

REGULATORY ASPECTS OF DECOMMISSIONING IN THE UK

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ABSTRACT

This paper discusses the regulation of decommissioning in the United Kingdom by HM Nuclear Installations Inspectorate (NII) and the factors considered in examining the adequacy of decommissioning and radioactive waste management on nuclear licensed sites. NII's principal requirements are for decommissioning to be undertaken as soon as it is reasonably practicable to do so, taking account of all relevant factors, and for radioactive wastes to be minimised and either disposed of or, if this is not practicable, stored in conditions of passive safety. These requirements are considered in the context of organisational change within the UK nuclear industry and the non-availability of disposal routes for some decommissioning wastes. Reference is made to guidance in the fields of decommissioning and radioactive waste management which we are currently developing for the information of our licensees and for use by our inspectors and assessors.

INTRODUCTION

Decommissioning in the UK has always been considered as an integral part of the operation of a nuclear facility. However, it is today's generation of operators and regulators that has to deal with existing legacies and future decommissioning requirements. Many facilities and plant still operating today were not designed with decommissioning in mind and some wastes have been stored with little thought for their eventual retrieval. Other wastes have been disposed of in an authorised disposal facility which has subsequently proved unacceptable. The paper explores some of the challenges and issues associated with decommissioning and radioactive waste management in the UK from the point of view of nuclear inspectors in the NII which is a part of the UK's Health and Safety Executive (HSE). The regulatory background is described, together with HSE policy, which is consistent with Government policy in these areas.

This paper discusses NII's developing expectations and builds upon our views as presented at recent conferences, including WM symposia [1] [2] [3]. Our expectations have been incorporated in draft guidance material which we are developing for the information of our licensees and for use by our inspectors and assessors. This guidance material is currently undergoing consultation with the environment agencies and other Government departments and the views expressed in this paper should therefore be regarded as those of only the authors.

REGULATORY BACKGROUND

The Health and Safety Executive (HSE) is the executive arm of the Health and Safety Commission which, in turn, is appointed by the Secretary of State for the Environment, Transport and the Regions. HSE aims to ensure that the risks to people's health and safety arising from work activities are properly controlled. HM Nuclear Installations Inspectorate (NII), which is part of HSE, aims to secure the maintenance and improvement of standards of safety at licensed nuclear installations. In regulating decommissioning and other aspects in accordance with statutory powers, NII has a duty to ensure consistency with UK Government Policy [4].

The Nuclear Installations Act 1965 (as amended) (NIA 65) requires a site licence to be issued before prescribed activities may be undertaken. NIA 65 allows HSE to attach such conditions to the site licence as it may think fit with respect to the handling, treatment and disposal of nuclear matter, or as may appear to HSE to be necessary or desirable in the interests of safety. It is largely through this route that we achieve our regulatory aims. The conditions which are attached to a licence are essentially non-prescriptive and generally require the licensee to make and implement adequate arrangements to address safety and waste management issues. The non-prescriptive nature of the licence conditions enables a continuous and flexible form of regulation which applies throughout all stages in the life of a nuclear installation, including decommissioning.

Of particular interest is the requirement of NIA 65 for the period of responsibility (the time during which NIA65 applies to a site) to continue "until there has ceased to be any danger from ionising radiation from anything on the site". We have adopted a pragmatic approach in interpreting this requirement, and have expected licensees to demonstrate that radiation and radioactivity levels on the site are indistinguishable from background levels in the vicinity of the site [5]. In this way we have been able to delicense (ie end the period of responsibility for) a number of sites. However, for sites where there has been extensive contamination of the ground or subsoil, this criterion may not be applicable.

A fundamental requirement of nuclear site licences is for licensees to produce safety cases for all operations which may affect safety. This applies to the construction, commissioning, operation and decommissioning of plant. In addition to routine verification that the safety case is consistent with plant and its future operation, licensees are required to carry out a periodic review of the safety case which is much more comprehensive. This review, which is typically required every 10 years, is intended to consider previous operational history, provide a comparison with modern safety standards and justify any differences or concerns. Provisions should be made at the design stage for decommissioning the plant and arrangements for decommissioning (including the management of human and financial resources as well as technical aspects) should be progressively developed throughout its life.

