Office for Nuclear Regulation

ONR GUIDE			
CIVIL ENGINEERING - POST OPERATION			
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LIST OF ABBREVIATIONS

ACI	American Concrete Institute
BS	British Standards
BS EN	Eurocode Standards
C&M	Care and maintenance
EIMT	Examination, Inspection, Maintenance and Testing
HSE	Health & Safety Executive
IAEA	International Atomic Energy Agency
LC	Licence Condition
ONR	Office for Nuclear Regulation
OPEX	operational experience
POCO	Post Operational Clean Out
SAP(s)	Safety Assessment Principle(s)
SQEP	Suitably qualified and experienced personnel
SSC(s)	structure(s), system(s) and component(s)
TAG(s) #	Technical Assessment Guide(s) reference # (ONR internal guidance documents)
UK	United Kingdom
WENRA	Western European Nuclear Regulators' Association
WGWD	Working Group on Waste and Decommissioning

GLOSSARY

Term	Description	Source
Ageing	General process in which characteristics of a structure, system or component gradually change with time or use.	WENRA Decommissioning Safety Reference Levels (DSRL)
Ageing Management	Engineering, operations and maintenance actions to control within acceptable limits the ageing degradation of structures, systems or components.	WENRA DSRL
Care and Maintenance	A phase within the decommissioning stage of a facility, for which the deferral of further decommissioning has been substantiated, and for which safety is maintained by passively safe means and an appropriate examination, inspection, maintenance and testing programme.	For this purpose of this document only
Construction	"construction work" means the carrying out of any building, civil engineering or engineering construction work and includes— (a) the construction, alteration, conversion, fitting out, commissioning, renovation, repair, upkeep, redecoration or other maintenance (including cleaning which involves the use of water or an abrasive at high pressure, or the use of corrosive or toxic substances), de-commissioning, demolition or dismantling of a structure; (b) the preparation for an intended structure, including site clearance, exploration, investigation (but not site survey) and excavation (but not pre-construction archaeological investigations), and the clearance or preparation of the site or structure for use or occupation at its conclusion; (c) the assembly on site of prefabricated elements to form a structure or the disassembly on site of the prefabricated elements which, immediately before such disassembly, formed a structure; (d) the 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; (e) the installation, commissioning, maintenance, repair or removal of mechanical, electrical, gas, compressed air, hydraulic, telecommunications, computer or similar services which are normally fixed within or to a structure, but does not include the exploration for, or extraction of, mineral resources, or preparatory activities carried out at a place where such exploration or extraction is carried out	CDM2015
	The activities related to installation or building, modifying, testing, remediating, repairing, renovating, repurposing, alteration, refurbishment, replacement, maintaining, decommissioning, decontamination, dismantling or demolishing a civil engineering structure, system or component. 'Construction' can happen at any stage in the lifecycle of the site, including earthworks, site preparation, enabling works, ground investigations, geotechnical or ground engineering, foundations and superstructure construction works, mock-ups and trials, and temporary works to support the same. Construction may also include civil engineering works associated with examination, inspection, testing and maintenance.	For the purposes of this TAG and the associated annexes
Containment / Confinement	IAEA guidance refer to confinement (rather than containment) of nuclear material. IAEA define the containment as the physical structure that confines the nuclear material. Methods or physical structures designed to prevent the dispersion of radioactive material	IAEA Safety Glossary
Contractors	All references to 'contractors' include proportionate consideration of the whole contracting and supply chain, whether for the provision of goods and services to the licensee or on the licensed site. This includes designers, vendors, suppliers, manufacturers etc. as appropriate.	SAPs definition

