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1. INTRODUCTION

1.1 The Office for Nuclear Regulation (ONR) has established its Safety Assessment Principles for Nuclear Facilities (SAPs) [1] which apply to the assessment by ONR Inspectors of safety cases for nuclear facilities that may be operated by potential licensees, existing licensees, or other duty-holders. The outcome of an assessment by ONR is to reach an independent and informed judgement on the adequacy of a nuclear safety case [2]. The principles presented in the SAPs are supported by a suite of guidance to further assist ONR's Inspectors in their technical assessment work in support of making regulatory judgements and decisions. This Technical Assessment Guide (TAG) is one such guide [3].

2. PURPOSE AND SCOPE

2.1 This TAG provides guidance to ONR Inspectors to advise and inform their regulatory judgements in relation to decommissioning at nuclear licensed sites. The TAG supplements the guidance in the SAPs [1], in particular principles DC.1 to DC.9 on decommissioning. The TAG has been written with due cognisance of relevant International Atomic Energy Agency (IAEA) safety standards for the decommissioning of nuclear facilities [4] and the Western European Nuclear Regulators' Association (WENRA) Safety Reference Levels (SRL) for decommissioning [5].

2.2 Duty holders may refer to the TAG as a source of good practice, although the TAG should not be interpreted as a set of prescriptive legal requirements.

2.3 The IAEA defines decommissioning as, "the administrative and technical actions taken to remove all or some of the regulatory controls from an authorised facility so the facility and its site can be reused" [6]. For the purposes of this guidance, delivery of decommissioning is assumed to start on cessation of operations and continues until the defined end-state has been demonstrably achieved.

2.4 In the UK, decommissioning is carried out under the same legislative framework as the preceding steps in the lifecycle. The general legal duties and principles of nuclear safety, control of nuclear matter, radiological protection and conventional safety continue to apply to decommissioning. Consequently, the general advice provided in other TAGs continues to be relevant when a plant enters into decommissioning. This TAG focusses on the specific factors that are particularly important to consider in decommissioning, with references to the general advice where appropriate.

2.5 Licensees may assign particular terms to stages of decommissioning, such as Post Operational Clean Out (POCO), Care and Maintenance (C&M), Surveillance and Maintenance (S&M) and Final Site Clearance. As ONR's objectives in regulating decommissioning are outcome-focussed, this TAG is not prescriptive in respect of the terminology licensees may use. However, it is important for a licensee to provide clear definitions of the terms it applies, to ensure a common understanding of the intended approach amongst both its own staff and other stakeholders.

3. RELATIONSHIP TO LICENCE AND OTHER RELEVANT LEGISLATION

Licence Conditions

3.1 All 36 standard Licence Conditions (LCs) [7] apply during decommissioning and are relevant to activities involving decommissioning on nuclear licensed sites. However, a number of LCs are of particular relevance:

- 4 Control of nuclear matter
- 6 Documents, records, authorities and certificates
- 15 Periodic review
- 17 Management systems

- 18 Radiological protection
- 22 Modifications
- 23 Operating rules
- 25 Operational records
- 28 Examination, inspection, maintenance and testing
- 32 Accumulation of radioactive waste
- 33 Disposal of radioactive waste
- 34 Leakage and escape of radioactive material and radioactive waste
- 35 Decommissioning
- 36 Organisational capability

3.2 In addition to NIA65, the licensee must continue to comply with all other relevant statutory provisions arising under the Health and Safety at Work etc. Act 1974 and subordinate legislation, including the Ionising Radiations Regulations 2017, Lifting Operations and Lifting Equipment Regulations 1998, and Control of Asbestos Regulations 2012. Some particularly important legislation in the context of decommissioning is highlighted below.

Nuclear Reactors (Environmental Impact Assessment for Decommissioning) Regulations 1999 (EIADR)

3.3 EIADR applies to decommissioning of all nuclear reactors that had a continuous thermal load above 1kW whose decommissioning started after the regulations came into force on 19th November 1999.

3.4 EIADR can also apply to reactor decommissioning projects that commenced prior to 19th November 1999, in the event of a change or extension to the project that may have a significant adverse environmental impact. In the event of such a change, the licensee must apply to ONR for a determination as to whether a new environmental impact assessment is required and if so, the regulations apply thereon.

3.5 Specific guidance on EIADR is available at www.onr.org.uk/eiadr

Ionising Radiations Regulations 2017

3.6 The Ionising Radiations Regulations 2017 (IRR17) apply to the use of ionising radiation in the workplace, with the intent of restricting exposure and limiting dose to the workforce and the public and apply throughout the lifecycle of a nuclear facility.

3.7 Radiological protection has particular importance during decommissioning, due to the range of activities undertaken, inherent uncertainties and personnel entries into controlled areas when systems that provided protection during the operational phase have been retired. Specific regulations of particular relevance to decommissioning include, but are not limited to:

- Regulation 8 (radiation risk assessments)
- Regulation 9 (restriction of exposure)
- Regulation 12 (dose limitation)

3.8 Further guidance is provided in NS-TAST-GD-038 (Radiological Protection) [3] and the Approved Code of Practice [8].

Construction Design and Management Regulations 2015 (CDM)

3.9 Decommissioning typically gives rise to significant challenges of a conventional safety nature, such as working at height, work in confined spaces, work with high temperatures, demolition of civil structures and export of large heavy items.

3.10 The CDM regulations provide the main legislative requirements in respect of the management of health, safety and welfare during construction projects. The relevance

of CDM to decommissioning is derived from the CDM definition of 'construction work' which includes:

- The decommissioning, demolition or dismantling of a structure
- Removal of a structure, or of any product or waste resulting from demolition or dismantling of a structure, or from disassembly of prefabricated elements which immediately before such disassembly formed such a structure;
- Removal of mechanical, electrical, gas, compressed air, hydraulic, telecommunications, computer or similar services which are normally fixed within or to a structure

3.11 Specific guidance on CDM is available at www.hse.gov.uk/pubns/books/l153

Environmental Legislation

- 3.12 Decommissioning results in significant quantities of radioactive wastes, which then need to be managed to the point of disposal.
- 3.13 The relevant environmental regulator – the Environment Agency (EA) in England, the Scottish Environment Protection Agency (SEPA) in Scotland, or Natural Resources Wales (NRW) in Wales – have responsibility for permitting the disposal of radioactive and non-radioactive wastes arising from site activities, and for regulating the site against the corresponding permit limits and conditions.
- 3.14 Inspectors on sites undertaking decommissioning should familiarise themselves with ONR's Memoranda of Understanding with the environmental regulators [9] and supporting guidance [10], as well as the joint guidance document, "Basic Principles of Radioactive Waste Management" [11].

4. RELATIONSHIP TO SAPS, WENRA REFERENCE LEVELS AND IAEA SAFETY STANDARDS ADDRESSED

- 4.1 The SAPs [1] provide ONR's nuclear inspectors with a framework for making consistent regulatory judgements on the safety of activities, and include the legal duty to reduce risk so far as is reasonably practicable (SFAIRP). The SAPs are split into sections relating to different aspects of nuclear safety. One section of the SAPs is dedicated to decommissioning and those principles are summarised here:
- **DC.1** – this principle relates to consideration of decommissioning during the planning, design construction and operation of a new facility, or modification to an existing facility to facilitate safe decommissioning.
 - **DC.2** – this principle relates to preparation and maintenance of a decommissioning strategy that is appropriately integrated with other relevant strategies.
 - **DC.3** – this principle relates to timing of decommissioning and justification of the continuing safety of the facility for the period prior to its decommissioning, with identification of any necessary remedial and operational measures to reduce the risk where this cannot be underpinned.
 - **DC.4** – this principle relates to preparation of a decommissioning plan that sets out how the facility will be safely decommissioned.
 - **DC.5** – this principle relates to facilities being passively safe before entering a care and maintenance phase.
 - **DC.6** – this principle relates to identification, preparation, update, retention and ownership of documents and records required for decommissioning purposes.
 - **DC.7** – this principle relates to arrangements for establishing and maintaining the decommissioning organisation to ensure safe and effective decommissioning.