Licence conditions related to radioactive waste management require arrangements to ensure that waste arising are minimised and properly contained, and that use is made of available disposal routes. Other conditions require the licensee to prepare decommissioning plans which NII can approve. The effect is to "freeze" the plans, subject to environmental impact assessment before

the start of decommissioning. This provides a means of regulatory control whereby no changes can be made without consultation and, where appropriate, our consent.

NII continues to review the adequacy of the licence conditions for the regulation of all activities, including decommissioning and the management of radioactive waste.

The disposal of radioactive waste and discharge of radioactive material in airborne and liquid discharges from any facility, including nuclear licensed sites, is regulated, under powers derived from the Radioactive Substances Act 1993, by the Environment Agency (EA) in England and Wales and the Scottish Environment Protection Agency (SEPA) in Scotland. All other aspects of radioactive waste management on licensed nuclear sites, including its generation, accumulation, treatment and storage, are regulated by NII using conditions attached to the nuclear site licence. The vast majority of radioactive waste in storage in the UK is located at nuclear licensed sites. Liaison is maintained between NII and the two environment agencies, through interdepartmental agreements, with the aim of ensuring that waste management aspects are regulated in a consistent manner.

Recent regulations in the UK [6] require the decommissioning of nuclear reactors to be subject to an Environmental Impact Assessment (EIA). Under this process the licensee produces an Environmental Statement (ES) in support of its application for Consent, and HSE consults with statutory consultees, including the environment agencies, before coming to a conclusion on whether to grant Consent. We will grant Consent only if satisfied that an adequate EIA has been performed, and we may attach conditions to the Consent. More recently it has been decided that submissions under Article 37 of the Euratom Treaty, which relate to possible impact of decommissioning proposals on other member states of the European Community, will be required for decommissioning sites and plant (including the reactor sites at Hunterston, Berkeley and Trawsfynydd where decommissioning has already started). We believe that such submissions should be made in a timely fashion since it is in the interests of safety to enable the timely decommissioning of reactors and the general reduction of hazards.

HSE's DECOMMISSIONING POLICY

HSE's policy on decommissioning and radioactive waste management at nuclear licensed sites [7] is based on UK Government policy [4]. Key elements include:

- The process of decommissioning nuclear plants should be undertaken as soon as is reasonably practicable, taking account of all relevant factors.
- Operators should draw up strategies for decommissioning their redundant plant which should include justification of the proposed timetables and a demonstration of adequate financial provisions.
- The strategies should ensure that the hazards presented by the plant or site are reduced in a systematic and progressive way.

- Radioactive waste should be segregated and characterised to facilitate its safe management, including conditioning (where appropriate), storage, retrieval and disposal.
- Where disposal routes exist, radioactive wastes should be disposed of as soon as reasonably practicable.
- Where it is necessary to store radioactive waste, this should be done in conditions of passive safety and in a manner which facilitates monitoring, surveillance and retrieval for final disposal.

In accordance with Government policy, we expect decommissioning to be undertaken as soon as reasonably practicable taking into account all relevant factors. We consider that decommissioning requires the systematic and progressive reduction of all hazards on a licensed site. This interpretation reflects a shift in emphasis towards the deterministic reduction of hazard, with risks being optimised throughout.

In addition, the Government placed a duty on HSE to undertake a quinquennial review of each licensee's arrangements and provisions for decommissioning [4]. These reviews look in detail at provisions against specific decommissioning objectives in order to provide confidence that plans can be implemented without any restriction due to resource limitations.

NII also has a duty to ensure that its regulation of decommissioning and other matters is consistent with Government policy in support of sustainable development and inter-generational equity.

THE CHALLENGES

In the UK we have a wide range of experience in decommissioning and delicensing early research reactors and parts of nuclear chemical plant sites [1]. Larger plant and nuclear sites now being decommissioned include Magnox power stations at Berkeley, Trawsfynydd and Hunterston 'A', two liquid metal cooled fast reactors at Dounreay, three materials test reactors and the Windscale Pile No. 1 which was damaged by fire in 1957. Some fuel cycle and nuclear chemical facilities, such as the Capenhurst Diffusion Plant, are also being decommissioned. Advanced technology for remote operations is readily available and decommissioning is increasingly being seen as an important and challenging discipline and business opportunity in its own right. One of the challenges in the field of decommissioning is the need to gain public acceptance. This is borne out by UK experience in seeking to develop a national waste repository for intermediate and high level wastes. For example, the previous UK Government decided not to allow the development of a rock characterisation facility at Sellafield, as part of a programme to determine the suitability of such a site as a waste repository. This has had a major impact on decommissioning and radioactive waste management strategies as discussed below.