Decommissioning	Administrative and physical actions taken to allow removal of some or all of the regulatory controls from a nuclear facility.	SAPs definition:
Decommissioning	Decommissioning is the set of actions taken at the end of a nuclear facility's operational life to take it permanently out of service, with adequate regard for safety. The ultimate aim of decommissioning is to make the site available for other purposes.	derived
	Administrative and technical actions taken to allow the removal of some or all of the regulatory controls from a facility. The use of the term decommissioning implies that no further use of the facility (or part thereof) for its existing purpose is foreseen. Decommissioning actions are taken at the end of the operating lifetime of a facility to retire it from service, with due regard for the health and safety of workers and members of the public and the protection of the environment. For a repository, the corresponding term is closure.	IAEA Safety Glossary
Decommissioning Plan	An initial or final document – depending on the operational phase of the facility with detailed information about the concept and schedule for the decommissioning and dismantling of the nuclear facility.	WENRA DSRL
Decommissioning Plan	A document containing detailed information on the proposed decommissioning of a facility.	IAEA Safety Glossary
	The Decommissioning Plan shall be supported by an appropriate safety assessment covering the planned decommissioning activities and abnormal events that may occur during decommissioning. The assessment shall address occupational exposures and potential releases of radioactive substances, with resulting exposure of the public.	IAEA WS-R-5
Decommissioning Strategy	A document providing an overview of the approach to the decommissioning of a site (or a group of similar sites) encompassing all existing and proposed new facilities, setting down the overall decommissioning objectives as far as the assumed end-state, taking account of relevant factors, and integrated with other relevant strategies.	SAPs definition
Decontamination	The complete or partial removal of contamination by a deliberate physical, chemical or biological process.	WENRA DSRL
Demolition	Removal of the buildings, structures and plant and disposal of the arising materials.	For this document only
Design	The definition of design for this civil engineering annex applies equally across all stages of a nuclear facility's lifecycle, including generic and/or concept design, licensing, site identification, site specific design, construction and installation, operation, modifications, post-operation, decommissioning and demolition, 'care and maintenance' phase etc. 'Design' can also include, the safety case documentation, supporting references, justification and substantiation of claims, modelling or other analysis tools, the process(es) and records of design decision making, and independent reviews of the above. It should be recognised, within the life cycle of 'civil engineering works', that the assumptions made by the designer and incorporated within the justification of the design within a safety case, must be properly carried through the construction stage and through to modifications, demolition and site clearance. All associated construction activities throughout the life cycle are much a part of the safety case as the design.	For this purpose of this document only
	"design" includes drawings, design details, specifications and bills of quantities (including specification of articles or substances) relating to a structure, and calculations prepared for the purpose of a design;	CDM2015
Design Life	The period of time during which a facility or component is expected to perform according to the technical specifications to which it was produced.	IAEA Safety Glossary
Design intent	The fundamental criteria and characteristics (including reliability levels) that need to be realised in a facility, plant or SSC in order that it achieves its operational and safety functional requirements.	SAPs definition

Dutyholder	For the purpose of this annex, the dutyholder is any organisation or person that holds duties under legislation that ONR regulates. 'Dutyholder' includes Licensees, Requesting Parties, Potential Future Licensees, Operational Licence Dutyholders, Decommissioning Site Licensees, New Build Site Licensees, budget holders, vendors and supply chain members.	For this purpose of this document only
End state	A predetermined criterion defining the point at which the specific task or process is to be considered completed. The licensee can apply for termination of the license when the proposed end-state of decommissioning activities has been reached.	WENRA DSRL
Management system	A set of interrelated or interacting elements (system) for establishing policies and objectives and enabling the objectives to be achieved in an efficient and effective manner. The management system integrates all elements of an organization into one coherent system to enable all of the organization's objectives to be achieved. These elements include the organizational structure, resources and processes. Personnel, equipment and organizational culture as well as the documented policies and processes are parts of the management system. The organization's processes have to address the totality of the requirements on the organization as established in, for example, IAEA safety standards and other international codes and standards.	WENRA DSRL
Nuclear Facility	A facility and its associated land, buildings and equipment in which nuclear materials are produced, processed, used, handled, stored or disposed of on such a scale that consideration of safety is required.	WENRA DSRL
Nuclear Safety	The achievement of proper operating conditions, prevention of accidents or mitigation of accident consequences, resulting in protection of workers the public and the environment from undue radiation hazards	WENRA DSRL
Operation	All activities performed to achieve the purpose for which an authorized facility was constructed.	WENRA DSRL
Risk	The chance that someone or something is adversely affected in a particular manner by a hazard (R2P2).	SAPs definition
Safety Case	A collection of arguments and evidence in support of the safety of a facility or activity. This will normally include the findings of a safety assessment and a statement of confidence in these findings. SAPs definition: 'safety case' refers to the totality of a licensee's (or dutyholder's) documentation to demonstrate safety, and any sub-set of this documentation that is submitted to ONR. Note: Licence Condition 1 defines 'safety case' as the document or documents produced by the licensee in accordance with Licence Condition 14.	WENRA DSRL
Safety function	A specific purpose that must be accomplished for safety	IAEA Safety Glossary
Structure	"structure" means— (a) any building, timber, masonry, metal or reinforced concrete structure, railway line or siding, tramway line, dock, harbour, inland navigation, tunnel, shaft, bridge, viaduct, waterworks, reservoir, pipe or pipeline, cable, aqueduct, sewer, sewage works, gasholder, road, airfield, sea defence works, river works, drainage works, earthworks, lagoon, dam, wall, caisson, mast, tower, pylon, underground tank, earth retaining structure or structure designed to preserve or alter any natural feature and fixed plant; (b) any structure similar to anything specified in paragraph (a); (c) any formwork, falsework, scaffold or other structure designed or used to provide support or means of access during construction work, and any reference to a structure includes part of a structure;	CDM2015
Structures Systems and Components (SSCs)	A general term encompassing all of the elements (items) of a facility or activity which contribute to protection and safety, except human factors. - Structures are the passive elements: buildings, vessels, shielding, etc. - A system comprises several components, assembled in such a way as to perform a specific (active) function. - A component is a discrete element of a system.	WENRA DSRL