- **DC.8** – this principle relates to periodic review and modification to the management system prior to and during decommissioning.
 - **DC.9** – this principle relates to preparation of the decommissioning safety case to demonstrate the safety of the decommissioning plan and its associated decommissioning activities, which is to be kept up to date as the work progresses.
- 4.2 In addition to principles DC.1-DC.9, the following may also be of relevance to decommissioning assessments:
- **RW.1 to RW.7** – these principles relate to the management of radioactive waste at all stages of the lifecycle of a facility.
 - **RP.1 to RP.7** – these principles relate to radiation protection and control of areas to limit spread of radioactive contamination.
 - **MS.1 to MS.4** – these principles relate to effective leadership and management which is crucial to maintain during decommissioning which is a dynamic state leading to progressive reduction in resource on the site.
 - **EAD.2** – this principle relates to provision of adequate margins to allow for ageing and degradation of SSCs.
 - **EMT.2** – this principle relates to frequency of examination, inspection, maintenance and testing of SSCs, which may need re-examination during decommissioning.
 - **ECE.26** – this principle relates to consideration of decommissioning at the design stage to ensure incorporation of features to facilitate decommissioning.
 - **RL.1 to RL.9** – these principles relate to land quality management which will likely become more prominent as decommissioning progresses towards final site clearance and release from regulatory control.
 - **FP.1 to FP.8** – these are the fundamental principles which underpin the SAPs and outline ONR's expectations regarding responsibility, leadership and management for safety, optimisation of protection measures, safety assessment, limitation of risks to individuals and protection of present and future generations.
- 4.3 The SAPs form a complete document and Inspectors should consider them as a whole. Inspectors are advised to base their judgements not only on the decommissioning principles (DC.1 - DC.9) and the additional SAPs suggested above, but to consider the specific case under assessment and which other SAPs and associated TAGs may be relevant.
- 4.4 This TAG therefore provides advice to inform assessments of licensees' early considerations of decommissioning, in addition to the practical delivery of decommissioning that takes place after operations have ceased.
- 4.5 NS-TAST-GD-005 [3] identifies the Western European Nuclear Regulators' Association (WENRA) Safety Reference Levels (SRL) as a source of Relevant Good Practice (RGP) for operating reactors, facilities in decommissioning and facilities for storage of radioactive waste and spent nuclear fuel. This TAG has therefore been benchmarked against the Decommissioning SRLs [5] and the guidance in Section 5 is structured in accordance with the SRL topic areas:
- Safety Management System (SRLs D-01 to D-14)
 - Decommissioning Strategy and Planning (SRLs D-15 to D-29)
 - Conduct of Decommissioning (SRLs D-30 to D-49)
 - Safety Verification (SRLs D-50 to D-62)
- 4.6 The most relevant IAEA [4] documents to decommissioning are:
- Fundamental Safety Principles (SF-1)

- Decommissioning of facilities (GSR part 6)
- Safety Assessment for the Decommissioning of Facilities Using Radioactive Material (WS-G-5.2)
- Decommissioning of Nuclear Power Plants, Research Reactors and Other Nuclear Fuel Cycle Facilities (SSG-47)
- Decommissioning of Medical, Industrial and Research Facilities (SSG-49)
- Application of the Concepts of Exclusion, Exemption and Clearance (RS-G-1.7)

5. ADVICE TO INSPECTORS

SAFETY MANAGEMENT SYSTEM

Responsibility during decommissioning (WENRA SRLs D-01 – D-04)

- 5.1 The site licensee retains prime responsibility for safety throughout the lifetime of facilities and activities. This responsibility cannot be delegated, as stated in SAP FP.1 [1]. This fundamental principle applies equally to decommissioning as it does to operations, therefore licensees are expected develop their organisation, resource levels, capabilities, strategies and administrative arrangements to ensure safety throughout the entire lifecycle.
- 5.2 When a facility enters decommissioning the licensee may need to broaden its base of decommissioning skills, knowledge and capability, which may result in an increase in deployment of specialist contractors. Inspectors should refer to NS-TAST-GD-049 (Licensee use of contractors and intelligent customer capability) [3] for general guidance and note the relevant requirements of the CDM Regulations, especially the responsibilities of the nominated Client and Principal Designer.
- 5.3 At all times, the licensee must ensure that it has sufficient in-house expertise and resource to manage and make informed decisions on issues affecting nuclear safety, and be able to demonstrate that it is an intelligent customer for any bought-in items or services as well as exercising adequate control and supervision of contractors working on the licensed site.
- 5.4 Decommissioning can give rise to new safety challenges, which might require pre-existing systems to be augmented or reconfigured (e.g. ventilation). Inspectors should be mindful that delivery of decommissioning often requires elements of construction work and modifications to the existing plant, including the identification and management of any asbestos containing materials. Decommissioning arrangements therefore need to link with all relevant arrangements made under licence conditions other than LC35, for example LC22 (Modification or Experiment on Existing Plant).
- 5.5 The UK Government expects all nuclear operators should take the steps necessary to ensure that adequate funds are in place to meet their decommissioning liabilities. Whilst ONR does not directly regulate financial provisions, ONR provides advice to other organisations and the government on the adequacy of the plans on which the financial provisions are based. Further information is provided in Appendix 1.

Organisational Structure (WENRA SRLs D-5 – D-8)

- 5.6 A licensee should retain adequate suitably qualified and experienced personnel (SQEP) to ensure nuclear safety throughout the full range of its business. In general this is achieved by developing a Nuclear Baseline, against which ONR's overall expectations can be found in NS-TAST-GD-65 (Function and Content of the Nuclear Baseline) [3].
- 5.7 Decommissioning gives rise to cultural challenges with potential to undermine workforce morale, such as a high rate of staff turnover, loss of operational knowledge, widespread changes in role, a need to develop new skills, loss of employment,

increasing use of contractors and a constantly changing workforce environment. It is therefore important for licensees to maintain a robust safety culture to underwrite the increased reliance on human performance that typically occurs when a plant transitions into decommissioning.

5.8 Inspectors should also refer to SAPs MS.1 to MS.4 [1] and TAGs NS-TAST-GD-061 (Staffing levels and task organisation), NS-TAST-GD-048 (Organisational capability) and NS-TAST-GD-080 (Challenge Culture, Independent Challenge Capability (including an Internal Regulation function) and the Provision of Nuclear Safety Advice) [3 for general guidance.

5.9 Inspectors may consider whether a licensee's organisational structure is robust to the challenges that typically occur in respect of decommissioning, such as:

- Loss of operational knowledge
- Quantification and retention of sufficient in-house resources, at a time of uncertain future employment prospects
- Management of uncertainties
- Pressures to achieve rapid hazard reduction
- Requirements for new skills, to progress decommissioning projects
- A need for greater flexibility as the workforce undergoes significant change
- Increased reliance on administrative measures to deliver safety and a reduced extent of engineered protection
- Ensuring the licensee's Nuclear Safety Committee exercises sufficient independent challenge of the overall decommissioning strategy in addition to scrutinising individual activities

5.10 The licensee's organisational structure should clearly identify:

- Responsibilities for ensuring decommissioning is conducted safely
- An intelligent customer capability for decommissioning wherever reliance is placed on contractors
- Recognition of the increased prevalence of conventional health and safety risks as decommissioning progresses
- Recognition of the importance of maintaining radiological protection standards throughout decommissioning
- Priorities for hazard reduction, which should be based on addressing the highest hazards and risks in a timely manner
- Project management arrangements, noting the scale and nature of decommissioning projects may vary considerably from those in the operational phase
- A reporting hierarchy, to allow any conflicts that could compromise safety during decommissioning to be resolved
- Adequate integration of all parts of the licensee's organisation that contribute to decommissioning and management of the resulting wastes

5.11 Inspectors may consider whether the licensee's organisational structure is sufficiently flexible to ensure safety as the anticipated progressive (and often rapid) change in plant status occurs during decommissioning, noting this should allow a precautionary approach to any inherent uncertainties.

5.12 Inspectors should also seek assurance that the licensee maintains adequate focus on the following throughout decommissioning:

- Its leadership function, to provide adequate direction and oversight.
- An internal challenge function is sustained and appropriate to decommissioning.

- Safety culture, to identify signs of deterioration (e.g. patterns of events or near-misses) and measures to address this should it be identified.

