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| ONR Technical Assessment Guide  Decommissioning |



ONR Technical Assessment Guide

Decommissioning

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**Issue No**.: 6

**Publication Date**: January 2024

**Next Major Review Date**: January 2029

**Doc. Ref**.: NS-TAST-GD-026

**Record Ref. No**.: 2019/144943

Revision commentary

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| Issue No. | Description of Update(s) |
| 5.1 | Minor update - updated review period. |
| 5.2 | Minor update – removal of extant URLs from the document to mitigate potential configuration control issues arising because of changes to third-party web domains. |
| 6 | Major update - Restructuring of Section 5 to follow the lifecycle. Inclusion of specific appendices on Design for decommissioning and Transition into decommissioning. Clarification of guidance on ONR review of licensee decommissioning strategies and plans. |

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# Introduction

1. The Office for Nuclear Regulation (ONR) has established its Safety Assessment Principles (SAPs) [[[1]](#endnote-2)] which apply to the assessment by our specialist inspectors of safety cases for nuclear facilities that may be operated by potential licensees, existing licensees, or other duty-holders. The principles presented in the SAPs are supported by a suite of guides to further assist our inspectors in their technical assessment work in support of making regulatory judgements and decisions. This technical assessment guide (TAG) is one of these guides [[[2]](#endnote-3)].

# Purpose and Scope

1. This TAG provides guidance to our 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 government policy on decommissioning of nuclear sites, relevant International Atomic Energy Agency (IAEA) safety standards for the decommissioning of nuclear facilities [[[3]](#endnote-4)] and the Western European Nuclear Regulators’ Association (WENRA) Safety Reference Levels (SRL) for decommissioning [[[4]](#endnote-5)].
2. Licensees 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.
3. The IAEA defines decommissioning as, the “administrative and technical actions taken to allow the removal of some or all of the regulatory controls from a facility” [3]. The SAPs take this further by defining decommissioning as the “administrative and technical actions taken to reduce hazards progressively and thereby allow the removal of some or all of the regulatory controls from a facility”. A ‘facility’ is defined as “a part of a nuclear site identified as being a separate unit for the purposes of nuclear or radiological risk” and taken to encompass both ‘nuclear installation’ (as defined in the nuclear Installations Act 1965 (NIA65)) and ‘plant’ (as defined in LC 1) [1].
4. This means that decommissioning not only applies to a site as whole at the end of its operational period, but any individual plant or group of plants on that site which may reach the end of operations whilst other facilities on the same site continue to operate.
5. 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. Different facilities may have different end states, particularly if they will reach the end of operations at different times. Decommissioning may proceed as a continuous activity, or as a series of sequential stages, the result of each stage being a significant reduction in hazard often referred to as ‘interim states’. The aggregate of the different facility and land restoration end states will define the site end state, which may be for release of the site for another use following removal of the licence, or re-use under the nuclear site licence.
6. 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, nuclear site health and safety, nuclear safeguards, and nuclear security continue to apply during decommissioning. Consequently, the general advice provided in other TAGs remains relevant when a site or facility enters decommissioning. This TAG focusses on the specific nuclear safety related factors that are particularly important to consider in relation to decommissioning, with references to the general advice where appropriate.
7. 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. Indeed, some licensees may consider POCO to be part of operations, whilst others consider it part of decommissioning. Our objectives in regulating decommissioning are outcome-focussed, meaning 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 interested parties.
8. The IAEA recognises that there is a "transition period” from the operational phase to the beginning of implementation of the decommissioning strategy for nuclear facilities, during which time activities such as defueling may take place. This period is often a critical time for the workforce as it changes its focus from continued operations towards end-of-life activities and commencing decommissioning of the site. There is further guidance on this in Appendix 2.

# Relationship to Licence and other Relevant Legislation

## Licence Conditions

1. All 36 standard Licence Conditions (LCs) [[[5]](#endnote-6)] apply during decommissioning and are relevant to activities involving decommissioning on nuclear licensed sites. However, the following LCs, listed in numerical order, 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

### Licence Condition 35 – Decommissioning

1. Under LC 35, licensees are required to make and implement adequate arrangements for the decommissioning of any plant or process which may affect safety, and to make arrangements for the production and implementation of decommissioning programmes for each plant.
2. A ‘decommissioning programme’ is not a term used anywhere else in legislation, policy or international guidance. However, considering LC 35 requires a decommissioning programme for each plant, the term should be equated with a decommissioning plan which the IAEA define as “a document containing detailed information on the proposed decommissioning of a facility”.
3. Furthermore, LC 35 requires licensees to split the decommissioning into stages, where appropriate. The arrangements must also include requirements to provide adequate documentation to justify the safety of the proposed decommissioning activities, meaning a licensee’s strategy and plans should be adequately optimised, justified, and underpinned by appropriate safety case(s). Guidance on decommissioning strategies and plans is available in section ‎5.2.
4. LC 35 provides us with various ‘primary powers’ through which we can exert regulatory control. Further guidance is available in the LC35 Technical Inspection Guide (TIG) [[[6]](#endnote-7)].

## Other relevant legislation

1. 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, the Radiation (Emergency Preparedness and Public Information) Regulations 2019, the Lifting Operations and Lifting Equipment Regulations 1998, and the Control of Asbestos Regulations 2012. Some of the relevant legislation in the context of decommissioning is discussed further below.

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

1. 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.
2. 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. Specific guidance on EIADR is available at [www.onr.org.uk/eiadr](http://www.onr.org.uk/eiadr.htm)

### Ionising Radiations Regulations 2017

1. 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.
2. 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 may 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)

1. Further guidance is provided in NS-TAST-GD-038 (Radiological Protection) [2] and the IRR17 Approved Code of Practice [[[7]](#endnote-8)].

### Construction (Design and Management) Regulations 2015 (CDM)

1. Decommissioning typically gives rise to significant challenges relating to nuclear site health and safety, such as working at height, work in confined spaces, work with high temperatures, demolition of civil structures and export of large heavy items.
2. The Construction (Design and Management) Regulations 2015 (CDM) 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; and,
* Removal of mechanical, electrical, gas, compressed air, hydraulic, telecommunications, computer or similar services which are normally fixed within or to a structure.

1. Specific guidance on CDM is available at [www.hse.gov.uk/pubns/books/l153](http://www.hse.gov.uk/pubns/books/l153.htm)

### Environmental protection legislation

1. Decommissioning is likely to result in the production of significant quantities of radioactive wastes which then need to be managed to the point of disposal.
2. The environment agencies – the Environment Agency in England, the Scottish Environment Protection Agency (SEPA) in Scotland, or Natural Resources Wales (NRW) in Wales – have responsibility for regulating environmental protection under the relevant legislation, which includes:

* Environmental Permitting (England and Wales) Regulations 2016
* Environmental Authorisations (Scotland) Regulations 2018

1. Inspectors on sites undertaking decommissioning should familiarise themselves with our Memoranda of Understanding with the relevant environmental regulator [[[8]](#endnote-9)] and supporting guidance [6], and the joint guidance document, “Basic Principles of Radioactive Waste Management” [[[9]](#endnote-10)].

# Relationship to Safety Assessment Principles, WENRA Reference Levels, and IAEA Safety Standards and Guides

1. The SAPs provide our inspectors with a framework for making consistent regulatory judgements on the safety of activities including the legal duty to reduce risk so far as is reasonably practicable (SFAIRP). The SAPs contain sections which relate 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 in a passively safe state 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.

1. In addition to principles DC.1-DC.9, the following may also be of relevance to decommissioning assessments:

* **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 generation
* **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 radiological protection and control of areas to limit spread of radioactive contamination.
* **MS.1** to **MS.4** – these principles relate to the maintenance of effective leadership and management 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 Structures, Systems and Components (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 and may become more significant as decommissioning progresses towards final site clearance and release from regulatory control.

1. 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 SAPs listed above, but to consider the specific case under assessment and which other SAPs and associated TAGs may be relevant.
2. 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.
3. NS-TAST-GD-005 [2] 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 been benchmarked against the Decommissioning SRLs [4].
4. The IAEA guidance [3] most relevant to decommissioning are:

* Fundamental Safety Principles (SF-1)
* Decommissioning of Facilities (GSR Part 6)
* Release of Sites from Regulatory Control on Termination of Practices (WS-G-5.1)
* 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 Concept of Exemption (GSG-17)
* Application of the Concept of Clearance (GSG-18

# Advice to Inspectors

## Design for decommissioning

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

1. The requirements for decommissioning should be considered at all phases in the overall lifecycle of the facility, starting at the planning and design phase. This principle is derived from GSR Part 6 paragraph 7.3 under Requirement 10 (Planning for decommissioning), which states that:

‘For a new facility, planning for decommissioning shall begin early in the design stage and shall continue through to termination of the authorisation for decommissioning.’

1. The expectation that nuclear facilities are designed with decommissioning in mind is expressed in SAPs DC.1 (Design and operation) and ECE.26 (Provision for decommissioning).
2. Planning and preparation for decommissioning should occur with an appropriate level of detail from the moment design commences, although the practical delivery of decommissioning is the last stage of a nuclear facility’s lifecycle. Consideration of decommissioning during the preceding lifecycle stages can significantly reduce the risks and costs of delivering decommissioning.
3. 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.
4. 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 [[[10]](#endnote-11)]. Further guidance on good practice and learning relating to design for decommissioning is contained within Appendix 1, with specific guidance regarding civil engineering within NS-TAST-GD-017 [2]. The potentially long timescales involved in decommissioning of nuclear sites means that the impacts of climate change should be appropriately assessed in the safety case(s). Further guidance is available in NS-TAST-GD-013 and its supporting annexes [].
5. In the case of new facilities, inspectors should check that the licensee’s arrangements and processes recognise the need to challenge the design to reduce the risks of future decommissioning to as low as reasonably practicable (ALARP). Further guidance on ONR’s expectations for the demonstration of ALARP is provided in NS-TAST-GD-05 [2]. Design of new nuclear facilities should also adequately consider the impact of climate change over its full lifetime.
6. 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
* condition of civil structures.