1. INTRODUCTION

1. This annex to Technical Assessment Guide 17 (TAG 17) provides guidance on the main aspects of ONR's approach to the assessment of the post operational phase of nuclear facilities. It includes general guidance and advice to ONR inspectors on aspects of post operational management and related assurance. This TAG is not intended to provide detailed guidance on any decommissioning or demolition processes: its main purpose is to highlight certain salient areas for inspectors to consider as part of their regulatory assessment. It aims to highlight the application of the Safety Assessment Principles (SAPs) [1] to aid the assessment of civil engineering works and structures (see Appendix 1 of TAG 17), for activities in the phases that occur after ceasing operation.

1.1 Scope

2. The post operational phases considered herein include:

- inactive quiescent storage,
- post operational clean out (POCO),
- decommissioning,
- care and maintenance (C&M),
- demolition,
- site remediation,
- delicencing.

3. The timing of demolition of the civil engineering structures, systems and components (SSCs) on sites varies as decommissioning and clear-out processes are progressed. These phases of post operation are rarely site-wide, so an area, section or structure can be considered as 'post operation', when surrounding SSCs are still 'operational'.

4. Residual nuclear safety functions may be required of civil engineering SSCs once the site has ceased operation. These demands are likely to extend well beyond the originally envisaged design life of the civil engineering SSCs. These residual nuclear safety functions usually include structural support to, and protection, containment and shielding of, nuclear inventory, including contaminated or activated components.

5. When nuclear safety functions are no longer applicable, civil engineering SSCs may still be required to provide residual security, environmental or conventional safety functions, such as a weatherproof envelope, confining hazardous substances such as asbestos or other waste materials, or providing support for security equipment.

1.2 Structure of this annex

6. This TAG annex identifies key civil engineering assessment principles and should be read alongside the general guidance of ONR-NS-TAST-GD-026 'Decommissioning'. This TAG annex is structured in the following order:

- Section 2 outlines the general activities to consider for post-operation,
- Section 3 explains the expected content of a decommissioning plan,
- Section 4 describes the phases of post-operation,
- Section 5 expands on guidance relevant to civil engineering assessment,
- Section 6 contains the references for this document.

1.3 Applicable SAPs to this annex

7. The following SAPs are particularly relevant for this annex:

- ECE.6 and EHA.18 states the expectation for loadings to be appropriately considered e.g. for the intended use of structures, or extension of operations
- ECE.9 and EHA.12 consider the flooding hazard e.g. climate change predictions for long term e.g. for the longer durations of the Care and Maintenance phase,
- ECE.17, EMT.6 and ECE.20 establishes the expectation that provision should be made for maintenance for the anticipated lifetime of the structure and considered during changes
- ECE.26 and DC.1 state the design should facilitate decommissioning and dismantling
- ECS.1 refers to adequate categorisation and classification of SSCs and how this can change during decommissioning
- EHA.7 states the expectations of consideration of cliff edge effects
- DC.3 states an expectation that if you can't operate a site safely then the unsafe part of the site should be decommissioned
- DC.4 outlines the content of a Decommissioning Plan
- DC.5 and RL.2 states the expectation for there to be updates to decommissioning strategies and plans, to include identification and remediation of any contaminated land, to ensure the site is passively safe before entering the care and maintenance phase
- DC.6 requires adequate arrangements to be implemented for the acquisition, retention and storage of relevant information and records
- DC.9 sets out the expectations for an adequate decommissioning safety case
- EAD.2 states the expectations that there are adequate margins for the whole life of the facility
- EMC.11 failure models should be gradual and predictable.
- ENM.4 relates to 'corporate memory' and relates to record keeping
- MS.2, EHF.8, DC.7 and DC.8 explain the expectations that the organisation will consider retention of information during handover between lifecycle phases with sufficient resource to undertake activities
- RL.1, RL.2, RL.4, RL.6 and RL.8 state the expectations around radioactively contaminated land management where civil engineering input may be required.
- RW.6 states the expectation that hazards will be removed systematically and progressively to achieve passive safety
- SC.1 refers to decisions made regarding assessment and categorisation (SC.1) of decommissioning activities and the impact on safety
- SC.8 states the expectation that the dutyholder maintains responsibility for safety