Record and Knowledge Keeping (WENRA SRLs D-9 & D-10)

- 5.13 Licensees are required to make adequate provision for recording and preserving all the data and information that may be required in the future to ensure safe decommissioning on nuclear licensed sites for as long as such information may be required.
- 5.14 It is particularly important for licensees to recognise the value to decommissioning of accurate information on nuclear facilities, their radioactive inventory and the Systems, Structures and Components (SSCs) that contribute to safety. Licensees should ensure this data is kept up-to-date and maintained in a readily available format, which should align with the relevant decommissioning strategy and plan. In considering the scope of information to be retained, licensees should be cognisant of the unique objectives of decommissioning and how delivery of those objectives may drive different information needs to those of the operational phase.
- 5.15 LC 6 requires licensees to make adequate records to demonstrate compliance with each condition of the site licence, and to ensure that such records are preserved for a further 30 years. LC 25 requires licensees to ensure that adequate records are made a kept of the operation, inspection and maintenance of nuclear facilities, which will include the decommissioning phase of the lifecycle of a facility.
- 5.16 The record preservation period of 30 years reflects the requirements of NIA65 with respect to third party liability. This period starts from the time when decommissioning or decontamination of the plant is complete and all radioactive waste has been transferred to another location or disposed of.
- 5.17 Inspectors should seek evidence that licensees have put arrangements in place to ensure knowledge of its facilities and inventory are maintained in a secure and accessible form, noting the potentially long timescales over which decommissioning can take place.
- 5.18 For general guidance, Inspectors should refer to NS-TAST-GD-027 (Training and assuring personnel competence), NS-TAST-GD-79 (Licensee design authority capability), NS TAST-GD-061 (Staffing levels and task organisation) and NS-TAST-GD-033 (Dutyholder management of records) [3].
- 5.19 The joint ONR/EA/SEPA/NRW guidance on management of higher activity radioactive wastes [12] provides further guidance on managing information and records relating to radioactive waste, some of which may be relevant to decommissioning.
- 5.20 Inspectors should confirm that the licensee has recognised the need to capture information of relevance to decommissioning, starting from the design stage and continuing through the whole life-cycle. The most valuable information to decommissioning typically includes:
- Design and construction records describing the as-built situation.
 - Material choices and process criteria.
 - Operational history (e.g. use of the facility, historic events and incidents, radionuclide fingerprint).
 - Radiological characterisation data (e.g. radionuclide inventories, dose rates and contamination levels).
 - Physical condition of the facility, including examination, maintenance, inspection and testing records.
 - Underground services.

- Reinforcing arrangements.
 - Established degradation mechanisms (e.g. corrosion, embrittlement).
 - Asbestos surveys to inform an appropriate management strategy.
 - Any instances of partial decommissioning or POCO, the end state that was achieved and when (e.g. capped off pipework).
 - Waste inventory and location.
 - Significant plant modifications.
 - Location and function of any concealed (eg buried) systems.
- 5.21 In considering the timeframe for record retention the licensee should recognise that some records may need to be maintained beyond the completion of decommissioning.

Implementation of a management system (WENRA SRLs D-11 – D-14)

- 5.22 An organisational structure should be in place for the management and implementation of decommissioning, with clear responsibilities for ensuring that decommissioning is conducted safely.
- 5.23 Further guidance on ONR's expectations for an effective management system is provided in NS-INSP-GD-017 (Management Systems) [13], NS-TAST-GD-048 (Organisational capability) and NS-TAST-GD-065 (Function and Content of the Nuclear Baseline) [3].
- 5.24 In response to events of significance to safety at any point during the lifecycle, arrangements should be in place to conduct reviews as soon as practicable, in accordance with LC7. Inspectors should be aware that a significant radiological release may require amendment to the extant decommissioning strategy or undermine the ability of a site to meet the previously assumed end state.
- 5.25 The arrangements for controlling any modifications to the decommissioning strategy, methodology, programme or procedures should include an assessment of the safety implications associated with any such changes.

DECOMMISSIONING STRATEGY AND PLANNING

Facilitating decommissioning during design, construction and operational phase (WENRA SRLs D-15 & D-16)

- 5.26 The requirements for decommissioning should be considered at all phases in the overall lifecycle of the facility, starting at the planning and design phase.
- 5.27 Although the practical delivery of decommissioning is the last stage of a nuclear facility's lifecycle, planning and preparation for decommissioning should occur with an appropriate level of detail from the moment design commences.
- 5.28 Targeted consideration of decommissioning during the preceding lifecycle stages can significantly reduce the risks and costs of delivering decommissioning. Throughout the steps of design, construction, commissioning, maintenance and operation, the evaluation of options should consider the potential impacts on future decommissioning – licensees should take the opportunity to reduce the challenges and risks of future decommissioning wherever it is reasonably practicable to do so.
- 5.29 Licensees should take steps to secure a smooth transition out of the operational phase into decommissioning, which firstly requires development of a clear and comprehensive decommissioning strategy and plan. The safety case should be proactively managed, initially to avoid breaches of operating rules and the maintenance schedule as plant runs down. Adequate safety margins will need to be sustained as the engineered systems that provided protection during the operational phase are taken out of service and removed. Decommissioning can also require

development of new capabilities, such as large-scale waste stores, an enhanced scope of characterisation and a process of exemption and clearance to address large volumes of demolition waste and spoil.

- 5.30 Therefore before entering into decommissioning, licensees should carefully consider the choreography between; cessation of operations; characterisation of the facility and its inventory; removal of the inventory; a precautionary approach to any inherent uncertainties; determination of the target end state and any preceding interim states, and; deployment of reasonably practicable measures to ensure the safety of workers as decommissioning tasks are delivered.
- 5.31 National and international experience has shown that many of the challenges and risks of decommissioning legacy nuclear facilities could have been significantly reduced or avoided, had the initial design and operational philosophy given greater thought to the needs of future decommissioning.
- 5.32 In the case of new facilities, Inspectors should check that the licensee's arrangements and processes recognise the need to challenge the design in order to reduce the risks of future decommissioning to as low as reasonably practicable (ALARP). Practical examples include:
- Selection of materials and surface finishes that minimise activation and the ingrowth of radioactivity while aiding decontamination.
 - Provision of lay down areas and temporary storage.
 - Accommodate the needs of decommissioning into the scope of downstream waste management facilities, to avoid bottlenecks, logistical delays and unnecessary double handling.
 - The design of civil structures should provide for long-term stability over the timescales envisaged for decommissioning to be completed.
 - Minimise the use of embedded piping and the potential for chronic leaks and escapes, for example by routing piping in accessible areas and using double containment for pipes that have to traverse concrete walls or floors.
 - Construction methods should take cognisance of the fact that the facility will ultimately have to be decommissioned, noting that some modern techniques are not easily reversible.
 - Use of building information modelling (BIM) where appropriate.
 - Incorporation of design features to aid the decommissioning sequence, for example egress routes for removal of large heavy items and provision of cranes with sufficient lifting capacity to deal with the largest expected loads from decommissioning.
 - Provision of extra space and localised ventilation points around process vessels, to simplify the logistics of size reduction and export at the end of life.
 - Use of easily removable modular plant, which may benefit both decommissioning and preceding maintenance.
 - Development of robust asset management arrangements, ideally in accordance with the relevant international standard, and of appropriate systems for monitoring the condition and health of facilities.
- 5.33 Further guidance on ONR's expectations for the demonstration of ALARP is provided in NS-TAST-GD-05 [3].
- 5.34 Inspectors should ensure the licensee has undertaken adequate site baseline surveys to inform the proposed strategy and end-state for decommissioning, including but not limited to: the radiological conditions, presence and condition of asbestos bearing materials, and condition of civil structures. Baseline surveys should consider both surface and subsurface conditions as well as groundwater. For existing sites without such survey data, then data from analogous, undisturbed areas with similar characteristics should be used.

Decommissioning strategy (WENRA SRLs D-17 & D-18)

- 5.35 Each UK nuclear operator is expected to produce and maintain a decommissioning strategy and plan for each site it is responsible for. Such strategies and plans should take into account the views of stakeholders (including relevant local authorities and the public). The strategy should be to a level of detail commensurate with the type and status of the facility, the hazards presented and the stage in the lifecycle.
- 5.36 Strategies should consider all 'relevant factors', presenting them in a transparent way and demonstrating objectively how each has been reflected in the adopted approach. Examples of 'relevant factors' are listed in UK government policy and include:
- Ensuring worker and public safety.
 - Maintaining site security.
 - Minimising the generation of radioactive wastes.
 - Effective and safe management of the radioactive wastes that are created.
 - Minimising environmental impacts including reusing or recycle materials whenever practicable.
 - Maintaining adequate site stewardship.
 - Using resources effectively, efficiently and economically.
 - Providing adequate funding.
 - Maintaining access to an adequate skills and knowledge base.
 - Conducting research and development (R&D) to develop necessary knowledge or capability.
 - Consulting appropriate public and stakeholder groups on the options considered and the contents of the strategy.
- 5.37 The future intended use of the site is a significant factor in determining the scope and end state for decommissioning.
- 5.38 Inspectors should be aware of relevant government strategies and policies, in conjunction with this TAG and other regulatory expectations, when considering the adequacy of a licensee's decommissioning strategy. Although ONR does not enforce government policy, inspectors should regulate in accordance with the framework of government policy whilst ensuring that national law and regulatory requirements are met.
- 5.39 Inspectors should assess whether the licensee's decommissioning strategy is consistent with relevant national policies and strategies. Management of radioactive wastes and nuclear decommissioning are devolved matters, so government policy can vary between England, Scotland and Wales. Licensees should identify and justify any differences.
- 5.40 The licensee is expected to review its strategies periodically, and in response to any significant change in circumstances. An up-to-date decommissioning strategy is an established regulatory expectation of a robust periodic review of safety (NS-TAST-GD-050 and SRL D72).
- 5.41 Inspectors should consider whether the licensee's decommissioning strategies, programmes and plans adequately demonstrate a systematic and progressive reduction of hazard. This does not mean that hazards must reduce year on year, but that in the long term hazards progressively reduce to a level where decommissioning can be considered complete in terms of reaching the defined end state for the relevant facility or site.