1. Baseline surveys should consider both surface and subsurface conditions, including groundwater. For existing sites without such survey data, then data from analogous, undisturbed areas with similar characteristics should be used.

## Decommissioning strategy and planning

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

1. Under UK Government policy, each UK nuclear operator is expected to produce and maintain a decommissioning strategy and plan for each site it is responsible for [[[11]](#endnote-12)][[[12]](#endnote-13)]. This expectation is aligned to the international good practice set out in GSR Part 6 Requirements 6 (Responsibilities of the licensee for decommissioning) and 8 (Selecting a decommissioning strategy). Furthermore, the expectation that a decommissioning strategy be prepared, supported by facility specific plans implementing the strategy are expressed in SAPs DC.2 (Decommissioning strategies) and DC.4 (Planning for decommissioning), respectively.
2. GSR Part 6 identifies two broad options for decommissioning strategies that have been adopted, or are planned, internationally; immediate dismantling or deferred dismantling. In the case of a strategy pursuing immediate dismantling, the decommissioning actions commence shortly after the permanent shutdown of the facility and continue until the end state has been achieved. A deferred dismantling strategy may involve some early decontamination or dismantling activities but involves a period where the remaining parts of the facility are maintained through a period of safe storage pending final dismantling. GSR Part 6 states immediate dismantling should be the preferred strategy.
3. Inspectors should be aware that entombment, where all or part of a facility is encased in a structurally long-lived material (e.g. concrete), is not considered as an acceptable decommissioning strategy, as per GSR Part 6 and UK government policy [12]. Entombment may only be considered under exceptional circumstances, such as following a severe accident. The on-site disposal of radioactive waste for a purpose made in accordance with an environmental permit is not considered to be entombment. An example of disposal for a purpose is where waste is placed into below ground void spaces such as basements, and then potentially grouted in-situ [13].
4. Operators should engage early with interested parties (including regulators, local authorities and local communities) on their decommissioning strategies and plans and should take their views into account. Inspectors should engage with licensees on the development of decommissioning strategies and plans throughout the lifecycle of a facility. Licensees should be encouraged to discuss their strategies and plans with inspectors early, enabling appropriate advice and guidance to ensure the developing plans take due account of regulatory expectations. However, inspectors need to maintain regulatory independence from the licensee’s decision-making processes.
5. The strategy should provide a level of detail commensurate with the type and status of the facility, the hazards presented and the stage in the lifecycle. Strategies should consider all ‘relevant factors’ highlighted in government policy [11][12], presenting them in a transparent way and demonstrating objectively how each has been reflected in the adopted approach. Although ONR does not enforce government policy, inspectors should assess whether the licensee’s decommissioning strategy is consistent with relevant national policies and strategies. Licensees should identify and justify any differences to national policy and strategies.
6. The precise format of the decommissioning strategy is for the licensee to propose and justify, but inspectors should expect the following aspects to be adequately considered:

* A defined inventory of the plant(s) 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 criteria for the end state, or interim states where a staged decommissioning strategy proposes periods of quiescence (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 where a staged approach is applied.
* Where appropriate decommissioning should be divided into stages, in which case we may specify where consent is required to commence a stage or to proceed from one stage to the next.
* Arrangements for asset management during the decommissioning process.
* If the plans include a deferral of decommissioning with an associated care and maintenance period, the arrangements should include procedures and plans to maintain safety during that period, and address 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.
* A safety case, including the identification of safety and radiological protection measures/strategies. The overarching strategy for safety management systems should also be evident, and should 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.

1. 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.
2. The future intended use of the site is a significant factor in determining the scope and interim or end state for decommissioning. Integral to this is meeting the requirements for environmental protection, regulated by the relevant environment agency. Inspectors should familiarise themselves with the guidance published by the environment agencies on the requirements for release from radioactive substances regulation [[[13]](#endnote-14)].
3. Inspectors should consider whether the licensee’s decommissioning strategies and plans adequately demonstrate a systematic and progressive reduction of hazard at a pace which is proportionate to the hazard and risk. 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.
4. Inspectors should consider whether the strategy is sufficiently integrated at facility and site levels, 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;
* The decommissioning strategy should be linked to facility asset management plans such that appropriate asset care is in place to enable the whole decommissioning plan, and to protect residual hazards until these are removed;
* Key interactions and interdependences are taken into account within the planning process, e.g. any reliance on shared 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-wide considerations may also be appropriate if the licensee operates multiple licensed sites; and,
* Consideration of factors external to the licensee should also be evident, such as confirmation that wastes anticipated to be generated meet the relevant intended waste route, or that suitable transport packages have been identified.

1. Optimisation is the term used by the IAEA in its Fundamental Safety Principles [3] where principle 5 states, “Protection must be optimised to provide the highest level of safety that can reasonably be achieved.” Licensees must demonstrate compliance with the legal requirement to reduce risks SFAIRP, which usually involves application of optimisation to demonstrate it has reduced risks to ALARP. Inspectors are referred to guidance on the demonstration of ALARP (NS-TAST-GD-005) [2] which includes guidance on optimisation.
2. In respect of decommissioning, there are some specific aspects of optimisation that inspectors may seek to be addressed as part of a licensee’s arrangements to comply with LC35. A precautionary approach should be applied to the uncertainties that often need to be managed during decommissioning. NS-TAST-GD-005 [2] provides guidance on this topic. Another important aspect relates to the potentially long timescales involved, and hence the increased importance of intergenerational economic, social, and environmental factors such as sustainable development and long-term environmental effects.
3. 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. These should be defined and developed by the licensee, but inspectors may wish to make a comparison with the list of relevant factors in the SAPs under principle DC.3 (timing of decommissioning). Inspectors should work with colleagues from the relevant environmental regulator to ensure consistency in relation to management of radioactive waste and long-term environmental impact.
4. 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.

1. 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.
2. The prioritisation of activities should be consistent with achievement of risk reduction but should take account of other considerations where relevant and justified. Examples might include:

* Enabling tasks may be required to facilitate future risk reduction, for example 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; and,
* Value and cost-benefit arguments, i.e. efficiency.

1. Decommissioning may proceed as a continuous activity, or as a series of sequential stages, the result of each stage being a significant reduction in hazard often referred to as ‘interim states’. 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.
2. In general, Inspectors should expect the licensee to prioritise the removal (for treatment, storage or disposal) and/or immobilisation of the most active or mobile material. These activities should 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 overall risk reduction to take place. In such circumstances the licensee should justify its overall approach and ensure that risks are reduced to ALARP across all stages.
3. Inspectors should recognise that risks associated with particular decommissioning tasks can be increased due to the presence of uncertainty or specific safety challenges, for example accessibility or confined space working.
4. There are inherent uncertainties in decommissioning. Inspectors should look to see that a licensee’s arrangements, strategies, and safety cases adequately take these into account, and put in place appropriate mitigation and contingencies.

### Post-operational clean out

1. POCO has become a widely used term in the UK to refer to actions taken to remove radioactive inventory from a facility following shutdown, including but not limited to, wash out of tanks and pipework, fixing of any residual radioactivity and removal of any accumulated radioactive waste.
2. POCO is not a term used internationally, with IAEA guidance referring to a period of transition following the permanent shutdown of a facility and prior to implementation of the decommissioning plan during which preparatory actions for decommissioning can be performed.
3. Typically, POCO is delivered under the operational safety case since many of the activities are similar to those routinely undertaken during operations. However, some aspects of POCO may be more invasive and could require modification to the safety case, or it may be delivered under the decommissioning safety case.
4. Where necessary, a POCO strategy should be developed and integrated with the wider decommissioning strategy, and include the following:

* A defined POCO end state, linked to the decommissioning plan demonstrating lifecycle ALARP;
* A characterisation strategy;
* Interdependencies with other facilities on the site, either in operations or decommissioning;
* Retiring of SSCs no longer required; and
* Retention of sufficient staff who are suitably quailed and experienced, to deliver POCO safely following shutdown.

### Period of Deferral (WENRA SRLs D-48 – D-49)

1. If a deferred decommissioning strategy has been chosen, inspectors should seek adequate justification that risks are reduced to ALARP. The strategy and supporting plans should provide demonstration that safety will be adequately managed during the period of deferral.
2. 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 the potential for deterioration of containment barriers.
3. 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 or prior to dismantling and final site clearance, as part of a deferred decommissioning strategy. Prior to entering C&M, the facility should undergo POCO, which may also potentially include removal of some plant, to ensure the facility is placed into a passively safe state in accordance with the expectations of SAP DC.5.
4. 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 the strategy to ensure continued safety of the facility and demonstrate the ability to safely decommission the facility in the future.
5. 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 and risks presented by the remaining 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 examination, inspection, maintenance and testing arrangements.

1. During the C&M period the facility should be maintained in a passively safe configuration, so far as 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 the safety case.
2. 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, and which does not renew the short-term safety case underpinning such decisions.
3. 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 deferral.
4. The safety case should justify and demonstrate safety for the proposed period of deferral. The inspector should assess whether the following are 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.