8. Inspectors should also be cognisant of the broad intent of the SAPs; namely that it is not the level of conservatism assigned to one element of the civil engineering analysis and maintenance process, but the (overall) level of conservatism, applied to the substantiation and justification process and the structure as a whole.

9. Particularly key to decommissioning are the WENRA Decommissioning Safety Reference Levels [2], which are identified in Appendix 1 table at the end of this annex. These Decommissioning Safety Reference Levels all begin with the reference 'DE' and are referenced within this document where they are relevant.

1.4 Exclusions

10. Disposal of radiological waste, including a geological disposal facility, is outside the scope of this annex.

11. Structural integrity, impact protection and a weatherproof envelope are potential civil engineering nuclear safety functions for nuclear waste stores or buildings that are present on a site still performing safety functions post operation. The assessment of civil engineering on sites where operation has ceased is heavily linked to the examination, inspection, maintenance and testing (EIMT) where a safety functional requirement (SFR) is still placed on a structure. When considering condition assessments for modification to existing structures, see:

    - TAG 17 Annex 5, 'Civil Engineering – Ageing Management and Damaged Structures'

2. POST OPERATION OVERALL CONSIDERATIONS

12. Safety functions must be maintained after the site has cease operation to ensure the ongoing safety of the facility. The Inspector may wish to consider the risk of foreclosure, that safe options for future demolition are not limited un-necessarily by lack of maintenance.

2.1 Decommissioning Strategy

13. Each dutyholder is expected to develop an overall site decommissioning strategy. Each licensed site is expected to have a specific decommissioning plan (see Section 79) which addresses the what, when and how of the post operation phases.

14. SAP DC.2 establishes the expectation for decommissioning strategies, including the intent that the site will be passively safe before entering the care and maintenance phase in line with the expectation of DC.5. Passive in this context is not intended to be interpreted as not requiring ongoing examination, inspection, maintenance and testing (EIMT) throughout the care and maintenance period.

15. WENRA Decommissioning Safety Reference Levels [2] DE-17 and DE-18 describe the decommissioning strategy and the relevant aspects to document, including overall timescales for the decommissioning of the facility and the end state after completion of all decommissioning activities. These also provide explanation of the preferred options and the expectation for a rigorous justification if the selected option does not involve immediate dismantling.

16. Within the United Kingdom, decommissioning is often carried out in a sequence of operations separated by one or more periods of time i.e. phased decommissioning. For more information, see:

    - paragraph 5.12 of IAEA Safety Standard SSG-47 'Decommissioning of Nuclear Power Plants, Research Reactors and other Nuclear Fuel Cycle Facilities' [3].

17. A site can employ different strategies for individual civil engineering SSCs, with some structures that can be decommissioned and dismantled without delay, some that need to remain in place as a 'safe store' for the Care and Maintenance Phase. The Inspector may wish to seek assurance in the adequacy of decision-making processes associated with ALARP considerations, when the dutyholder is choosing the decommissioning strategy of their civil engineering SSCs.

2.2 Decommissioning Plans

18. SAP DC.4 establishes the expectation that there will be a decommissioning plan, and SAP DC.5 establishes the expectation that the site is passively safe before entering the care and maintenance phase.

19. WENRA Decommissioning Safety Levels defines two types of decommissioning plans:

Initial Decommissioning Plan, based on the design / construction / operational decommissioning strategy. This document is general in nature during the design and operational phase and will be updated during the operational phase to the level as appropriate (see WENRA Safety Reference Levels DE-19, DE-20 and DE-21). This plan should:

- take into account major safety issues,
- support the fact that decommissioning can be safely conducted using proven techniques or ones being developed,
- include a generic study showing the feasibility of decommissioning,
- include consideration of environmental aspects of decommissioning, such as management of waste and radioactive effluents,
- provide a basis to assess the costs of the decommissioning work and the means of financing it.