- 5.42 Inspectors should consider whether the strategy is sufficiently integrated at facility and site levels, if and when appropriate, for example:
- The decommissioning strategy should be linked to, or integrated with, the strategy for the management of existing radioactive waste from the site(s) and radioactive waste that will be produced during decommissioning.
 - Key interactions and interdependences are taken into account within the planning process, e.g. any shared reliance on equipment, services and infrastructure.
 - Where decommissioning is reliant on, or affected by, work at other sites (for example treatment, storage or disposal of radioactive waste) then the strategy should address these interdependences.
 - Fleet considerations may also be appropriate if the Licensee operates multiple site licenses.
 - Consideration of factors external to the licensee should also be evident, such as confirmation that wastes anticipated to be generated meet the relevant meet for the intended waste route, or that suitable transport packages have been identified.
- 5.43 Inspectors should consider whether the licensee has examined an adequate range of options for decommissioning and confirm that these form the basis of the licensee's decommissioning strategy. The optioneering process should be based on appropriate assessment criteria. The assessment criteria should be defined and developed by the licensee, but inspectors may want to make a comparison with the list of relevant factors in the SAPs under principle DC.3 (timing of decommissioning).
- 5.44 In particular inspectors should also consider whether the following factors are included in the option selection criteria:
- How options deliver longer-term risk reduction.
 - The dis-benefits of not pursuing any particular option.
 - Avoiding the foreclosure of options for later decommissioning stages, particularly where there are uncertainties associated with the possible success of options.
- 5.45 Inspectors should consider how the option selection process addresses the major assumptions and uncertainties relevant to the decommissioning task or project being considered. Sensitivity analysis and contingency planning should be considered for any areas of significant uncertainty.
- 5.46 The licensee's strategy and plans need to be in evidence, but should be at a level of detail commensurate to the current stage in the lifecycle. These should deliver the desired outcome of risk-reduction. Hence, prioritisation of activities should be in line with achievement of risk reduction.
- 5.47 However, prioritisation should take account of other considerations where relevant and justified. Examples might include:
- Enabling tasks may be required to facilitate future risk reduction, e.g. in the installation of decommissioning infrastructure.
 - In some cases dismantling of lower risk systems/facilities may be required or beneficial in creating the space and access necessary for other decommissioning operations, or to provide training and experience.
 - Where age limiting features dictate the early removal of a lower risk system or facility in preference to a higher risk one.
 - Value and cost-benefit arguments, i.e. efficiency.

- 5.48 Licensees may have their own prioritisation process, but inspectors should look to see that key prioritisation decisions have been appropriately justified, whichever process the licensee has adopted.
- 5.49 Decommissioning strategies may take account of the benefits of radioactive decay (e.g. cobalt in reactor steelwork) while taking due cognisance of any dis-benefits, such as ingrowth of longer-lived or higher dose-rate daughter radionuclides and potential for deterioration of containment barriers. They should seek to avoid the creation of radioactive wastes in forms that may reduce the number of options for safe and effective long-term waste management.
- 5.50 The timescales over which decommissioning will take place should be defined in a decommissioning programme. Decommissioning programmes should deliver the desired outcome of risk-reduction and prioritisation of activities should be in line with achievement of this principle. The licensee should explain the timescales for these programmes / projects.
- 5.51 When assessing such justifications inspectors should take into account the relevant factors listed in the SAPs [1] under principle DC.3 which may be influencing the licensee's proposed strategy. This list of factors is applicable to all types of nuclear facilities.
- 5.52 When justifying the timing of decommissioning it is good practice for the licensee to undertake appropriate stakeholder engagement.
- 5.53 Decommissioning tasks typically lead to the generation of radioactive waste in solid, liquid or gaseous forms and may result in short-term increases in discharges of some radionuclides. In such circumstances, the licensee will need to demonstrate to the relevant environmental regulator that the adopted strategy represents an optimal approach and reflects the application of Best Available Techniques (BAT), as required by the relevant environmental legislation.
- 5.54 Decommissioning may proceed as a continuous activity, or as a series of sequential stages, the end result of each stage being a significant reduction in hazard. The order, timing and extent of each stage will be influenced by the hazard posed by a particular facility on a site. Licensees should adequately justify the order and timescales over which it proposes to address each hazard.
- 5.55 In general, Inspectors should expect the licensee to prioritise the removal and/or immobilisation of the most active or mobile material to be carried out on the shortest practicable timescale, with further actions following with timescales appropriate to the remaining hazards they address. In some circumstances, actions may be required that temporarily increase risk to enable hazard reduction to take place. In such circumstances the licensee should justify its overall approach and ensure that risks are reduced ALARP across all stages.
- 5.56 Inspectors should recognise the risks associated with particular decommissioning tasks can be increased due to the presence of uncertainty or specific safety challenges, e.g. accessibility or confined space working.
- 5.57 Adequate arrangements should include the production and maintenance of strategies, programmes and plans for the decommissioning of all nuclear facilities for which the licensee is responsible, including the future management and disposal of all the radioactive waste arising from the site. These should take into account government policy and related national strategies, for example on decommissioning or radioactive waste management and disposal.

- 5.58 There are inherent uncertainties in decommissioning. Inspectors should look to see that a licensee's arrangements, strategies and safety cases adequately take account of these, with appropriate mitigation and contingencies put in place.
- 5.59 Inspectors should give careful consideration to assessing arrangements, strategies, programmes and safety cases involving facilities where the risks are intolerable, close to becoming intolerable, or may soon become intolerable. In addition to the guidance given throughout this TAG, inspectors should particularly consider the following:
- How the Licensee's longer-term strategy and plans should deliver the desired outcome of large-scale hazard and risk reduction over an appropriate period of time.
 - How short-term hazard and risks will be managed and longer-term hazard and risk reduction achieved. Regulatory monitoring of enabling milestones is required to provide evidence that projects are progressing as agreed, given that projects may run over many years to reach the desired outcome.
 - The Licensee should have a clearly defined, robust, but not overly bureaucratic process for managing risk-reducing projects. This should focus on delivering safe and timely remediation of high-risk hazards.
 - The principle of defence-in-depth with a suitable number of barriers should be applied. Inspectors should acknowledge that some levels of defence-in-depth will not be available in certain circumstances, and that mitigation will have to be strengthened where protection is missing or rudimentary.
 - The worst-case accident scenarios need to be identified to allow adequate protection or mitigation and recovery measures to be developed.
 - Simultaneous high-risk activities on the same facility or related facilities should be avoided so far as is reasonably practicable, i.e. to prevent the occurrence of one fault leading to the initiation and progression of another(s). This should include consideration of any foreseeable beyond-design-basis fault progression, as illustrated by the Fukushima incident.
 - Clear mitigation/contingency measures need to be provided and developed to an appropriate level against fault sequences assigned a high probability of occurrence. However, for some legacy facilities it needs to be recognised that emergency response/contingency measures will be an essential part of the safety demonstration, given the absence of some of the levels of protection that would be in place in a modern plant. These should not be the sole safeguard against identified fault scenarios, so far as is reasonably practicable.
 - Operating and emergency procedures/instructions should recognise and address key issues and identified fault sequences related to the implementation of a proposed modification to ensure measures are tailored to specific circumstances.

Review of Decommissioning Strategies

- 5.60 In 1995 the UK Government issued a policy statement [14] that introduced a responsibility on ONR (the then Nuclear Installations Inspectorate of HSE) to review the decommissioning strategy of each UK licensee at least every 5 years, which became known as the Quinquennial Review process (QQR).
- 5.61 In recognition of the creation of NDA, the UK Government revised its decommissioning policy in 2004 [15] and therein supported continuance of the QQR process, except where "equivalent arrangements" are made, e.g. by the NDA.
- 5.62 The Energy Act 2004 requires NDA to review its strategy at least every 5 years and to undertake statutory consultation with the public and regulators. ONR has therefore scrutinised each revision of NDA's strategy to date and interprets this to be an 'equivalent arrangement' to QQR for the licensed sites owned by NDA. As a consequence, individual QQRs are no longer carried out at sites in the NDA estate.