The future national strategy for radioactive waste management is under review and the latest statement is given in the Government's recent response [8] to a report on this subject by the House of Lords Select Committee on Science and Technology [9]. The Government has made

clear that it wishes to “take account of the Committee’s views and undertake wide consultation before announcing how it wishes to proceed”. The Government (and devolved administrations in Scotland and Wales) plan to publish a detailed and wide-ranging consultation paper in early 2000 to “discuss the processes that would be involved in the various management options for radioactive waste, rather than the relative merits of the options themselves”. Low level waste (LLW) is currently disposed of to one of two repositories managed by British Nuclear Fuels plc (BNFL) at Drigg in Cumbria and by the United Kingdom Atomic Energy Authority (UKAEA) at Dounreay. However, it may be many decades before a disposal route, or other long-term management option, is available for handling intermediate level and high level wastes (ILW, HLW). UK Government policy [4] in Cmnd 2919 notes that the presumption of non-foreclosure of options may be relaxed where there are worthwhile safety benefits in conditioning waste to achieve passively-safe storage. The requirement for passive safety is therefore reinforced under current circumstances. This is further supported by the outcome of a recent Citizens’ Panel [10] which examined radioactive waste management and concluded in favour of long term surface or shallow storage of radioactive waste.

The pace of decommissioning progress in the UK will increase over the next 10 - 20 years as steel pressure vessel Magnox power stations come to the end of their operational phase and licensees increasingly address the current legacies, in particular, of nuclear chemical plant. For example, in 1998 HSE and SEPA published a joint report into a safety audit of the United Kingdom Atomic Energy Authority (UKAEA) research site at Dounreay [11]. The audit concluded that much needed to be done at Dounreay to enable the site to be safely decommissioned and made safe for future generations. This includes the need to empty approximately 700 m³ of radioactive waste from a shaft which had been used as an authorised disposal route for radioactive wastes between 1959 and 1971. NII believes that this waste should be recovered and conditioned as soon as is reasonably practicable. The growth of decommissioning activity at power station sites and nuclear chemical sites such as Dounreay will inevitably lead to increases in the quantities of low and intermediate level wastes arising on nuclear licensed sites.

In early 1999 NII published the findings of its review of ILW storage in the UK [12]. This showed that many of the existing storage facilities will need to be replaced, and that a number of new stores will be required to ensure the safe storage of this waste until a repository is available for its ultimate disposal. Our review also found that a delay in the development of a disposal route beyond 50 years would require programmes for the refurbishment or replacement of more than 20 existing stores and, possibly, for the handling and repackaging of existing wastes.

We believe that the UK nuclear industry should plan on the assumption that such a repository, or other waste management option, is unlikely to be available for many decades and have concluded that there are significant safety benefits in the conditioning of raw operational wastes into a passively-safe form for a period of long-term on-site storage in purpose-built facilities.

These developments are taking place at a time of change in the structure of the UK nuclear industry, with some parts (such as British Energy) having been sold to the private sector, others (such as BNFL and Magnox Electric) having merged and a public/private partnership (PPP)

proposed for BNFL. Furthermore the recent inter-Government agreement reached at the Sintra meeting of OSPAR [13] states that “by the year 2020 the Commission will ensure that discharges, emissions and losses of radioactive substances are reduced to levels where the additional concentrations in the marine environment above historic levels are close to zero”. The underlying message is one of proper management of a hazard and not only the potential risk. This means returning to basic principles and deterministic standards for radioactive waste management and the setting of discharge limits.

THE ISSUES

NII expects licensees, in developing their preferred decommissioning strategy, to give particular weight to good engineering practice taking account of national or international standards such as those of the International Atomic Energy Agency (IAEA). Our criteria in this respect are set out in NII's Safety Assessment Principles [14]. As we have seen, decommissioning strategies are being developed in the face of a range of challenges. Key issues to be addressed include the timing of decommissioning, the allocation of adequate financial and human resources and the management of radioactive waste. Our developing views on these issues are explored below.