Final Decommissioning Plan shall be prepared before the beginning of the decommissioning phase together with the safety case. This detailed document will be updated as required during the decommissioning stages (see also WENRA Safety Reference Levels DE-27, DE-28 and DE-29). This plan should:

- be consistent with the decommissioning strategy proposed for the facility,
- be consistent with the safety case for decommissioning (DE-50),
- describe the decommissioning activities, including the timeframe and the end-state of the decommissioning project, and the content of the individual phases, if a phased approach is applied,
- describe the facilities, systems and equipment needed to perform the decommissioning project,
- describe the organisational structure, skills and qualifications required for safe decommissioning,
- describe the management of residual material and waste in accordance with the national waste strategy,
- describe the program of the final radiation survey of the end-state of decommissioning.

20. Due to the advances in technology, health and safety legislation and the application of the ALARP principle to activities undertaken during decommissioning, there may be cases where the final decommissioning plan may differ from the information in the initial decommissioning plan. The final plan will be developed as site ceases operations, and advances in health and safety regulation and available technology may provide alternative options that were not feasible at the time of writing the initial decommissioning plan.

21. The Inspector may wish to seek assurance that the initial decommissioning plan is possible with existing technologies. The principles of assessment for decommissioning apply at all stages in the lifecycle of a nuclear facility and should be applied proportionately, in line with the requirements of SAPs paragraph 826 (see also WENRA Safety Reference Level DE-24)

22. The Inspector may wish to seek assurance that constructability of the final decommissioning plan is in line with Construction (Design and Management) Regulations (CDM2015) considerations and other relevant health and safety

legislation, alongside consideration of the ALARP principle. A list of legislation and guidance that is common to activities post operation is included in Section 5.2 & 5.3 of this document. The Inspector is reminded of the interface with ONR conventional health and safety colleagues when considering CDM2015 or other conventional health and safety legislation.

23. The Inspector may wish to seek assurance that there is a Decommissioning Plan in place for each facility which identifies the plan of how the facility will be safely decommissioned in line with the expectations of SAP DC.4 (see also WENRA Safety Reference Level DE-25). The Inspector may wish to review such plans and consider whether the civil engineering SSC condition has been assessed in order for it to continue to provide the necessary SFR for continued, changed or limited operations within the structure.

2.3 Design Authority

24. WENRA Safety Reference Level DE-03 states the expectation that the dutyholder maintains responsibility for safety, which sits alongside the SAP expectation SC.8. DE-03 also states the dutyholder can delegate tasks to contractors but must ensure the work is controlled appropriately and conducted safely. The Design Authority has a particular Intelligent Customer function when dutyholders request other agencies to undertake work, either for design or physical activities. This requirement is captured in SAP MS.1 for a management system that gives due regard to safety and safety should be considered explicitly when developing and implementing any new arrangements for managing the organisation. Therefore, the Inspector may wish to seek assurance regarding the adequacy of the arrangements for controlling works during post operation phases, including understanding the civil engineering type of contract that contractors are operating under.

25. SAP DC.1 establishes the expectation that the design should facilitate decommissioning and dismantling (as does WENRA Safety Reference Level DE-15). The civil engineering Design Authority (DA) is responsible for ensuring decommissioning and dismantling of the nuclear facility is considered at the early stages of concept design. The DA is then responsible for ensuring that any design intent to facilitate decommissioning is not compromised in the phases of detailed design, construction or operation.

26. During operation, the dutyholder's DA must ensure the safety functions of a civil engineering SSC are understood and met throughout its operational life. SAP DC.3 establishes the expectation that, if a facility cannot be operated safely, then it should be promptly decommissioned. The responsibility for the DA to ensure applicable safety functions are met continues through to the consideration and design of decommissioning and the project implementation.

27. The design intent and safety functional requirements are to be continually reviewed, to ensure they will continue to be met throughout all post operational phases, especially when there are changes in use of a structure.

28. SAP DC.7, including SAPs paragraph 864 (and paragraph 66) captures the need for Intelligent Customer function to be adequately fulfilled by the dutyholder, which includes the supervision, surveillance and approval of any tasks and the acceptance of the work as complete by the dutyholder.