- 5.63 The operators of sites owned by NDA are required through their contracts with NDA to produce and maintain detailed plans to a prescribed format that covers the whole site lifecycle, including decommissioning. These plans are reviewed regularly and summaries of the extant plans are made available on NDA's website.
- 5.64 A range of other bodies now have interests in decommissioning strategies across portfolios of sites outside the NDA estate (e.g. the Nuclear Liabilities Fund in respect of EdF; the Nuclear Liabilities Funding Assurance Board in respect of new build, and; MoD in respect of its liabilities on the defence sites). Each of these bodies has bespoke expectations for licensees within its remit, some of which have a formal basis in law (e.g. the requirement of the Energy Act 2008 for an operator of a new nuclear power station to have a Funded Decommissioning Programme approved by the Secretary of State prior to construction).
- 5.65 In judging whether alternative approaches constitute an 'equivalent arrangement' to QQR, Inspectors should consider whether ONR has exercised sufficient oversight of the decommissioning strategy in question to discharge the responsibility placed upon ONR in Government policy without recourse to an additional formalised review. This judgement should take account of outcomes from other regulatory interventions, such as compliance inspections against the requirements of LC15 and LC35 or assessments for the purposes of EIADR.

Facility decommissioning plan during design, construction and operational phases (WENRA SRLs D-19 – D-25)

- 5.66 Initial strategies, programmes and plans should:
- Demonstrate that decommissioning can be feasibly and safely conducted using proven techniques or ones being developed.
 - Take into account expected hazards and health & safety issues.
 - Incorporate design for decommissioning features.
 - As far as practicable, the design should take account of features which may assist future decommissioning, including contamination and activation control, and aim to avoid features which will introduce unnecessary decommissioning hazards, e.g. construction techniques which would be difficult to reverse.
 - The key decommissioning measures and design features should be described and justified by the Licensee. Such measures may need to be considered on balance with construction and operational safety considerations.
 - Include waste management and environmental aspects of decommissioning, such as management of waste and radioactive effluents.
 - Inform the design process and vice versa. ALARP considerations should also be apparent (appropriate to the design stage).
 - Be used to inform the development of the construction arrangements and the operational and maintenance regimes where appropriate. These should take due account of the needs of decommissioning, including features to facilitate decommissioning, providing for the early acquisition and maintenance of the records most important for decommissioning, and adoption of physical and procedural methods to prevent the spread of contamination. Building information modelling can be a very useful tool for this purpose.
 - Be used to provide a basis to assess the costs of the decommissioning work and the means of financing it.
- 5.67 Inspectors should expect to see initial plans developed at the planning phase of a new site or facility. These should be commensurate with the scale of the facility, the type of the inventory, and the stage in the facility's development i.e. proportionate and fit for purpose.

- 5.68 Some legacy facilities may not have had strategies in place from this early stage. In these cases, inspectors should expect these to be produced based upon sufficient characterisation of the site / facility and the challenges which decommissioning will need to address, i.e. an appropriate understanding of the start point condition.
- 5.69 Generally, inspectors should expect an increase in the level of detail presented in the decommissioning strategies and plans as the facility or site nears the end of its operational life and approaches the decommissioning phase.
- 5.70 Examples of how this may apply in looking at safety cases are:
- Inspectors should recognise that application of the engineering hierarchy and substantiation of safety measures to a level required for modern operating plants may not be practicable or desirable for aged facilities due to undergo decommissioning. Therefore, there is likely to be reliance on multi-legged arguments and managerial safety measures. These should be proportionate to the hazards.
 - The principle of defence-in-depth with a suitable number of barriers should be applied (as appropriate to the risks involved). Inspectors should acknowledge that some levels of defence-in-depth will not be available in certain circumstances and that mitigation will have to be strengthened where protection is missing or rudimentary.
- 5.71 Optimisation is the term used by the IAEA in its Fundamental Safety Principles: Safety Fundamentals [3] where principle 5 states, “Protection must be optimised to provide the highest level of safety that can reasonably be achieved.”
- 5.72 In order to comply with UK legislation, licensees are required to apply the concept of “optimisation” in order to reduce risks to health and safety so far as is reasonably practicable (SFAIRP) in addition to utilising Best Available Techniques (BAT) in respect of environmental protection. ONR’s guidance on the demonstration ALARP (NS-TAST-GD-005) [3] and its supporting references contain ONR’s general expectations in respect of a licensee’s demonstration that it has met the requirement to reduce risks SFAIRP, which is frequently expressed in terms of reducing risks ALARP.
- 5.73 In respect of decommissioning, there are some specific aspects of optimisation that ONR might expect to be addressed as part of a licensee’s arrangements to comply with LC35. The precautionary principle should be applied to the uncertainties that often need to be managed during decommissioning. NS-TAST-GD-005 [3] provides detailed guidance on this topic. Another important aspect relates to the potentially long timescales involved, and hence the increased importance of economic, social and environmental factors such as sustainable development and long-term environmental damage.

Final decommissioning plan (WENRA SRLs D-26 – D-28)

- 5.74 Strategies, programmes, plans and safety cases should be well developed and in place before decommissioning starts. Inspectors should check that there is no gap between the operational and decommissioning arrangements and that there is an appropriate interface between the two, where this is relevant.
- 5.75 Inspectors should consider whether the decommissioning strategy proposes appropriate end state conditions for the facility or site that are consistent with national policies and regulatory expectations.
- 5.76 One possible end state is where all licensable activity has ceased, the licence is revoked or handed back and the period of responsibility under NIA1965 has been

ended. This is referred to as de-licensing and inspectors are referred to ONR's separate guidance on this [20].

- 5.77 However this is not a mandatory requirement and other end states are possible in which some restriction on future use and continued legal responsibilities under nuclear legislation continue.
- 5.78 In some cases interim states may be identified. These should be treated as milestones within the overall decommissioning plan and are not end states as covered by this section of the guidance. The overall strategy/programme should show how decommissioning will progress safely beyond such interim states.
- 5.79 The precise format of the decommissioning programme is for the Licensee to propose and justify, but Inspectors should expect the following aspects to be adequately considered:
- A defined inventory of the plants and liabilities, e.g. radiological inventory, (or a predicted inventory for those plants not at the end of their operational life).
 - The rationale for selecting the chosen decommissioning option.
 - The rationale for the proposed timing of decommissioning.
 - Defined end state criteria (and the methodology for subsequently confirming that these criteria have been achieved).
 - A description of the decommissioning activities (including the content of the individual stages), if a staged approach is applied.
 - Where appropriate decommissioning should be divided into stages, in which case ONR may specify where consent is required to commence a stage or to proceed from one stage to the next.
 - A Post Operational Clean Out (POCO) strategy.
 - Arrangements for asset management during the decommissioning process.
 - If the plans include a deferment of decommissioning with an associated care and maintenance period, the arrangements should include procedures and plans to maintain safety during the care and maintenance period. Such arrangements must include plans to manage any risks arising to the health and safety of workers, such as those arising from asbestos containing materials.
 - Appropriate technical underpinning of the decommissioning methodology, including any key assumptions.
 - Identification of any relevant Research and Development (R&D) requirements or opportunities, e.g. technology developments.
 - Identification of the need for facilities to carry out decommissioning and waste management, including potential use of supply chain capabilities for treatment.
 - A safety case justification, including the identification of safety and radiation protection measures/strategies. The overarching strategy for safety management systems should also be evident, and will identify existing facilities and equipment that will be used during decommissioning and any necessary changes to the existing safety systems, or the need for replacement or new plant or equipment to carry out decommissioning operations.
 - The management arrangements to ensure safe delivery of the decommissioning projects, including arrangements for the management of change within the organisation during decommissioning.

Decommissioning plan update during decommissioning operations (WENRA SRL D-29)

- 5.80 Inspectors should assess whether arrangements for decommissioning include appropriate review and change control procedures for the decommissioning programmes, plans, safety cases and procedures. Reviews should take place at least as frequently as the periodic safety review as required under LC15, but an increased

frequency may be necessary to reflect the progressive change in plant status, hazards or decommissioning approach as decommissioning progresses.

- 5.81 Changes which could warrant a review and subsequent modification of plans and programmes may include (but are not limited to):
- Significant changes to the facility (physical, ageing, inventory, etc), including changes resulting from the decommissioning operations.
 - Improved plant characterisation data, resulting from plant characterisation tasks.
 - Significant changes to the decommissioning processes or strategy adopted; e.g. those that
 - Significantly affect the safety of the overall decommissioning programme;
 - Significantly affect the time in which decommissioning will be completed
 - Significantly affect the way in which decommissioning will be carried out, e.g. the use of new, untried or significantly different methods to those assessed previously;
 - Significantly affect the way in which radioactive waste will be dealt with, e.g. different disposal options or new methods of waste treatment; or
 - Change the proposed end state
 - Major deviations from the scheduled programme.
 - Major deviations in the assumed status of the facility, e.g. in light of new characterisation data. In particular the identification of new hazards or significant changes to the assessed consequences of hazards.
 - Relevant operational feedback, or changes in relevant good practice.
 - New or revised legislative or regulatory requirements.
 - Significant technological developments or opportunities.
 - Availability of anticipated external resources such as transport flasks, storage facilities or available disposal routes.

