974.

Further, the 2008 Regulation Act is in force, which calls for regulators to give warnings before escalating issues to court. In this regard, a case by the ONR against EDF Energy Nuclear Generation Ltd. and Doosan Babcock Ltd. was brought before his Honour Judge Ticehurst at Taunton Crown Court on 01 February 2019. The falling of the worker through a skylight at Hinkley Point B was a direct offence under the Health and Safety at Work Act 1974, section (3)1 for EDF as an operator and the Work at Height Regulations 2005, Regulation 4 (1) for Doosan Babcock as a contractor. Both companies were collectively fined £386,353.84, including court costs. In addition to the court proceedings, an enforceable improvement notice was issued to EDF and Doosan Babcock. Sentencing, the judge said that although both establishments in question had robust safety measures in place, it was clear they were not applied appropriately and as such both companies failed to meet their statutory obligations regarding the health and safety of workers.

Overall, the case demonstrates a *laissez-faire* approach by both the operator and the contractor in conducting safety inspections at the nuclear power station. Despite the regulator assigning fault to the two establishments, it is the responsibility of the ONR to preventively freeze operations to prevent incidents from occurring. In this regard, no one is holding ONR responsible, yet it is.

In addition to the HSWA 74, the Emergency Preparedness and Public Information Regulations 2019 (REPIR 19) plays an important role in the safety of the public and the environment. This requires the operators to prepare on- and off-site emergency plans after having conducted a hazard evaluation. Duties are also placed on local authorities to prepare for the occurrence of a radiation emergency. Both operators and local authorities must guarantee that all necessary safety information is provided to the affected population. However, major accidents which are prone to serious impacts on the environment are regulated by the Control of Major Accidents Hazardous Regulation 1999 (COMAH 99) and are subject to its definition of major accidents. The adoption of the Freedom of Information Act 2000 in 2005 heralded a 'right to know culture', supported in environmental matters by the Environmental Information Regulations 2004, which also came into force in 2005. The Freedom of Information Act 2000, S74 (1) implemented the Aarhus Convention. This means the Convention on Access to Information Public Participation in Decision-Making and Access to Justice in Environmental Matters in the UK. The Aarhus Convention is a great addition to environmental protection; however, it lacks sufficient enforcement measures, is unclear and takes on a *laissez-faire* approach, which makes it a weak legal instrument.

Challenges

Radiological waste management remains a contentious issue, with potential risks including environmental contamination and nuclear proliferation. The UK still faces significant challenges in finding long-term solutions for high-level radioactive waste. Nonetheless, the legal and regulatory provisions for decommissioning and radiological protection in the UK are comprehensive but face challenges related to regulatory complexities, funding uncertainties, waste management and evolving standards. The 'nuclear renaissance' will increase the volume of radioactive waste, including high-level waste, which must be safely managed and disposed of. The UK currently does not have a fully functional GDF to store high-level nuclear waste for extended periods of time.

The Chernobyl disaster in the former Soviet Union and the Fukushima Daiichi accident in Japan highlighted the lasting risks associated with nuclear technology. The regulatory provisions for decommissioning in the UK are intricate, involving multiple regulators, such as the ONR, the Environmental Agency and SEPA. The presence of overlapping jurisdiction can

result in difficulties in coordinating efforts, delays in implementation regulations and a rise in administrative expenses on operators.

The process of decommissioning can span several years, during which there is a possibility of standards and regulatory changes. This situation generates uncertainty for operators who need to adjust to changing demands while ensuring regulatory compliance. The extended duration of decommissioning also raises questions about the resilience of financial provisions and the potential regulatory changes that could impose additional costs and obligations.

Conclusion

The UK's approach to radiological protection and waste management during decommissioning is highly effective due to robust legal frameworks and independent oversight. However, ongoing challenges such as the non-binding nature of international guidelines and the fragmentation within devolved administrations highlight areas for improvement. While the 'nuclear renaissance' in the UK seeks to address energy security and tackle climate change, it also presents substantial legal and regulatory challenges during the decommissioning process. These challenges include managing increased waste volumes, ensuring adequate funding, adopting regulatory frameworks, addressing skills gaps and maintaining public trust. Effective legal and regulatory provision and coordination across the nuclear sector will be essential to overcome these challenges and ensure safe and sustainable decommissioning practices for the next generation of nuclear power stations.

It is crucial to ensure that the decommissioning processes for new nuclear power stations are in line with international rules and incorporate novel approaches. The interim waste storage facility should have sufficient capacity to accommodate possibly increased amounts of waste for extended durations, considering the lengthy timeframe needed to create a GDF. The regulatory systems must strike a delicate balance between promoting the advancement of nuclear technology and ensuring strict adherence to safety and decommissioning regulation, which can be a multifaceted and politically delicate undertaking.

The UK's experience in handling legacy sites offers valuable insights but also poses difficulties for the 'nuclear renaissance'. The legal and regulatory framework governing decommissioning

and radiological protection in the UK is highly developed and can serve as a standard for countries who are pursuing nuclear power as well as managing the 'nuclear renaissance'.

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