1. Notwithstanding a justified period of deferral, licensees should adopt decommissioning strategies which are sufficiently flexible to facilitate acceleration of the plans, should this be necessary for safety reasons.

### Decommissioning plans (WENRA SRLs D-19 – D-29 & D-57)

1. Inspectors should expect decommissioning plans for each facility that set out how it will be safely decommissioned at the end of its operational period, to meet the expectations of SAP DC.4. Initial plans should be developed at the planning phase of a new site or facility and maintained throughout the lifecycle with increasing detail as decommissioning approaches. This expectation aligns with GSR Part 6 Requirement 10 (planning for decommissioning).
2. The plan(s) should be commensurate with the scale of the facility, the type of the inventory, and the stage in the facility’s lifecycle. It may be appropriate for smaller, less complex facilities to be included in a single decommissioning plan, but where multiple facility-specific plans exist, the overarching decommissioning strategy should explain how these are integrated at the site level.
3. Decommissioning 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 and safety issues.
* Incorporate design for decommissioning features (refer to Appendix 1). The key decommissioning measures and design features should be described and justified by the licensee. Such measures may need to be considered against construction and operational safety considerations.
* Inform the design process and vice versa. ALARP considerations should also be apparent (appropriate to the design stage).
* Include waste management and environmental aspects of decommissioning, such as management of radioactive and non-radioactive wastes and effluents.
* 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.

1. The decommissioning plan(s) should include sufficient short- and long-term milestones and deliverables to enable progress to be monitored. These may be expected to coincide with major changes in the hazard profile of the site, 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.
2. Generally, inspectors should expect an increase in the level of detail presented in the decommissioning plans as the facility or site nears the end of its operational life and approaches the decommissioning phase.
3. Some older facilities may not have had decommissioning plans in place from an early stage. In these cases, inspectors should expect decommissioning plans to be produced, based upon sufficient characterisation of the radioactive and non-radioactive hazards and identification of the challenges which will need to be addressed during decommissioning.
4. GSR Part 6 Requirement 11 states that the licensee should submit a final decommissioning plan to the regulator for approval prior to commencement of decommissioning. Whilst we do not approve licensees’ decommissioning plans, we do have the ability to exert regulatory control over the commencement of decommissioning, or moving from one stage to the next where decommissioning is split into stages, under LC 35 – further detail is provided in NS-INSP-GD-035 [6].
5. 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.

### Review of decommissioning strategies and plans (WENRA SRL D-23)

1. 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, as per NS-TAST-GD-050 [2] and SRL D72 [4].
2. Inspectors should assess whether arrangements for decommissioning include appropriate review and change control procedures for the decommissioning plans. During the operational phase, review of the decommissioning strategy and plan should take place at least as frequently as the periodic safety review as required under LC15. During decommissioning, an increased frequency of PSRs may be necessary to reflect the progressive change in plant status, hazards or decommissioning approach as decommissioning progresses. Similarly, during any period of quiescence, it may be appropriate to accept reduced frequency of PSRs. Further guidance is available in NS-TAST-GD-50 [2] and NS-INSP-GD-35 [6].
3. Changes which could warrant a review and subsequent modification of plans may include (but are not limited to):

* Significant changes to the facility (physical, ageing, inventory, etc), including changes resulting from the decommissioning operations.
* 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.
* Improved plant characterisation data.
* 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 interim or end state
* 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.

#### Regulatory review of decommissioning strategies and plans

1. Paragraph 7.5 in IAEA GSR Part 6 [3] creates an expectation that regulators should review licensee’s decommissioning plans on a periodic basis, typically every five years or when circumstances merit.
2. In 1995 the UK Government issued a policy statement [[[14]](#endnote-15)] that introduced a responsibility on the then Nuclear Installations Inspectorate of HSE, in conjunction with the relevant environment agency, to review the decommissioning strategy of each UK licensee at least every 5 years, which became known as the Quinquennial Review process (QQR). The position was reaffirmed in the 2004 policy statement [11], except for sites where “equivalent arrangements” are made, e.g. by the NDA. QQR aligned to the international good practice in GSR Part 6 but created significant burdens for both the licensee and regulators.
3. In March 2023, the UK government published a consultation on revised policy proposals for managing radioactive substances and nuclear decommissioning [12], which no longer contain the requirement for QQR. This change enables us to apply a graded approach, working with the environment agencies, to securing regulatory oversight of licensee decommissioning plans on a periodic basis.
4. We continue to undertake periodic review of operators’ decommissioning plans via a range of regulatory tools appropriate to the sites’ lifecycle stage, applying a graded approach, and subject to appropriate internal governance. The range of regulatory tools available includes:

* Inspection of decommissioning arrangements and their implementation, in accordance with the requirements of Licence Condition 35, including regulatory agreement of key milestones in decommissioning;
* Ongoing regulatory oversight of progress with implementation of decommissioning strategies and plans as part of routine site regulation;
* Assessment of periodic review of safety submissions in accordance with Licence Condition 15, particularly where a facility is expected to enter into decommissioning in the next review period; and
* Assessment of decommissioning strategies and plans for proposed new Nuclear Power Plants in the Generic Design Assessment process.

1. Internal governance is provided by the Nuclear Liabilities Regulation (NLR) specialism on behalf of the Technical Director, with performance reported in the Annual Review of Regulation.
2. NLR maintains a register of regulatory engagements with all licensees which delivers a proportionate periodic review of decommissioning strategy and plans for each site [[[15]](#endnote-16)]. As part of the annual planning round, the lead NLR inspector deployed to each Division will advise which sites require targeted and proportionate engagement on decommissioning in the forthcoming financial year to maintain alignment with GSR Part 6. Such engagements should be delivered jointly with the relevant environment agency, where possible, to ensure environmental protection matters are appropriately integrated. Once completed, NLR will update the register identifying the relevant record (i.e. WIReD inspection or assessment record, or Contact Record) which records our judgement on the adequacy of the decommissioning strategy and plans.

## Control of decommissioning operations

### Safety case for decommissioning (WENRA SRLs D-50 – D-56)

1. Inspectors should refer to NS-TAST-GD-051 (The purpose, scope and content of nuclear safety cases) [2] 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, to meet the expectations of SAP DC.9.
2. 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 necessary to support the decommissioning programme and include the final decommissioning of such infrastructure itself.
3. Before entering decommissioning, licensees should carefully consider the interdependences 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 during decommissioning.

1. 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 and 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.
2. 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. Additional guidance on operational experience processes is provided in NS-INSP-GD-007 [6].
3. The safety case should be proactively managed, initially to avoid breaches of operating rules and the maintenance schedule as plant ceases to operate. 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 or enhanced capabilities, such as new waste stores, scope of characterisation and processes for exemption and clearance to manage large volumes of decommissioning wastes and spoil.
4. During decommissioning, the risks associated with nuclear site health and safety hazards arising from de-planting and demolition activities (e.g. asbestos, confined spaces), are expected to increase. As such, the safety case should adequately consider the appropriate management of nuclear site health and safety risks where these have the potential to impact upon nuclear safety, and vice versa.
5. The safety case should be appropriately underpinned by knowledge of the risks and assessment of associated uncertainties, particularly in the case of legacy facilities. This should be supported by the examination of records and the results of characterisation 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.
6. Where the licensee identifies that 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 for delivery.
7. Inspectors should consider the licensee’s arrangements for maintaining the safety case(s) when significant changes occur, according to the safety relevance of such changes and licensee’s categorisation. Changes might include modifications to the facility, plan or decommissioning practice at major steps in the decommissioning project, or new relevant regulatory requirements.
8. 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 adequate plans to address such deviations are implemented.
9. The review should also consider 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 to update the safety case accordingly.
10. 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) [2].

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

1. Licensees are required to control activities that may impact upon safety during decommissioning through the use of approved processes and procedures 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, as necessary, to ensure they remain adequate and applicable to decommissioning activities.
2. 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.
3. Modifications, to the plant and of planned decommissioning activities, should be controlled by the licensee, in accordance with 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.
4. 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 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) [2].
5. 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) [2].

### Records and knowledge keeping (WENRA SRLs D-9 – D-10 & D-59)

1. Licensees are expected to make adequate provision for recording and preserving all the data and information that may be necessary in the future to ensure safe decommissioning on nuclear licensed sites, in accordance with the expectations in SAP DC.6. International good practice is that records relevant to decommissioning should be kept for the lifetime of the facility, as stated in paragraph 7.7 of GSR Part 6.
2. It is particularly important for licensees to recognise the value to decommissioning of accurate information on nuclear facilities, their radioactive inventory and the SSCs that contribute to safety. Licensees should ensure this data is kept up-to-date and maintained in a readily available format. In considering the scope of information to be retained, licensees should be cognisant of the objectives of decommissioning and how their delivery may drive different information needs to those of the operational phase.
3. 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 30 years unless otherwise agreed with ONR. LC 25 requires licensees to ensure that adequate records are made and kept of the operation, inspection, and maintenance of nuclear facilities, which includes the decommissioning phase of the lifecycle of a facility. Further guidance is provided in NS-TAST-GD-033 (Licensee management of records) [2].
4. The record preservation period of 30 years reflects the requirements of NIA65 with respect to third party liability. In considering the timeframe for record retention the licensee should recognise that some records may need to be maintained for longer than the period specified in LC 6, such as records important to an adequate demonstration of completion of decommissioning and those to enable disposal of radioactive waste. 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. 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 lifecycle. 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;
* Location and function of any concealed (e.g. buried) systems
* 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, including any on-site waste diposals; and
* Significant plant modifications.