CONDUCT OF DECOMMISSIONING

Safety classification (WENRA SRL D-30)

- 5.82 As decommissioning progresses, there may be a change in the importance of designated SSCs to safety. It may therefore be appropriate to declassify or downgrade SSCs not required post-operations, or as decommissioning transitions between phases, provided this is justified in an update of the safety case. Conversely, some SSCs may become more important, or new SSCs may even potentially be required to support decommissioning operations.
- 5.83 Inspectors should consider the sufficiency and appropriateness of any remaining SSCs to the operations planned during subsequent phases of decommissioning. It is desirable for the licensee to minimise its reliance on active safety systems to maintain adequate safety margins during any C&M phase(s).
- 5.84 Further guidance is contained within NS-TAST-GD-094 (Categorisation of safety functions and classification of structures and components) [3].

On-site emergency preparedness (WENRA SRLs D-31 – D-34)

- 5.85 The licensee's emergency planning arrangements should be updated to reflect the changing hazard as the site transitions from operations through the various stages of decommissioning, such that the arrangements remain appropriate to the current state of the plant.
- 5.86 Amendments to the emergency plan associated with decommissioning typically result in a reduced scope of available on site resource, with increasing call for off-site responders to support the emergency organisation.

- 5.87 Guidance on licensee's arrangements for emergency preparedness are covered elsewhere under specific guidance, such as NS-INSP-GD-011 (LC11 Emergency arrangements) [16] and the new Approved Code of Practice (ACoP) to the Radiation (Emergency Preparedness and Public Information) Regulations 2019 [17].

Decommissioning experience feedback (WENRA SRLs D-35 – D-37)

- 5.88 The licensee's arrangements should include procedures to identify, screen, analyse, and document events, at the facility and from external sources, in a systematic way to improve and ensure safe decommissioning. Inspectors should ensure that operational feedback is appropriately considered within the decommissioning safety case.
- 5.89 This feedback may come from events during decommissioning, or from other facilities operated by the licensee. Inspectors should look to see that feedback from events prior to decommissioning is included, for example findings of differences between "as built" plant and the design drawings, past plant modifications, incidents, spillages etc. Learning from post-project reviews should also be considered and incorporated as appropriate. Additional feedback can be sourced from other operators and wider industry organisations, both national and international.
- 5.90 The licensee's duties under LC7 are unchanged during the decommissioning phase of the lifecycle, to notify record and investigate incidents on the site. Where learning points are identified following investigation of an event with significance for safety, appropriate corrective actions should be implemented to prevent reoccurrence of similar events or address other developments adverse to safety.

Waste management (WENRA SRLs D-38 – D-40)

- 5.91 Decommissioning generally results in a broader range of wastes than the preceding phases of the lifecycle, in terms of physical characteristics, radiological contents, chemo-toxic properties and the volumes arising. The licensee should therefore consider the need to strengthen its waste management infrastructure and processes prior to undertaking decommissioning, to ensure all the anticipated wastes will be managed in accordance with regulatory expectations such as LC32 and the Joint Guidance on management of Higher Activity Wastes.
- 5.92 The licensee should adopt a precautionary approach to any inherent uncertainties in respect of its decommissioning wastes and put in place contingency arrangements against potential cliff-edge effects (e.g. a lack of characterisation data may preclude an accurate assessment of a waste stream's categorisation as LLW or ILW).
- 5.93 The licensee's decommissioning strategy and plan should identify the types of waste that are expected to be generated and demonstrate that the chosen decontamination and dismantling techniques meet regulatory expectations with respect to the waste management hierarchy [11].
- 5.94 The hierarchy encourages adoption of options for managing waste in the order of:
- **Prevent** waste from arising in the first place
 - **Minimise** the quantity of waste produced
 - **Reuse** of those wastes that cannot be prevented
 - **Recycling** of waste into a form that allows it to be reclaimed
 - **Disposal** should only occur when waste cannot be prevented, reused or recycled and must be implemented in a manner that is compliant with the environmental legislation
- 5.95 An essential first step in implementation of the hierarchy is for a licensee to appropriately characterise and then segregate its wastes, to enable optimised waste management through to the point of disposal. The licensee's system of

characterisation and segregation should enable the wastes arising to be disposed of at the lowest practicable categorisation. This should include exemption and clearance of those decommissioning wastes that have potential to be disposed of as non-radioactive material. Further guidance may be found in IAEA Safety Guide RS-G-1.7 [4].

- 5.96 LC32 imposes the duty upon licensees to minimise the total quantity, and rate of production of radioactive waste, so far as is reasonably practicable [3], which is particularly pertinent to decommissioning given the potential to generate large quantities of waste.
- 5.97 The licensee's radioactive waste management arrangements should therefore be updated to reflect the changing nature of the radioactive waste being generated, including consideration of appropriate characterisation and segregation to enable optimised management and minimise the volumes of radioactive waste requiring disposal, so far as is reasonably practicable. This may be captured in an Integrated Waste Strategy and/or the Waste Management Plan that is formally required by the environmental regulators.
- 5.98 The SAPs state that radiological hazards should be reduced systematically and progressively, with radioactive waste generated processed into a passive safe state, as soon as is reasonably practicable (RW.6), and stored in accordance with good engineering practice (RW.5) [1].
- 5.99 Information that might be needed for the current and future safe management of radioactive waste should be recorded and preserved (RW.7). This is particularly important for any radioactive wastes generated during decommissioning which do not yet have an available waste route and will therefore be stored for an extended period prior to disposal. The records should capture necessary information to enable the continued safe management of that waste whilst in storage, and also support the future disposability case, as defined in the waste management and decommissioning plans.
- 5.100 NS-TAST-GD-024 [3] and the joint regulatory guidance The Management of Higher Activity Radioactive Waste on Nuclear Licensed Sites [12] provide further general guidance on management of radioactive waste management.

On-site and off-site monitoring (WENRA SRL D-41)

- 5.101 Licensees normally implement an on- and off-site monitoring programme to demonstrate effective management of its operations and protection the public. This monitoring should include on plant monitoring for the purposes of demonstrating compliance with LC34 (Leakage and escape of radioactive material and radioactive waste), as well as environmental monitoring.
- 5.102 As a facility transitions into decommissioning, the type of operations conducted on the site and the hazards they pose will naturally differ to those during operations. As such the licensee should review and modify its monitoring programme to ensure it remains appropriate and takes due account of the changes to the facility, any specific hazards arising, and the effluents associated with each phase of decommissioning.
- 5.103 One key aspect of environmental monitoring relates to land quality management (LQM). Whilst this is an area of regulation which requires joint working with colleagues at the relevant environmental regulator, it should be recognised by the Inspector that ONR has lead responsibility for regulation of radioactively contaminated land on nuclear licensed sites.
- 5.104 The joint regulatory guidance Regulatory Expectations for Successful Land Quality Management at Nuclear Licensed Sites [18] advocates licensees implement LQM

throughout the lifetime of the facility. However, as a site moves into decommissioning and implements plans to reach its desired end state, LQM will take on greater importance. Further guidance is provided in NS-TAST-GD-083 (Land Quality Management) [3].