Timing of Decommissioning

Decommissioning strategies sometimes include a proposal to defer the start of some elements of the decommissioning programme. As safety regulators we will expect any such deferral to be substantiated in terms of providing a significant safety benefit, for example, in respect of radioactive decay. Deferral may reduce operator dose uptake and the hazard associated with the inventory of radioactive material. In addition, deferral might enable the volumes of some shielded waste packages to be minimised and enable others to be disposed of without the need for double-handling. In such cases we expect predicted operator dose uptakes to have been optimised as ALARP. However, if the deferral of decommissioning does not result in such a benefit, we believe that it should be undertaken sooner rather than later, since any delay is likely to increase the risk of radioactive materials spreading from existing containments into the surrounding environment.

For power reactors, following defuelling, a substantial proportion of the radioactive inventory comprises relatively short-lived activation products, notably cobalt-60. Deferral of the start of reactor dismantling may be warranted in such cases, although we believe that the site specific arguments we have seen to date do not demonstrate that a significant safety benefit will be gained from deferring final dismantling beyond 40 - 50 years. Deferral is unlikely to be appropriate for facilities with longer-lived contamination such as cooling ponds and fuel production plants. For chemical plant contaminated with plutonium, dose rates may increase over time owing to the ingrowth of americium-241. In such cases we believe that post-operational decontamination and dismantling should always be carried out promptly.

In our evidence to the recent House of Lords Select Committee [9], we commended the segregation and classification of wastes according to half-life as is done in France and in other countries. This would have implications for the extent and timing of decommissioning at sites,

such as Magnox power reactors, where dose rates from steel in the steam generating units and pressure vessels are initially dominated by the relatively short-lived cobalt-60.

The current lack of a disposal facility for ILW and HLW in the UK presents a problem for the timing of decommissioning. There is a balance to be struck between the multiple handling of materials, the constraints of future disposal options, the deferral of decommissioning until a disposal route becomes available and the many powerful arguments in favour of early decommissioning. For example, a prolonged period of deferral will bring with it growing safety disbenefits in terms of the transfer of skills, competence and knowledge to future working generations. Clearly, any deferral must be shown to be consistent with Government policy in support of sustainable development and inter-generational equity.

Financial Resources

NII considers that a range of safety, health, environmental and economic factors should be fully taken into account when selecting and justifying the preferred decommissioning option and that discounted costs, based on currently available technology, should then be applied in calculating the required funding. We believe that consideration of discounted costs alone would lead simply to the indefinite deferral of decommissioning.

Should a licensee be unable to provide resources to decommission a facility immediately operations have ceased, then they must demonstrate that they are able to provide at least those resources needed to manage safety in the meantime. It is not in the interests of safety to demand decommissioning on a timescale that would bankrupt a licensee, but ultimately it may be necessary for national authorities to take over responsibility for decommissioning if the licensee defaults on earlier commitments.

Human Resources

The transition from operation to decommissioning is a process of major organisational change for the licensee. NII has required such changes to be carried out in accordance with rigorous and comprehensive management of change arrangements [15]. Licensees should always be able to show that the organisation remains able to meet projected resource and competence needs, and that staff morale, commitment and safety culture are maintained. This is particularly important on decommissioning sites, where stages in the decommissioning process are often accompanied by reductions in staff and increases in the numbers of specialist contractors. It is important that the skills of staff with local knowledge and understanding of the plant are factored into decommissioning plans at an early stage. Clearly, the earlier the decommissioning, the greater the benefits that can be gained in this respect.

The licensee has a legal requirement to retain responsibility for the safety management system and be in control of the day-to-day activities on the site until the site is delicensed. This applies throughout the decommissioning process during which large numbers of external contractors may be employed. It is vital that the licensee retains sufficient competent personnel to

understand and own the plant's safety case, and to act as an intelligent customer for the work done by all contractors.

Radioactive Waste Management

As regulators, we expect decommissioning to make full use of all available disposal routes. This includes the disposal of non-radioactive wastes and the recycling of scrap as well as the disposal of radioactive wastes. For example, contaminated steels have been cleaned for free-release, non-radioactive steels have been recycled and aluminium from a fuel cycle plant has been recovered and recycled.

A primary requirement is for arisings of all radioactive wastes to be minimised. This is done by avoidance at source, the prevention of cross-contamination and the characterisation and segregation of wastes.

All wastes should be contained, physically stable, chemically inert and stored in conditions of passive safety enabling their subsequent handling and disposal. Wasteforms and waste packages will require careful design to ensure containment and protection of the wastes and resistance to foreseeable hazards.