1. 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 control arrangements for the information to be kept by a third party, for example at the Nucleus Archive in Caithness.

### Classification of safety systems, structures, and components (WENRA SRL D-30)

1. 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 be required to support decommissioning operations.
2. 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).
3. Further guidance is contained within NS-TAST-GD-094 (Categorisation of Safety Functions and Classification of Structures and Components) [2].

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

1. 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. This expectation aligns with GSR Part 6 Requirement 13.
2. Amendments to the emergency plan associated with decommissioning typically result in a reduced scope of available on-site resource, and a need for off-site responders to support the emergency organisation.
3. Guidance on licensee’s arrangements for emergency preparedness are covered elsewhere under specific guidance, such as NS-INSP-GD-011 (LC11 Emergency arrangements) [6] and the Approved Code of Practice (ACoP) to the Radiation (Emergency Preparedness and Public Information) Regulations 2019 [[[16]](#endnote-17)].

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

1. 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 assess whether that operational feedback is appropriately considered within the decommissioning safety case.
2. 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 are 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.

### Radioactive waste management (WENRA SRLs D-38 – D-40)

1. 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 may need to vary their permit accordingly to secure regulatory permission for increased disposals and ensure they have appropriate disposal routes approved. Any such variation 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) (England and Wales) or Best Practicable Means (BPM) (Scotland), as required by the relevant environmental legislation.
2. Decommissioning generally results in a broader range of wastes than the preceding phases of the lifecycle, in terms of physical characteristics, radionuclides, chemo-toxic properties and the volumes arising. The licensee should therefore consider the need to optimise its waste management infrastructure and processes prior to undertaking decommissioning, to ensure all the anticipated wastes will be managed in accordance with our regulatory expectations as expressed in SAPs RW.1 – RW.7, and requirements of the environmental permit/authorisation. NS-TAST-GD-024 [2] and the joint regulatory guidance “The Management of Higher Activity Radioactive Waste on Nuclear Licensed Sites” [[[17]](#endnote-18)] provide further general guidance.
3. The licensee should adopt a precautionary approach to any inherent uncertainties in respect of its decommissioning wastes and put in place appropriate contingency arrangements to address risks and uncertainties (e.g. a lack of characterisation data may preclude an accurate assessment of a waste stream’s categorisation as LLW or ILW).
4. 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 implementation of the waste management hierarchy [9]. Waste aspects of strategies and plans should also recognise and be consistent with the Waste Management Plans required by the environment agencies [].
5. An essential first step in implementation of the hierarchy is for a licensee to appropriately characterise and segregate its wastes, to enable optimised management and minimise the volumes of radioactive waste requiring disposal, so far as is reasonably practicable. The licensee’s system of characterisation and segregation should enable the wastes arising to be disposed of at the lowest practicable categorisation, without inappropriate dilution. 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 Guides GSG-17 and GSG-18 [3].
6. LC32 imposes the duty upon licensees to minimise the rate of production and total quantity of radioactive waste accumulated so far as is reasonably practicable [5], which is particularly pertinent to decommissioning given the potential to generate large quantities of waste.
7. The licensee’s radioactive waste management arrangements should therefore be updated to reflect the changing nature of the radioactive waste generated during decommissioning. This may be captured in an Integrated Waste Strategy, radioactive waste management case(s) [] and/or the Waste Management Plan that is formally required by the environmental regulators.
8. 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 prior to disposal. The records should capture necessary information to enable the continued safe management of that waste whilst in storage and support the future disposability case as defined in the waste management and decommissioning plans.

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

1. Licensees normally implement an on- and off-site monitoring programme to demonstrate effective management of its operations and protection of 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.
2. As a facility transitions into decommissioning, the type of operations conducted on the site and the hazards they pose will 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, including any specific requirements of the relevant environment agency.
3. One key aspect of environmental monitoring relates to land quality management (LQM). Whilst this is an area of regulation which requires joint working with the relevant environmental regulator, the inspector should recognise that ONR has lead responsibility for regulation of radioactively contaminated land on nuclear licensed sites.
4. The joint regulatory guidance Regulatory Expectations for Successful Land Quality Management at Nuclear Licensed Sites [[[18]](#endnote-19)] 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) [2].

### Examination, inspection, maintenance and testing (WENRA SRLs D-42 – D-44)

1. Structures, systems, and components should be capable of delivering their required safety function until the associated hazards have been removed or mitigated. There should be adequate consideration of continued examination, inspection, maintenance, and testing (EIMT) of SSCs during decommissioning until the SSC is no longer required, as justified within the safety case.
2. Maintenance schedules should consider operational limits and conditions as required in the decommissioning safety case and re-evaluated in light of operational experience and changes to the plant throughout decommissioning.
3. 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, should therefore address ageing, and consider the future decommissioning plan timescales. Inspectors should ensure the licensee has made appropriate consideration of asset management plans, should decommissioning programmes be delayed, to ensure this does not lead to unacceptable degradation of plant or buildings and the unnecessary creation of radioactive waste.
4. Inspectors should consider whether the licensee’s plans adequately address the following:

* Appropriate baseline characterisation of the assets and the hazards against which they protect.
* 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, inspection, maintenance and testing regimes, to take account of the rapid changes to the facility during decommissioning.
* In taking account of the above factors, plans should adequately address any risks to workers arising from access to buildings, facilities, and structures.

1. 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), NS-TAST-GD-098 (Asset Management) and NS-TAST-GD-109 (Ageing and Degradation Management) [2].

## Decommissioning organisation

1. For general guidance, inspectors should refer to NS-TAST-GD-027 (Training and assuring personnel competence), NS-TAST-GD-79 (Licensee design authority capability) and NS TAST-GD-061 (Staffing levels and task organisation) [2].
2. Licensees should take steps to secure a smooth transition from the operational phase into decommissioning, which should be based on development of a clear and comprehensive decommissioning strategy and plan. Further guidance on transition into decommissioning can be found in Appendix 2.

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

1. The site licensee retains prime responsibility for safety throughout the lifetime of facilities and activities. As stated in SAP FP.1 [1], this responsibility cannot be delegated. This fundamental principle applies equally to decommissioning as it does to operations, therefore licensees are expected to develop their organisation, resource levels, capabilities, strategies, and administrative arrangements to ensure safety throughout the entire lifecycle.
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) [2] for general guidance and note the relevant requirements of the CDM regulations, especially the responsibilities of the nominated Client and Principal Designer.
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. The licensee must also 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.
4. Decommissioning can give rise to new safety challenges, which might require pre-existing systems to be augmented or reconfigured (ventilation systems, for example). 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 and other hazardous 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). The licensee may consider reviewing these arrangements to ensure they are fit for purpose to support decommissioning activities; this may include developing alternative arrangements to meet a specific challenge whilst remaining compliant with relevant legislation.
5. The UK Government expects all nuclear operators to take necessary steps 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.

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

1. As per SAP DC.7, organisational arrangements should be established and maintained to ensure safe and effective decommissioning, evidenced through an adequate organisational baseline and, where required, suitable and sufficient intelligent customer capability.
2. Licensees 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. Guidance on our expectations can be found in NS-TAST-GD-65 (Function and Content of the Nuclear Baseline) [2].
3. Decommissioning may give 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 workface 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.
4. 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) [2] for general guidance.
5. 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 risk reduction;
* Requirements for new skills, to progress decommissioning projects;
* A need for greater flexibility as the workface undergoes significant change;
* Increased reliance on administrative measures to deliver safety and a reduced extent of engineered protection; and
* Ensuring the licensee’s Nuclear Safety Committee exercises sufficient independent challenge of the overall decommissioning strategy in addition to scrutinising individual activities.

1. 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 nuclear site health and safety and environmental risks as decommissioning progresses;
* Recognition of the importance of maintaining radiological protection standards throughout decommissioning;
* Priorities for risk 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; and,
* Adequate integration of all parts of the licensee’s organisation that contribute to decommissioning and management of the resulting wastes.

1. Inspectors should consider whether the licensee’s organisational structure is sufficiently flexible to ensure safety as the anticipated progressive (and often rapid) changes in plant status occur during decommissioning, noting this should allow a precautionary approach to any inherent uncertainties.
2. 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 which is sustained and appropriate to decommissioning; and,
* Safety culture, to identify signs of deterioration (e.g. patterns of events or near-misses) and mitigation measures .

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

1. GSR Part 6 Requirement 7 requires the licensee’s management system covers all aspects of decommissioning, and SAP DC.8 expects that it should be reviewed and modified as necessary prior to entering and during decommissioning.
2. An organisational structure should be in place for the management and implementation of decommissioning, with clear responsibilities for ensuring that decommissioning is conducted safely.
3. Further guidance on ONR’s expectations for an effective management system is provided in NS-INSP-GD-017 (Management Systems) [6], NS-TAST-GD-048 (Organisational capability) and NS-TAST-GD-065 (Function and Content of the Nuclear Baseline) [2].
4. 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. The arrangements for controlling any modifications to the decommissioning strategy, methodology, plans, or procedures should include an assessment of the safety implications associated with any such changes.