Maintenance, Testing and Inspection (WENRA SRLs D-42 – D-44)

- 5.105 Structures, systems and components should be capable of delivering their required safety function until the associated hazards have been removed or mitigated. There should therefore be adequate consideration of continued maintenance, testing and inspection of SSCs during decommissioning until the SSC is no longer required, as justified within the safety case.
- 5.106 Maintenance schedules should take into account operational limits and conditions as required in the decommissioning safety case, and re-evaluated in light of operational experience and continuous changes to the plant throughout decommissioning.
- 5.107 Adequate asset management is required to ensure the facility remains safe and does not degrade to an unacceptable state. Major issues can arise if decommissioning programmes are delayed and as such the maintenance, testing and inspection of SSCs and important assets, which may not necessarily be claimed within the safety case, must therefore address ageing and consider the future decommissioning plan timescales, as appropriate. Inspectors should ensure appropriate consideration of asset management plans should decommissioning programmes be delayed to ensure this does not lead to unacceptable degradation of plant or buildings.
- 5.108 Inspectors should consider whether the licensee's plans adequately address the following:
- Appropriate baseline characterisation of the assets and the hazards that they protect against.
 - Programmes for the identification, examination, maintenance, testing, surveillance and inspection of SSCs important to safety, which take into account operational limits and conditions.
 - Consideration of ageing, deterioration mechanisms, and obsolescence of SSCs, and the inspection and monitoring of such factors, particularly where decommissioning is expected to take place over long timescales.
 - Periodic review (e.g. inspections or tests) of SSCs to determine whether they are still acceptable.
 - Systems to ensure the prompt repair of SSCs, prioritised to take account of the relative importance to safety of the defective SSC.
 - Systems to ensure the appropriate remedial action following any abnormal event which is significant for the safety of decommissioning activities, including inspection, testing, maintenance and repair of SSCs, as appropriate.
 - Arrangements to review, as necessary, the examination and maintenance and testing program, to take account of the rapid changes to the facility during decommissioning.
 - Similar arrangements to those listed above for any key building structures, services or other systems which are not designated as SSCs but do perform important functions.
 - In taking account of the above factors, plans should adequately address any risks to workers arising from access to buildings, facilities, and structures.
- 5.109 Further general guidance on expectations relating to maintenance is contained in NS-TAST-GD-009 (Examination, Inspection, Maintenance and Testing of Items Important to Safety) and NS-TAST-GD-098 (Asset Management) [3].

Control of decommissioning activities (WENRA SRLs D-45 – D-47)

- 5.110 Licensees are required to control activities it undertakes during decommissioning that may impact upon safety through use of suitable processes and procedures approved by the licensee as part of its management system. Given the dynamic state of a facility during decommissioning, the licensee should review and update its processes and procedures used during operations, as necessary, to ensure they remain adequate and applicable to decommissioning activities.
- 5.111 The arrangements should ensure that no decommissioning activity is undertaken without a prior assessment of its impact on safety, taking into account the postulated initiating events with internal causes included in the safety case for decommissioning. Such arrangements should give due consideration to different decommissioning activities executed in parallel, which might adversely affect safety of each other.
- 5.112 Modifications, to the plant and of planned decommissioning activities, should be controlled by the licensee, as per its LC22 arrangements, according to the safety significance through application of an adequate categorisation scheme; ensuring appropriate focus is retained on those activities which may have a significant impact upon safety. The LC22 arrangements should also take into account the cumulative effects of changes to procedures, modifications to the facility and the decommissioning organisation, technical developments, decommissioning experience accumulated and ageing of safety systems and components, to ensure there is no overall degradation in safety standards.
- 5.113 As facilities are decommissioned and redundant safety systems removed, there may be increased reliance on administrative controls over engineered controls. Where this is the case, the inspector should consider whether the licensee has adequately considered human factors when determining the appropriate controls. The inspector may also deem it necessary to seek specific assessment by a Human Factors specialist, depending upon the significance of any change. Further guidance is available in NS-TAST-GD-058 (Human Factors Integration) and NS-TAST-GD-063 (Human Reliability Analysis) [3].
- 5.114 Additional Human Factors specialist support may be relevant where the licensee intends to deploy new equipment during decommissioning, to ensure its design appropriately considers the human-machine interface. Further guidance is available in NS-TAST-GD-059 (Human Machine Interface) [3].

Period of Deferment (WENRA SRLs D-48 – D-49)

- 5.115 In the UK, care and maintenance (C&M) refers to a specific period of planned quiescence on the site or in the facility between decommissioning phases, usually after POCO or de-planting with deferred dismantling and final site clearance.
- 5.116 During the C&M period the facility should be maintained in a passively safe configuration, so far as it is reasonably practicable, minimising the need for active safety systems, monitoring, and human intervention. This approach may necessitate removal or downgrading of existing SSCs associated with operations, where appropriate, if justified by an update of the safety case.
- 5.117 If the licensee proposes a prolonged deferral strategy then the C&M requirements should be developed, prior to the deferral commencing. These should be justified within a C&M programme that ensures continued safety of the facility, and this programme should ensure the ability to decommission the facility safely in the future.
- 5.118 When assessing the adequacy of the C&M arrangements inspectors should consider whether the licensee has adequately:

- minimised, so as far as reasonably practicable, the hazards presented by the radiological inventory prior to entering the C&M phase;
 - addressed ageing, deterioration and obsolescence for safety systems that will be required to remain operational, including potential for upgrade or replacement and that this is included within the plan; and
 - specified the maintenance and examination regime.
- 5.119 The licensee should record clear decisions regarding whether a period of C&M is appropriate, taking account of the status of the facility, the decommissioning strategy, timescales, etc. Inspectors should expect a robust safety case that takes account of long-term safety as opposed to just renewing the short-term safety case underpinning such decisions.
- 5.120 The Licensee should demonstrate that they can ensure long-term safety by ensuring and monitoring a safe plant configuration and maintaining an appropriate organisation, supporting infrastructure and corporate memory. The safety case should define a limit to the period of proposed deferment.
- 5.121 The safety case should justify and demonstrate safety for the proposed period of deferral. The Inspector may choose to assess whether the following is adequately considered in the safety case:
- any cliff-edge effects, e.g. those associated with infrastructure availability, degradation of the structures or obsolescence of systems;
 - the effects of deferral should not impact upon the ability to conduct future decommissioning in a safe way where risks are ALARP;
 - the whole lifecycle radiation doses associated with C&M and decommissioning should be ALARP;
 - interdependences of different facilities on a site; and
 - knowledge management and retention of necessary skills and expertise.
- 5.122 Notwithstanding a justified period of deferral, licensees should adopt decommissioning programmes which are sufficiently flexible to facilitate acceleration of the programme, should this be necessary for safety reasons.

SAFETY VERIFICATION

Contents, review and update of the safety case for decommissioning (WENRA SRLs D-50 – D-56)

- 5.123 Inspectors should refer to NS-TAST-GD-051 (The purpose, scope and content of nuclear safety cases) [3] for general guidance on safety cases. The following provides additional guidance to inspectors regarding the assessment of safety cases for the decommissioning of facilities on nuclear licensed sites.
- 5.124 A decommissioning safety case should demonstrate how the licensee will manage short-term risks and achieve longer-term risk reduction over the full term of the decommissioning programme. The safety case should include assessment of any planned new installations, facilities or systems to necessary to support the decommissioning programme, and include the final decommissioning of such infrastructure itself.
- 5.125 Specific radiological hazards that are of particular importance in the case of decommissioning include, for example, cutting of activated and contaminated material, modification of safety barriers, entry into areas of the plant that were previously inaccessible, decontamination of large items, dispersion of contamination during demolition. This is not an exhaustive nor exclusive list, and licensees should

demonstrate that its hazard identification process has adequately considered all relevant hazards and fault conditions.

- 5.126 The safety case should incorporate learning from experience of operating the facility, as well as learning from relevant decommissioning projects elsewhere, whether in the UK or internationally.
- 5.127 During decommissioning, the risks associated with conventional health and safety hazards arising from de-planting and demolition activities (eg asbestos, confined spaces), will inevitably increase. As such, the safety case should adequately consider the appropriate management of conventional health and safety risks where these have the potential to impact upon nuclear safety.
- 5.128 The safety case should be appropriately underpinned by knowledge of the risk and balanced assessment of associated uncertainties, particularly in the case of legacy facilities. This should be supported by the examination of records and conducting of surveys and measurements to verify the inventory and locations of radioactive, fissile or other hazardous materials in the facility, and the surrounding potentially affected areas.
- 5.129 Where the licensee identifies additional research is required to underpin its decommissioning proposals, or to mitigate uncertainties, this should be recognised in the safety case, and appropriate plans put in place to deliver the necessary work.
- 5.130 Inspectors should consider the licensee's arrangements to maintain the safety case(s) when significant changes occur, according to the safety relevance of such changes and licensee's categorisation. These might include modifications to the facility, plan or decommissioning practice at major steps in the decommissioning project, or new relevant regulatory requirements.
- 5.131 Licensees should periodically review the safety case to confirm the decommissioning activities and states are, and will continue to be in accordance with regulatory expectations and legal requirements. Such reviews should also identify and evaluate the safety significance of any deviations from applicable current safety standards and relevant good practice, and ensure an adequate plan to address such deviations are implemented.
- 5.132 The review should also take into account the cumulative effects of, for example, changes to procedures, modifications to the facility or the decommissioning organisation, and ageing of safety systems and components. Additionally, the review should consider technical developments and decommissioning experience accumulated to update the safety case accordingly.
- 5.133 In determining the frequency of reviews, the licensee should consider aligning periodic reviews with any major changes in the facility or hazard(s) which may arise well before an otherwise planned periodic review, notwithstanding the general expectation that the interval between periodic safety reviews (PSR) should not exceed 10 years. General guidance on PSRs is provided in NS-TAST-GD-050 (Periodic safety reviews) [3].