Waste stores should be designed to enable the engineered safe keeping of radioactive waste in conditions of passive safety until radioactivity has decayed and there is no longer any danger, or until a suitable alternative waste management option becomes available. The store design should enable wastes to be monitored to enable the licensee to provide confirmation and reassurance that they remain contained and in a suitable condition throughout the period of storage. Stored radioactive wastes should be retrievable for detailed examination, inspection, maintenance or testing or consignment for disposal. The store design should facilitate periodic maintenance and refurbishment of the store fabric and its contents in the event that this is considered necessary. The potential energy acting on stored waste and its storage environment should be minimised.

Whilst waste package and store designs should provide passive safety, we consider that a degree of human intervention and surveillance will be necessary to provide reassurance in the continuing adequacy of waste packages and storage conditions. Furthermore, we believe that there are benefits to be gained by designing future stores to enable members of the public to view the waste, where necessary through suitable shielding, for reassurance purposes.

Other Liabilities

The safe management of long term radioactive material liabilities is of particular interest to NII. These are issues which we expect to examine as part of our quinquennial review of licensees' decommissioning strategies. They include the management of residues from the fuel cycle, long term uranic storage (including other potentially recyclable materials such as plutonium), and contaminated land which cannot meet our current "no danger" criterion. We expect such materials to be treated as radioactive wastes and for similar standards to apply. In particular, we will require that these materials are contained in a passively-safe form.

NII'S EXPECTATIONS FOR DECOMMISSIONING AND RADIOACTIVE WASTE MANAGEMENT

NII is currently developing guidance in the areas of decommissioning and radioactive waste management, consistent with Government and HSE policy, for use by our inspectors and assessors and for the information of our licensees and the public. We are currently consulting with other Government departments on this guidance, which reflects legal requirements and our expectations as discussed in this paper. The guidance will set a regulatory framework for assessing the adequacy of licensee's decommissioning and radioactive waste management strategies in the light of the current background and issues. Our developing expectations are summarised below.

NII's expectations for decommissioning are as follows:

- Decommissioning should involve the systematic and progressive reduction of hazard until there is no danger.
- Decommissioning should be undertaken as soon as reasonably practicable.
- Decommissioning should only be deferred if there are substantial safety benefits in doing so.
- Decommissioning should make full use of available disposal routes.
- Decommissioning should achieve a passively safe state as soon as reasonably practicable.
- Decommissioning costs can be discounted once the technical methods to be used have been chosen and proven, and the timing substantiated.
- Full use should be made of existing knowledge to undertake decommissioning safely and to minimise the need to transfer information to future generations.
- Decommissioning plans should be kept under continuous review to ensure that best options are selected.
- Decommissioning plans shall be included in safety cases, which should address the provision of staff and the adequacy of plant knowledge and site infrastructure and services: these safety cases should be reviewed at least every 10 years until the site is delicensed.

NII's expectations for radioactive waste management are as follows:

- Radioactivity should be immobile.
- Wasteforms should be physically stable and chemically inert.

- Potential energy acting on stored waste and its storage environment should be minimised.
- A multibarrier approach should be taken to containment.
- Wasteforms and packages should be resistant to degradation.
- Waste packages and storage systems should be resistant to foreseeable hazards.
- The need for active safety systems, monitoring and maintenance should be minimised.
- The waste should be accessible to enable a response to foreseeable accidents.
- The storage arrangements should facilitate inspection and retrieval for final disposal.
- The lifetime of the storage arrangements and waste package should be appropriate for the planned storage period and for the chosen method of disposal operations.
- There should be no requirement for prompt remedial action.
- Waste stores should be designed to allow periodic and continual refurbishment.

CONCLUSIONS

In the UK we are faced with a challenging future as nuclear plants reach the end of their useful lives and existing legacies are addressed over the years and decades to come. However, decommissioning is increasingly being seen as an important discipline and business opportunity in its own right and it is clear that technical options already exist for dismantling and waste recovery, conditioning and storage. In this paper we have discussed a number of challenges and relevant issues from NII's point of view as regulators of radioactive waste management, reactor decommissioning and nuclear safety, taking account of our duty to ensure consistency with Government policy. We believe that the guidance which we are developing will be helpful to our licensees and the public in clearly setting out our expectations in the fields of decommissioning and radioactive waste management.

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