## Completion of decommissioning

### Licence revocation or variation to exclude relevant parts of a site from the licence (WENRA SRLs D-58 & D-60 – D-62)

1. As decommissioning progresses towards its final stages and the nuclear hazard is progressively reduced, the hazard profile will tend to change towards non-nuclear safety and environmental protection issues. In 2016, the government consulted on proposals to improve the arrangements that applied to the regulation of the final stages of nuclear site decommissioning and clean-up, to enable a more flexible approach to site clean-up that takes account of a range of possible site end states and opportunities to optimise waste management [[[19]](#endnote-20)]. Subsequently amendments have been made to NIA65 by the Energy Act 2023 to implement these proposals, enabling earlier removal of a site, or parts of a site, from the nuclear site licence and nuclear third-party liability requirements.
2. NIA65 now adopts criteria to implement the 2014 OECD NEA exclusion criteria for nuclear installations in the process of being decommissioned [[[20]](#endnote-21)]. The Energy Act 2023 introduced new ‘applicable conditions’ (i.e. criteria) to remove types of relevant parts (such as nuclear installations and areas of land) from the nuclear site licence. This is expected to enable optimised decommissioning, radioactive waste management and end-state planning approaches which are not possible under the ‘no danger test’.
3. For instance, the licensed site may be reduced by removing parts, such as contaminated land and substantially decommissioned nuclear installations, when the relevant applicable conditions are met, and ONR is of the opinion that it is no longer necessary or desirable in the interests of safety for a licence to be in force for that site, or part thereof. Regulation of the remaining decommissioning and site clean-up activities would then pass to the Health & Safety Executive and the relevant environment agency.
4. Guidance on the regulatory processes for delicensing is provided in   
   NS-PER-PROC-004 [[[21]](#endnote-22)], which explains the circumstances in which a nuclear site licence may be revoked by ONR and the licensee’s period of responsibility ended. Guidance on assessment for determination against the applicable conditions is provided in TAG NS-TAST-GD-110 [].

This Text is Hidden - Appendix endnotes: [[22]](#endnote-23)

# References

# Glossary and Abbreviations

ALARP As Low As Reasonably Practicable

BAT Best Available Technique

BPM Best Practicable Means

C&M Care and Maintenance

CDM Construction (Design and Management) Regulations 2015

CNSS Civil Nuclear Security & Safeguards Division (ONR)

DAP Duly Authorised Person(s)

DF Decontamination Factor

EA Environment Agency

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

GSR General Safety Requirements (IAEA)

IAEA International Atomic Energy Agency

ILW Intermediate Level Waste

IRR17 Ionising Radiations Regulations 2017

LC Licence Condition

LLW Low Level Waste

LMfS Leadership and Management for Safety

LQM Land Quality Management

NDA Nuclear Decommissioning Authority

NIA65 Nuclear Installations Act 1965

NLR Nuclear Liabilities Regulation Specialism (ONR)

NRW Natural Resources Wales

POCO Post Operational Clean Out

PSR Periodic Safety Review

QQR Quinquennial Review

RGP Relevant Good Practice

SAP Safety Assessment Principle(s)

SEPA Scottish Environment Protection Agency

SFAIRP So Far As Is Reasonably Practicable

SRL Safety Reference Level (WENRA)

SSC Structures, Systems and Components

TAG Technical Assessment Guide(s)

TIG Technical Inspection Guide(s)

WENRA Western European Nuclear Regulators’ Association

# Appendix 1: Design for decommissioning

1. In 2019, we commissioned an independent review of good practices and operating experience and feedback on design for decommissioning, focussed on pressurised water reactors [22]. Although focused on pressurised water reactors, the review identified good practices and operating experience and feedback that is relevant for all nuclear facilities.
2. A key reference cited in the 2019 review is IAEA-TECDOC-1657, “Design Lessons Drawn from the Decommissioning of Nuclear Facilities” [10] which covers all types of nuclear facilities. The 2019 review considered it to have been based on a comprehensive review of learning available at the time and although published in 2011, remains a valid and valuable source of information.
3. It is for the inspector to consider whether practices set out in this Appendix, which are primarily drawn from the 2019 review and references therein, meet the criteria for being considered relevant good practice (RGP), taking account of the guidance in NS-TAST-GD-005 [2].
4. Learning and good practices relevant to design for decommissioning may be divided into two broad areas:

* how to adequately consider decommissioning during design; and
* design features to facilitate decommissioning.

## Decommissioning design considerations

1. It is preferable for licensees’ overall design processes to adequately consider decommissioning issues rather than having a separate “design for decommissioning” process. This recognises that features beneficial to decommissioning should be considered with other factors, such as operability and maintainability.
2. It is important that all those involved in the lifecycle of a facility, including designers, operators, and owners, have an appreciation of the relationship between the design of a facility and planning for its eventual decommissioning. It is desirable that designers of new plants are aware of the issues, strategies and techniques involved in decommissioning. Designers should be trained in layout and access for decommissioning.
3. Inspectors could check whether design teams include, or have adequate access to, individuals with decommissioning experience.
4. Organisations should put in place arrangements to obtain advice on design for decommissioning from external sources where appropriate.
5. Most features beneficial to operations and maintenance are also beneficial to decommissioning. If features beneficial to decommissioning are inherent in the design, their decommissioning benefit should be recorded so that they can be considered in the event of any proposed modification proposals. Where such features are not inherent in the design, inspectors should consider whether their inclusion results in a design where risks are reduced to ALARP.
6. A number of good practices were identified in considering design for decommissioning:

* review of OEF and learning from good practice literature;
* Hazard and Operability (HAZOP) studies or other hazard assessments, for example by including decommissioning as a key word and the intended decommissioning sequence as a node;
* multi-disciplinary design reviews, construction and deconstruction reviews, to include members with decommissioning knowledge and experience;
* inclusion of decommissioning considerations in design optioneering, including the generation of decommissioning wastes, noting that decommissioning would be likely to be accorded lower weighting than aspects such as operability and maintainability;
* envisaging the condition of a facility at the end of its operating life and the dismantling sequence, to allow estimates of the weight and size of equipment to support decommissioning and components for removal. Provision can then be made for access points, handling routes and lifting equipment; and,
* use of computer aided design (CAD) in layout design and production of 3D models to anticipate potential dismantling issues and demonstrate adequate access for decommissioning activities. Building Information Modelling (BIM) may also be beneficial. For example, layout improvement and associated operator dose reduction can be achieved by multi-disciplinary teams reviewing layout on scale models or 3D CAD models.

## Design features to facilitate decommissioning

1. In general, reducing the complexity of decommissioning is beneficial to its safety, as well as reducing costs and timescales. Complexities in decommissioning can be reduced by the measures listed below:

* The design of civil structures should provide for long-term stability over the timescales envisaged for decommissioning to be completed.
* The design life of structures and components planned to be relied on during decommissioning, such as buildings and waste tanks, should take into account the time needed to accommodate decommissioning. Where plant and equipment will be used in decommissioning then either their planned operating life should be sufficiently long, or provision made for their renewal/replacement. The selection of materials and design of systems such as piping and ventilation to last for the required lifetime may be beneficial. The type of materials and thicknesses used in ventilation systems should provide adequate corrosion resistance for their anticipated lifetimes.
* The design of facilities should consider the feasibility of utilising existing equipment and services during decommissioning, as this can reduce waste arisings. If it is planned to use such equipment and services during decommissioning, then the potential for changes in demands on them should be considered in the design. Any potential need for modifications should be identified and if practicable provisions made in the design.
* Maximising the ability to use conventional dismantling techniques (for example through the use of removable or readily decontaminable lining materials to prevent contamination of structural materials. Specific examples include the use of stainless steel liners in wet storage facilities for spent fuel.
* Minimising the total amount and extent of radionuclides present at the start of decommissioning, as this will reduce radiation doses to workers;
* Ensuring adequate access for decommissioning activities;
* Planning for the dismantling or removal of large components;
* Utilising construction techniques that promote straightforward dismantling and demolition, noting that some modern techniques are not easily reversible;
* Ensuring the adequacy of components, systems and services required during decommissioning.

1. The following paragraphs provide information on good practices and features in design that are beneficial for future decommissioning, noting that, as stated, most of the measures are also beneficial in terms of operability and maintainability.

## Minimisation and control of activation products

1. Materials that can become activated include primary coolant fluid, corrosion products present in the reactor systems, structural components in the region of the reactor core and surrounding materials. Radionuclides arising from activation in reactors include chromium-51, manganese-54, cobalt-58 and cobalt-60, iron-59, silver-110m, and antimony-124 and 125. Cobalt-60 is a penetrating gamma emitter with a half-life of 5.3 years and presents a significant hazard during decommissioning resulting from activation of cobalt-59 in corrosion products that are transported and deposited around primary systems and in trace amounts in structural materials and hard-facing alloys such as stellite, which are used in a range of components where hard-wearing materials are necessary to meet functional requirements.
2. Design for decommissioning should address the following objectives for activation products:

* minimisation of the generation of activation products;
* control of the release of activation products;
* removal of activation products from process streams;
* prevention and minimisation of the take-up of activation products into the surfaces of pipework and other structures.

1. These objectives can be achieved by:

* material selection (in which decommissioning is only one of many factors to consider);
* control of water chemistry in the circuit of a pressurised water reactor (which is outside the scope of this TAG);
* provision of clean-up systems to remove activation and corrosion products from process streams such as filters and ion-exchange systems (where the balance of the form and quantities of radioactive wastes is outside the scope of this annex);
* surface finishing to resist surface corrosion, minimise take-up of activation products into materials and resist the build-up of crud;
* reducing the neutron flux to items that may become activated through measures such as neutron shielding or locating equipment to reduce the neutron flux to which it is exposed.