Decommissioning reporting and Licence termination conditions (WENRA SRLs D-57 – D-62)

- 5.134 The decommissioning plan and associated programme(s) should include sufficient short and long term milestones and deliverables to enable progress to be monitored. These milestones will usually coincide with major step changes hazard profile of the site, as associated with the transition from one stage of decommissioning to the next. The licensee should develop suitable metrics to facilitate monitoring and reporting against the identified decommissioning milestones.

- 5.135 ONR may specify that the licensee may not move from one stage to the next without the consent of ONR (LC35). Examples may include transition into a period of care & maintenance, or commencement of final dismantling and demolition.
- 5.136 The licensee should identify those records to be available after the completion of decommissioning, how they will be kept and the necessary retention period. This can be done either by the licensee or under quality controlled arrangements for the information to be kept by a third party, eg at the Nucleus Archive in Caithness.
- 5.137 ONR's publication Licensing Nuclear Installations [19] explains the circumstances in which a nuclear site licence may be revoked by ONR or surrendered by the licensee. However a licensee's "period of responsibility" can only end when:
- a new licence has been granted for the site
 - the site is used by the Crown and does not require a licence, or
 - ONR has given written notice that in its opinion there has ceased to be any danger from ionising radiations from anything on the site.
- 5.138 Before issuing such a notice, ONR will assess whether the site has been decommissioned to the point where the remaining risks satisfy the "no danger" criterion derived from sections 3(12)(b) and 5(15)(a) of NIA65. Consideration of a licensee's case for demonstrating "no danger" should be carried out against ONR's dedicated guidance [20]. Until such time as the licensee can provide an adequate demonstration of compliance with the "no danger" criterion, it will retain responsibility for safety on the site.
- 5.139 As decommissioning progresses towards its final stages and the nuclear hazard is progressively reduced, the hazard profile will tend to change towards conventional safety and environmental protections issues. The continued application of the nuclear licensing regime to these final stages of decommissioning was subject to a government consultation on alternative approaches [21].
- 5.140 The UK Government is seeking to amend the regulatory framework that applies to the final stages of nuclear site decommissioning to by adopting the 2014 Paris Convention Decommissioning Exclusion [22]. Under this Exclusion, the nuclear liability regime will cease to apply for nuclear sites that meet the qualifying criteria; third party damage or injury will then be covered by ordinary law third party liability.
- 5.141 ONR will continue to provide effective and proportionate regulation of the delicensing of nuclear sites through amendment of the delicensing criteria, should the Exclusion be adopted into UK legislation.

6. REFERENCES

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- 3 Nuclear Safety Technical Assessment Guides, Office for Nuclear Regulation. www.onr.org.uk/operational/tech_asst_guides

NS-TAST-GD-005	Guidance on the Demonstration of ALARP (As Low As Reasonably Practicable)
NS-TAST-GD-009	Examination, Inspection, Maintenance and Testing of Items Important to Safety
NS-TAST-GD-024	Management of Radioactive Materials and Radioactive Waste on Nuclear Licensed Sites
NS-TAST-GD-027	Training and assuring personnel competence
NS-TAST-GD-033	Duty Holder Management of Records
NS-TAST-GD-038	Radiological Protection
NS-TAST-GD-048	Organisational Change
NS-TAST-GD-049	Licensee Core Safety and Intelligent Customer Capabilities
NS-TAST-GD-050	Periodic Safety Reviews (PSR)
NS-TAST-GD-051	The Purpose, Scope and Content of Nuclear Safety Cases
NS-TAST-GD-058	Human Factors Integration
NS-TAST-GD-059	Human Machine Interface
NS-TAST-GD-061	Staffing Levels and Task Organisation
NS-TAST-GD-063	Human Reliability Analysis
NS-TAST-GD-065	Function and Content of the Nuclear Baseline
NS-TAST-GD-079	Licensee Design authority Capability
NS-TAST-GD-080	Challenge Culture, Independent Challenge Capability (including an Internal Regulation function) and the Provision of Nuclear Safety Advice
NS-TAST-GD-083	Land Quality Management
NS-TAST-GD-094	Categorisation of Safety Functions and Classification of Structures and Components
NS-TAST-GD-098	Asset Management
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- 5 Western European Nuclear Regulators' Association. www.wenra.org
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- Guidance to support the joint regulatory memorandum of understanding between ONR and NRW on matters of mutual interest in Wales, ONR-INSP-GD-063 Revision 1, June 2019.
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7. ABBREVIATIONS

ACoP	Approved Code of Practice
ALARP	As low as reasonably practicable
BAT	Best Available Technique
BDP	Baseline Decommissioning Plan
CDM	The Construction Design and Management Regulations 2015
C&M	Care & Maintenance
EA	Environment Agency
EIADR	Nuclear Reactors (Environmental Impact Assessment for Decommissioning) Regulations 1999
EDF	Électricité de France
FDP	Funded Decommissioning Plan
GSR	General Safety Requirements (IAEA)
HSE	Health and Safety Executive
IAEA	International Atomic Energy Agency
LC	Licence Condition
LQM	Land Quality Management
MOD	Ministry of Defence
MoU	Memorandum of Understanding
NDA	Nuclear Decommissioning Authority
NEA	Nuclear Energy Agency
NLF	Nuclear Liabilities Fund
NLFAB	Nuclear Liabilities Funding Assurance Board
NRW	Natural Resources Wales
OPEX	Operational Experience
ONR	Office for Nuclear Regulation
POCO	Post Operational Clean Out
PSR	Periodic Safety Review
QQR	Quinquennial Review
RGP	Relevant Good Practice
SAP	Safety Assessment Principle(s) (ONR)
SFAIRP	So far as is reasonably practicable
SEPA	Scottish Environment Protection Agency
SQEP	Suitably Qualified and Experienced Personnel
SRL	Safety Reference Level (WENRA)
SSC	Structure, System and Component
TAG	Technical Assessment Guide(s) (ONR)
WENRA	Western European Nuclear Regulators' Association

8. APPENDICES

APPENDIX 1 – DECOMMISSIONING FUNDING

- 8.1 The UK Government expects all nuclear operators should take the steps necessary to ensure that adequate funds are in place to meet their decommissioning liabilities.
- 8.2 In practice ONR does not directly scrutinise the financial provisions made by licensees, but provides its view to other organisations who give relevant assurance to the UK Government. In such cases, ONR's advice is based on an assessment of whether the decommissioning strategy and plan on which the financial provisions are based aligns with UK regulatory expectations.
- 8.3 Sites owned by the Nuclear Decommissioning Authority (NDA) are subject to statutory financial arrangements made in accordance with the Energy Act 2004, which assure the provision of funds by the UK government. In addition to setting out the purposes, constitution, staffing and proceedings of the NDA, the Energy Act 2004 identified ONR as a statutory consultee on NDA's Strategy.
- 8.4 The UK Government established the Nuclear Liabilities Fund (NLF) in 1996 with the key purpose of funding the costs of decommissioning the eight nuclear power stations (7 AGR and 1 PWR) currently operated in the UK by EdF Energy (EdF). The UK Government also agreed to fund decommissioning of the eight power stations to the extent that the liability might exceed the assets of the NLF. In order to draw down on the NLF, EdF must apply to NDA with a demonstration that the intended spend is against a qualifying liability. EdF is also required to submit to NDA a baseline decommissioning plan (BDP), on which NDA seeks ONR's views.
- 8.5 The UK Government further legislated, in the Energy Act 2008, to ensure operators of any proposed new nuclear power stations built in the UK will have secure finance in place to meet the full costs of future decommissioning. Under the Act, any such operator is required to have a Funded Decommissioning Programme (FDP) approved by the Secretary of State in place before construction of its power station begins, and to comply with the FDP thereafter. To ensure the operator makes prudent financial provisions, the FDP is expected to:
- Identify all the steps necessary to decommission the power station and manage and dispose of all associated wastes, including spent nuclear fuel
 - Give due recognition to the government's 'Base Case' of key strategic assumptions
- 8.6 Financial aspects of FDPs are scrutinised by the dedicated Nuclear Liabilities Funding Assurance Board (NLFAB) and ONR is recognised as a statutory consultee. Therefore ONR would expect to provide advice to the Government on the technical content of an FDP in respect of its alignment with UK regulatory expectations.
- 8.7 The government published detailed guidance on the principles that the Secretary of State will expect to see satisfied in a duty holders' FDP prior to granting an approval: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/70214/guidance-funded-decommissioning-programme-consult.pdf