1. Designers should select materials that are:

* resistant to activation;
* resistant to degradation by chemicals and/or have sufficient wear resistance for their application to minimise the spread of activated corrosion products. It should also be noted that undesirable elements in non-structural materials such as lubricants can also be activated and/or can result in increased corrosion.

## Control of contamination

1. Historically the spread of contamination has been a significant contributor to the extent and magnitude of radioactivity present in and around facilities being decommissioned, including land and groundwater. Containment and other engineered systems should be included in the design to prevent the spread of contamination.
2. Design measures should include:

* minimising the generation and release of contamination at source (e.g. activation products in reactors);
* minimising the release of fission products from nuclear fuel (which is outside the scope of this TAG);
* equipment and processes to prevent leakage and spillage of contamination materials and provision for their detection;
* segregation of contaminated items (outside the scope of this annex as this is addressed in other TAGs);
* minimising the hold-up of contamination in pipes and other components/systems;
* ease of decontamination of equipment (e.g. provision of nozzles to allow application of decontamination agents); and
* provision of systems for clean-up of process streams, as discussed above.

1. Many of these measures are beneficial in terms of both operability and maintenance but it is useful to recognise their benefits in the context of reducing the risks to workers during decommissioning. Some control measures that prevent radiation exposures during operation such as containment, access restrictions and shielding will be removed during decommissioning.
2. Examples of measures to control contamination include:

* Provision of secondary containment for storage vessels and pipes to prevent the spread of leakage;
* Design of systems for handling and storing radioactive fluids to resist corrosion and minimise leaks, with the provision of leak detection and monitoring capabilities and isolation valves to terminate leaks;
* Automatic level monitoring and associated alarms for sumps;
* Sealing/lining of porous surfaces to prevent the ingress of radioactivity and minimise the spread of contamination, including walls and floors;
* The provision of impermeable linings (e.g. steel liner) in features such as spent fuel pools, sumps, trenches and process cells, with reinforcement measures for areas where wear and tear is expected;
* Use of leak chase systems (e.g. pipes or channels) for facilities such as spent fuel pools and reactor cavity liners to collect leakage from liner welds;
* Design and installation of expansion joints to prevent leaks and spills reaching areas beneath floors and foundations which will not be monitored for contamination;
* Sealing of concrete blocks expected to be removed for future maintenance or replacement of large components;
* Design of floor drain connections to ensure leaks and spills are collected in the floor drains’
* Minimising the use of embedded or buried pipes, tanks and other components containing radioactive fluids, as far as practicable and, if they are used, provision of features to prevent and/or detect leakage;
* Minimising 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; and
* Use of corrosion-resistant materials.

## Decontamination and Post-Operational Clean-Out (POCO)

1. POCO should be addressed in the design of facilities, in terms of considering what systems such as drainage and piping systems should be retained for the purpose of POCO, and for how long they should be retained. Where possible flushing of drainage systems should be carried out promptly using existing liquid waste treatment and purification processes. Provision of drying of systems should be considered if dismantling is to be deferred for a long period. It may be appropriate to provide fluid connections for connection of temporary hoses for decontamination during decommissioning, which can be blanked off during operation.
2. Piping systems should be designed to take account of the need to achieve effective flushing, purging and drainage to allow contaminants (and decontamination chemicals) to be removed efficiently. Designs should avoid the creation of areas where fluids will not naturally drain or sections of pipes where there is no regular flow of fluid. These measures will be of benefit with respect to future maintenance and decommissioning by reducing operator doses and facilitating dismantling. Another design measure of potential benefit is ease of system isolation (e.g. by means of valves) to allow segregation and flushing.
3. The design of facilities should provide for on-site decontamination for all foreseen operations. It is good practice to deal promptly with contamination arising from spills, leakage, and maintenance, where this is practicable.
4. There are two main objectives in undertaking decontamination in support of decommissioning. One is to reduce the risk of radiation exposure of workers and members of the public, which typically can take place before dismantling. The other is to decontaminate to reduce the category of radioactive waste and overall generation of radioactive waste and, where possible, enable recycling or re-use of materials. This may take place both before and after dismantling. Decisions on whether and when to decontaminate and the extent of decontamination undertaken need to take account of the requirement to reduce risks to ALARP (and whether BAT/BPM is being applied to reduce the activity and volume of radioactive wastes to be disposed of, as required by the relevant environment agency).
5. Decontamination may require additional facilities for the treatment of secondary wastes which should be considered as part of development of the decommissioning strategy and plan, which should start during the design phase.
6. It may be noted that chemical decontamination techniques are applied to pressurised water reactor systems during operations but typically the decontamination factors (DFs) achieved (typically a DF of 10) are lower than those achieved during decommissioning (which can achieve DFs significantly in excess of 100). Chemical decontamination during decommissioning can degrade surfaces and may increase the risk of leakage from components such as pumps.
7. Full system decontamination (FSD) techniques are used to decontaminate systems in pressurised water reactors during decommissioning, with a range of proprietary techniques available. It may be beneficial to consider FSD in the design in terms of interfaces and connections. Other aspects that should be considered include estimation of design volumes for systems to enable estimates of the amount of reagent needed and thus of storage and processing facilities, whether it is desirable to enable the bypass of some systems when decontaminating and space/layout considerations.
8. Examples of good practices for decontamination include the use of steel liners for spent fuel pools and reactor buildings and design layouts that allow sufficient space for characterisation and placement of in-situ decontamination equipment.

## Dismantling and large item removal

1. It is beneficial to make provision for space and localised ventilation points around process vessels, to simplify the logistics of size reduction and export at the end of life.
2. The design stage should include consideration of the removal of large items, which for nuclear power plants include items such as the reactor pressure vessel, steam generators and shield walls. The main options for removal of large items are either removal of intact items or in-situ dismantling and/or segmentation. Planning for future dismantling and removal should take account of radiological and industrial hazards, noting the mass of some large components can be hundreds of tonnes.
3. Where removal of intact items is planned then the design should include provision of adequate space and access (see information below on-site layout and access for decommissioning below) and ensure the adequacy of structural strength, safe working loads and working lifetimes of equipment and components used for lifting, including floor loading capacity. The design should consider the requirement for use of equipment to remove large items (and/or segments) and the space and services needed.
4. Designers of nuclear power plants should consider the incorporation of features to provide access/egress routes for removal of large items such as steam generators through special equipment hatches (e.g. in the side or roof of a reactor containment building) or through the use of a heavy lift crane operating through a hole in the concrete containment dome. There is now extensive experience of successful replacement of steam generators during operation of nuclear power plants and the same processes can be used during decommissioning. The polar crane can be designed to have the load capacity to lift the steam generators, in conjunction with a temporary lifting trolley, to allow removal from the reactor building. The available experience should be reviewed to inform the design of new nuclear power plants.
5. Removal of large items intact has been carried out in the UK, which facilitates options for the management of radioactive waste. Boilers and other large items have been exported for smelting, with recovery of the small amount of radioactive waste and recycling of most of the metal. In other countries intact steam generators have been stored to allow radioactive decay whilst awaiting the availability of waste disposal routes.
6. The design of facilities should consider the expected sequence for dismantling. The use of modular construction techniques may facilitate decommissioning, decontamination and lifting operations and some components may be designed for removal as intact items. Some items may only have parts that are contaminated or activated, and the design should facilitate separation of contaminated or activated parts from non-contaminated or non-activated components. The use of skid-mounted components, such as piping and valve modules, may provide flexibility to update systems during the operational phase whilst also facilitating decommissioning.
7. Segmentation of large items may be necessary where requirements to maintain shielding or containment make it difficult to provide access for removal of intact items. Experience indicates significant difficulties in segmenting large items in confined spaces. There should be consideration of inclusion of design features to facilitate future segmentation. There are similar considerations in terms of space and access for removal of segments as for intact components.
8. Where segmentation or other operations require operations in high dose rate or contaminated areas then consideration should be given to provision for use of remote handling techniques. The use of remotely operated equipment should be planned for in the design where this is envisaged, including the provision of adequate space and services.
9. There is experience of remote cutting underwater to segment highly activated components from pressurised water reactors such as the reactor pressure vessel and reactor vessel internals. Such operations have been carried out in flooded refuelling cavities or the reactor pit and may require the sealing of penetrations and surfaces. The design should consider the use of such areas for underwater segmentation.
10. The removal of shield walls in nuclear reactors generally involves segmentation to enable dismantling and the design of the biological shield should facilitate its future dismantling. The use of modular, prefabricated concrete blocks for shielding should be considered but safety considerations may necessitate massive, non-modular shield walls. It may be possible to identify those walls which do not affect structural integrity and are not required to protect highly classified safety systems, and which could be removed to facilitate removal of large plant items.
11. As noted above, designs should limit the use of embedded pipes and other components. The design should consider provision to allow removal of components without the need for cutting, such as routing embedded pipes through sleeves that will allow them to be removed intact. The generation of waste should be considered during dismantling and structural segmentation including the optimum size of waste components and the sizes of the packages that are suitable for the wastes. The size of waste packages is an important consideration in decommissioning as it can have a significant influence on the extent of dismantling required and thus on the overall risks of decommissioning. Consideration at the design stage should be of benefit in deciding what facilities are needed to manage wastes, including ease of removal.

## Site layout and access for decommissioning

1. The site layout should make provision for decommissioning. Where it is planned that new or additional facilities will be required to support decommissioning, such as new waste management facilities, the site layout should identify where these will be placed.
2. The plant layout should ensure control of contamination to facilitate decommissioning and minimising the generation of radioactive waste through the segregation of radioactive and non-radioactive facilities, for example the designation of “nuclear islands”.
3. During decommissioning space may be needed for the laydown or dismantling of large items, temporary storage and/or to transport items across the site, which should be considered in the design and site layout. Safe access for decommissioning should be considered in the sizing and layout of building entrances, buildings and roadways.
4. The routes for movements of packages of waste and spent fuel should be considered in site layout and design, taking account of the need for adequate ground strength where there may be underground services and structures.
5. Provisions should be made for safe ease of access for dismantling. Access to components should be considered, for example by means such as incorporation of hatches and large doors and may also include permanently installed ladders and walkways. Adequate space and access should be provided for survey, sampling and waste characterisation in support of decommissioning.
6. A number of factors can affect access to areas for either personnel or equipment, including physical space, entrances and exits for access/egress, radiation dose rates and non-nuclear hazards such as asphyxiants and confined spaces.
7. Where equipment or services are expected to be installed to support decommissioning, such as decontamination and waste-handling equipment then adequate access should be considered in the design.
8. Locations for installing cranes need to be suitable, including consideration of ground strength and/or protection of underground services.
9. Consideration should be given in design layouts to minimising the hazards of dismantling ventilation ducts that are potentially contaminated. Volume reduction of segments of large, contaminated ducts may be difficult to achieve without spreading contamination, particularly if duct routes are long and complex.

## Waste management

1. The guidance in NS-TAST-GD-024 [2] is applicable to the management of wastes arising from decommissioning. The information presented here is of specific relevance to design for decommissioning. The needs of decommissioning should be taken account of in downstream waste management facilities, where this is necessary.
2. The mixing of waste streams should be minimised as far as practicable through design. Facility design should facilitate the segregation of wastes during both operation and decommissioning. Examples of measures to achieve this include avoidance of the use of hazardous materials that can become activated or contaminated, segregating drains on the basis of potential activity levels in liquids, provision of barriers and partitions where different materials and activity levels are in proximity, minimising the use of lubricating oils where they can be contaminated, avoiding incompatible composite structures (e.g. lead in steel boxes) and limiting the use of embedded components, as discussed above. For example, pumps can become internally contaminated where there are integral motors and exposed controls. Separation of drive units and controls from process streams through use of equipment housings, separate lubrication modules and sealed bearings should be considered.
3. The ability to characterise waste adequately should be considered in the design. Consideration should be given to the installation of “test coupons” or other samples that are representative of materials of components and structures and the environment to which they are subject, so they can be characterised in support of decommissioning.
4. The design of nuclear power plants should enable the sampling of concrete, steel and other structures surrounding the reactor internals which may become activated and/or contaminated.
5. If the decommissioning strategy and plan envisages in-situ disposal of below ground structures and features, including pipes and tanks the design should enable adequate characterisation of what will remain in-situ. On-site and in-situ disposals of radioactive waste must be permitted by the relevant environment agency

# Appendix 2: Transition into decommissioning

1. This appendix is intended to apply primarily to reactor sites undergoing the transition from operations into decommissioning. It captures ONR’s experience of engagement with licensees during the transition to decommissioning, based on regulating Magnox sites and Calder Hall. It considers changes to the licensee’s safety case, emergency plan and organisational structure, and provides advice on engagement in each area. This guidance does not replace ONR’s technical inspection and assessment guides but offers suggestions on the interpretation of that guidance during the transition to decommissioning.
2. Ending operations with the completion of defueling and removal of fuel from site marks a significant risk reduction. As a result, licensees are likely to seek to reduce the controls they have in place. This may require ONR to permission certain activities or undertake additional inspection.
3. Parts of the guidance will be applicable to sites where the focus is not (or historically has not been) on operating reactors, but which have reactors as part of the site (for example, Sellafield, Harwell, Raynesway). On sites where the reactor is not necessarily the most significant hazard, removal of the reactor fuel from the site will not necessarily allow some of the relaxations in control discussed in this appendix.
4. Engagement with the licensee should start as early as possible, and certainly before defueling has started. Some features of the defueling process may be claimed as evidence during fuel-free verification and any issues with these features need to be identified up-front so that late changes do not affect the verification process.
5. The transition into decommissioning will influence both the safety and the security of the site. The relevant ONR inspectors will ensure co-ordination across all ONR purposes to avoid contradictory drivers, and the best advice can be provided to the licensee.
6. Magnox Ltd and EDF NGL have fleets of reactors which have been, or will go through, the transition into decommissioning. It may be prudent to carry out a greater level of inspection and assessment during the first transition of the fleet, to be able to use this as a baseline for subsequent transitions. If there is confidence in the first transition, and if the licensee can demonstrate that subsequent transitions are similar in nature, then less inspection and assessment may be required for the later transitions. This advice also applies to any parts of a site that transition into decommissioning before, or during, defueling. The licensee should be encouraged to learn lessons from previous experience.

## Post-defueling safety case

1. NS-TAST-GD-051 states ONR’s expectation that safety cases are kept up to date during each stage of a facility life cycle [2]. Upon completion of defueling, and removal of the principal hazard on the site, the licensee will therefore require a revised, post-defueling safety case.
2. The purpose of a safety case is to provide the licensee with the information required to enable safe management of the facility or activity in question. Historically, the consequences of non-fuel faults may have been assessed with a high degree of conservatism, since even with conservatism they remain bounded by fuel faults. Licensees should therefore ensure when developing the post-defueling safety cases that the faults that remain are dealt with in a proportionate and consistent manner. The assessment of faults may recognise a reduction in potential consequences to the public, however more ‘hands-on' activities may introduce the potential for worker exposure. The licensee’s safety case arrangements should adequately reflect the changing hazard and risk profile during this stage in the lifecycle...
3. The licensee may adopt one of two approaches to its post-defueling safety case:

* Re-write the existing defueling safety case to remove fuel-related faults; or
* Write an entirely new safety case to justify decommissioning operations.

1. In line with ONR arrangements, a permissioning and inspection strategy should be developed which is proportionate to the changes being implemented. Consideration should be given to what (if any) new activities are being introduced, complexity of the changes to be implemented, and the adequacy of the Licensee’s safety case arrangements given the change in hazard and risk profile. For example, if no new activities are being introduced at this stage, formal permissioning may not be appropriate. However, it may be appropriate to carry out an inspection against LC 14 to ensure that the licensee has followed an appropriate process in constructing and approving its case. That process should require the licensee to consider experience from other sites where appropriate, particularly those that have already been through a similar transition.
2. In principle the licensee may choose to justify some of its future decommissioning projects in a single safety case. In this case, there would likely be activities we would seek to permission, with regulatory engagement in accordance with an enabling approach.
3. Licensees have historically chosen not to write a safety case for decommissioning operations, preferring instead to write a re-baselined safety case for a semi-quiescent state which can then be modified under existing arrangements as decommissioning projects are proposed.

### Revised safety cases and periodic reviews of safety

1. The timing of periodic reviews of safety needs to be reviewed, taking into account the production of the post-defueling safety cases. ONR recognises that production of a revised safety case following defueling may, provided it contains the appropriate elements of review, fulfil the requirements of the site’s PSR submission. In this case, the next PSR would not be required until ten years after the adoption of the revised safety case.
2. The revised safety case must either satisfy the requirements for PSR or must be accompanied by a review of matters not specifically addressed within the new safety case. This is required regardless of whether the ten years have elapsed since the previous PSR. In practice licensees have chosen to produce a separate PSR submission, demonstrating how the requirements of PSR are met through the combination of revised safety case and review. This has been driven by the licensee’s own processes, however, it is not an expectation of ONR.
3. Likewise, if defueling is predicted to complete within a few years after a planned ten-year review period, then ONR should consider, in consultation with the licensee, whether a review at ten years remains appropriate; it may be acceptable to delay the PSR so that it can be carried out in conjunction with development of the revised safety case. More guidance is provided in NS-TAST-GD-050 [2].

### Operating rule withdrawals

1. ONR expects licensees to identify and implement all the conditions and limits necessary for the safety of their facilities, and to classify these accordingly. While defueling a reactor will remove a significant proportion of the site’s hazard potential, in this period a significant number of the operational conditions and limits will no longer be applicable and will likely be removed via LC22 arrangements. Operating rules will still be required for the remaining hazards but these would be expected to be appropriately graded in line with their safety function. The licensee’s LC23 arrangements need to be suitable and sufficient for the prevailing risks and hazards at the site. This allows all necessary operating rules to be identified in the safety case and implemented.
2. Following shutdown, the licensee may seek to remove certain operating rules. In the past, some licensees have waited until defueling is complete to do so, as the argument becomes trivial. However, more recently some licensees have chosen to make the argument that certain operating rules are no longer necessary while defueling is in progress.
3. Removing some of the highest tier operating rules early can bring benefit to the licensee, as it reduces the administrative and maintenance burden associated with those rules. However, that reduction may outweigh the effort required to make an adequate justification.
4. Should licensees wish to remove certain operating rules, inspectors are reminded that ONR does not normally approve operating rules and as such any change to the operating rules should be managed through the licensee’s LC22 arrangements. Further guidance is available in NS-TAST-GD-035 [2]

## Maintenance schedule revisions

1. The maintenance schedule should be revised in light of the revised safety case. The licensee should already have a process in place to make such revisions, and the transition to decommissioning should not introduce any unusual challenges other than the volume of work required. An LC 28 compliance inspection may be carried out using the maintenance schedule changes as an example. Any inspection should be targeted and proportionate, taking into account the adequacy of the licensee’s process, noting that it is not normally be necessary to carry out an additional inspection as a result of the changes to the maintenance schedule.

## Operating instructions

1. Likewise, operating instructions will require amendment to reflect both the revised safety case and the revised maintenance schedule. The licensee should have in place a process for these revisions. The licensee should track the progress of operating instruction updates and should ensure that safety-significant updates are complete prior to the transition. Unless there is doubt over the adequacy of that process, detailed inspection should not be necessary.

## Fuel-free verification

1. ONR views the declaration that the site is fuel free as a key piece of evidence supporting the transition of the site to a defueled safety case. It is not a regulatory requirement in its own right. Because of this it is not strictly necessary to demonstrate all fuel has been removed; if fuel remains, or if there is some uncertainty, the licensee may be able to demonstrate that this will not have a significant effect on the safety case and subsequent changes.
2. However, removal of fuel from the site is likely to change the site’s security classification. Fuel free verification will be a key piece of evidence allowing this. Demonstrating the absence of fuel is of greater importance in relation to security, as (depending on the fuel’s accessibility) if even a small amount of fuel remains it may not be possible to reclassify the site. It is usually the case that fuel free verification inspections will be undertaken by the nuclear safety inspector, however the nuclear safety inspector should discuss this with the nuclear security inspector to ensure that the inspection will satisfy their requirements. In particular, if fuel is found or suspected, the nuclear safety inspector should consult with the CNS security specialist inspector to develop a way forward.
3. The key principle in fuel free verification is defence in depth. As well as defueling and fuel movement records, independent physical inspections should be carried out to confirm the absence of fuel. These inspections can include (local or remote) visual inspection, radiological surveys, and physical checks (e.g. dip checks of reactor standpipes). These inspections should be carried out by a team independent from the defueling operation SFAIRP and should be supported by record keeping that should positively record the absence of fuel.
4. In practice, verification of the reactor has proved straightforward. Good defueling records are kept, and it is relatively simple to provide direct visual evidence of fuel channels using a camera. Verification of ponds and ancillary areas is more complicated and relies on a combination of physical checks and radiation surveys, particularly in ponds where visibility may be poor.
5. There will be areas where the licensee is unable to carry out an independent inspection, or where it would not be ALARP to do so. In such cases, the licensee should construct an argument that fuel is unlikely to be present. The argument should consider:

* Why it is unlikely that fuel is present.
* Why is it not ALARP to confirm this.
* What the effect on the safety case would be if fuel was in fact present.

1. Any such argument should be discussed with a security specialist inspector for the site. If inspection is not practicable it is likely that the fuel is in an inaccessible area, but CNSS will need to make a judgement on this.

## Post-defueling emergency plan

1. It has been established on a number of Magnox sites and via the Nuclear Emergency Arrangements Forum that, in principle, removal of fuel from the site allows a reduction in the emergency scheme. In particular, the need for urgent response is reduced and the reliance on district fire and rescue services is increased.
2. Licensees will therefore expect to be able to make similar changes to their emergency arrangements once defueling is complete. However, the fact that such changes have been made on one site is not in itself a justification for making those same changes on a different site. The licensee must demonstrate that it is appropriate to make those changes. ONR’s expectation is that the licensee should identify the types of possible incidents on the site and a strategy for dealing with them. Further guidance is available in NS-INSP-GD-011 [6].
3. The licensee’s emergency response is expected to be based on a range of potential accidents. This can be a particular issue on sites moving into decommissioning, as they tend to place greater reliance on contingency arrangements (with emergency responders on call, rather than being present 24/7). The licensee should be able to satisfy itself and ONR that those arrangements will allow for mobilisation of sufficient resources if theoretically required. However, the licensee has not historically been required to demonstrate that aspect of the arrangements in practice for approval to be given.
4. Greater reliance on contingency arrangements often means that responders will adopt their posts with less information available to them than they are used to. Licensees should ensure that all responders have had the opportunity to practice their roles under the revised arrangements, even where those roles have on the face of it not changed. Likewise, a reduction in the on-site capability may mean that responders cannot respond to events in the way they are used to, instead relying on being placed on the local fire and rescue services for casualty rescue, for example. The licensee should take care to ensure that this is understood throughout the response organisation, and inspectors are advised to ensure that this understanding is demonstrated as part of an emergency exercise.
5. A particular instance of this issue is dose control during an emergency. Responders may be used to accepting a certain level of dose in order to carry out early intervention to halt the progression of a fault with off-site consequences. If there is limited potential for off-site consequences in a particular scenario, the licensee will need to consider whether it is appropriate for responders to receive an elevated dose.
6. It should be recognised that any changes to the emergency arrangements will also affect the licensee’s ability to respond to a security event. There are specific requirements for timely response to security events, and it should not be assumed that an adequate safety response will translate into an adequate security response. Changes to the emergency plan should therefore not be approved without discussion with the relevant CNSS specialist inspector for the site.

### Demonstration of revised arrangements

1. The revised arrangements should be demonstrated to ONR prior to adoption. The demonstration should test the new parts of arrangements at their weakest point. The accident scenario should be the most challenging to the new parts of the arrangements. This may mean that the incident is predominantly industrial (for example, a fire or other fast-progressing fault).
2. In practice this is likely to mean that the exercise should be held out-of-hours, to test the call-in arrangements and the decision making of the initial responders. Once all responders have arrived on site, it is likely that the emergency organisation will not look significantly different from the pre-defueling case.
3. It should be remembered that the demonstration exercise is not a Level 1 exercise, although it is likely to be organised and run in a similar manner. In particular, the demonstration exercise is designed to test whether the licensee’s proposals are credible. At the time of the exercise, training and familiarisation may not be complete, and some infrastructure may require to be simulated. Those aspects would be expected to be in place for the subsequent year’s Level 1 exercise.
4. Furthermore, it is likely that the demonstration exercise will be shorter than a Level 1. The Level 1 exercise will normally test aspects of planning for the recovery phase. However, that planning will likely be done with a full emergency control centre, once all contingency staff have arrived on site. At that point, the new arrangements are likely to be effectively the same as the old arrangements and it may actually be appropriate to end the demonstration once the emergency controller has taken over. Effectively, once the site has reached a point it has previously demonstrated it can recover from, the demonstration can be seen as successful.

## Management of organisational change

1. Changes to the safety case and emergency plan are likely to reduce the number of people required to safely operate the site. This is an important change, as if cuts are too extreme the licensee is unlikely to be able to quickly recover lost staff. If it is the first time that the licensee has moved from an operational to a decommissioning organisation, it is recommended that a specialist inspector from the LMfS specialism be consulted.
2. If the licensee already operates decommissioning sites, then it is likely to have a better understanding of the organisational requirements. In such cases, the licensee can reasonably expect to be able to adopt a similar organisational structure, provided it can demonstrate that the site itself is similar. In particular, the licensee should be able to demonstrate through the safety case for the site that there are no additional hazards that require active management, and therefore additional staff.
3. It should be recognised that the reduction in staff has security implications, and that the nature of the security response may change. Therefore, the site’s CNSS specialist inspector should be consulted.
4. It should be recognised that, throughout the transition into decommissioning, the forthcoming organisational change (and the associated job losses) will be weighing significantly on the minds of the staff. Sensitivity is needed in interacting with staff during the transition process.

## Training and authorisation

1. Training will be required in the new safety case and security and emergency arrangements, in addition to training that is required for individuals adopting new roles.
2. New authorisations are likely to be required for DAPs. Licensees may choose to reauthorise all DAPs, or to carry over authorisations if it can be demonstrated that the existing authorisation is still appropriate.
3. Not all training will be required to be completed before the transition date. The licensee should have a means of prioritizing training with respect to safety significance, and of ensuring that training essential to safety is completed before the transition date.
4. Inspectors should confirm that:

* Training required for staff adopting new roles has been identified.
* Training in the revised safety case and emergency arrangements has been identified for staff in safety related roles.
* A plan is place to ensure that all training, or at least all safety-significant training, will be delivered prior to reorganisation.
* The transition quality plan has a hold point on completion of training.

## Management system update

1. The licensee will need to update its management system following the transition. It is likely that the areas of most significance will be inspected as part of the change to safety case, operating instructions, and emergency arrangements. Therefore, detailed examination of the management system update is unlikely to be warranted. What is important is that the licensee has a robust process that prioritises and tracks progress with changes and ensures that those significant to safety are completed before the transition date.

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   * NS-TAST-GD-009- Examination, Inspection, Maintenance and Testing ofn Items Important to Safety
   * NS-TAST-GD-013 - External Hazards
   * NS-TAST-GD-017 - Civil engineering
   * 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
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   * 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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   * NS-INSP-GD-007 - Licence Condition 7: Incidents on the site
   * NS-INSP-GD-011 - Licence Condition 11: On-site emergency arrangements
   * NS-INSP-GD-017 - Licence Condition 17: Management Systems
   * NS-INSP-GD-035 - Licence Condition 35: Decommissioning
   * NS-INSP-GD-061 - Guidance to support the joint regulatory memorandum of understanding between ONR and EA on matters of mutual interest in England
   * NS-INSP-GD-062 - Guidance to support the joint regulatory memorandum of understanding between ONR and SEPA on matters of mutual interest in Scotland
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