29. WENRA Safety Reference Level DE-07 establishes the expectation that there is clear allocation of responsibilities, interfaces and communication routes. SAPs MS.2 and DC.7 capture this requirement for assessing whether the organisation has adequate human resources, with clarity of roles and responsibilities and effective communication and collaboration. The Inspector may wish to seek assurance of the adequacy of the delegation of authority, of interfaces and communication routes for the civil engineering

work being undertaken during post operation activities. This Inspector may wish to consider how a site is managing change, especially during transitions from operation to decommissioning phases, and transitions between each sub-phase of decommissioning (see also WENRA Safety Reference Level DE-05).

30. There is a step-change in dutyholder activities after a site has ceased operation, as the tasks at hand change in their nature. The activities around clear-out and demolition can require civil engineering specialists to be engaged on the site that have not been needed at any stage of the lifecycle up to that point. SAPs DC.7 and EHF.8 establishes the expectation that the competence needs for personnel responsible for undertaking decommissioning activities, including contractors, should be identified. The Inspector may wish to consider whether personnel have received suitable training and have been assessed as being suitably qualified and experienced personnel (SQEP) to carry out their duties. The Inspector should expect that the dutyholder's management system considers the number of staff working at the facility, and the nature of their work during decommissioning, in line with the expectations of SAP DC.8.

31. WENRA Safety Reference Levels DE-08 and DE-12 set the expectation of skills and management systems which are specifically required for decommissioning activities. The Inspector may wish to include the expectations of SAPs EHF.8, DC.7 and MS.2 in assessment of decommissioning safety cases and civil engineering works, alongside the requirements as stated in Licence Condition 11 'Training' and Licence Condition 36 'Organisational Capability'.

32. For guidance on civil engineering principles when assessing Design Authority responsibilities, see

- TAG 17 Annex 1, 'Civil Engineering – Design',
- TAG 17 Annex 4, "Civil Engineering – Construction Assurance'.

33. For wider guidance on Design Authority and Intelligent Customer responsibilities, see

- ONR-NS-TAST-GD-079 'Licensee Design Authority Capability',
- ONR-NS-TAST-GD-049 'Licensee Core Safety and Intelligent Customer Capabilities',
- ONR-NS-TAST-GD-077 'Supply Chain Management Arrangements for the Procurement of Nuclear Safety Related Items or Services'.

34. For guidance on management of change when transitioning through phases, see:

- ONR-NS-TAST-GD-048 'Organisational Change',
- ONR-NS-TINS-GD-011 'LC 11 – Training',
- ONR-NS-TINS-GD-036 'LC 36 – Organisational Capability'.

2.3.1 Design

35. SAPs DC.1 and ECE.26 establishes the expectation that consideration should be given at the civil engineering design stage of a nuclear facility to the incorporation of features to facilitate radioactive materials and waste management and the future decommissioning and dismantling of the plant. Structural layout, designs and construction should enable dismantling to be undertaken using proven and simple working practices. When assessing design or modifications, the Inspector may wish to consider:

- provision of space and facilities for characterisation, decontamination and disassembly,
- provision of suitable access to allow intact removal of large plant items such as steam generators and large pumps,

- minimising penetrations, crevices, joints or cracks that trap contaminants or 90º angles by using chamfers, bevels or long radius bends,
- considering how porous surfaces will be sealed against ingress of activity, with the use of special surface finishes or treatments to prevent contamination from adhering to or penetrating surface of materials,
- avoiding the inappropriate specification of shielding, bearing in mind that the design of a biological shield involves a balance between structural aspects and minimising activation.

36. Facilities should be designed to minimise infiltration, contain spills and releases and attenuate contaminant transport. Active leak detection is paramount. Where drainage pipework has to be embedded into a concrete structure or if containment structures are buried or supported directly upon the ground, leakage detection system should be provided. Details must avoid potential traps for contamination. Designers should consider:

- minimising embedded pipework, ducts and equipment in floors and walls,
- minimising the use of potentially radioactive underground tanks, sumps, ducts and drains,
- lining sumps and trenches to concrete floors with impermeable corrosion resistant material, to protect from contamination and facilitate clean up e.g. by providing corrosion resistant liners,
- separation of radioactive and non-radioactive systems and areas (drainage systems should keep liquids separated according to their potential radioactivity),
- avoiding unmonitored voids and sub-spaces within structures,
- designing and installing pipes and ductwork to minimise the holdup and deposition of potentially active dust particulates.

37. In line with the expectations of SAP DC.1 and ECE.26, the original design and subsequent plant modifications should incorporate provision for decommissioning which should be included in decommissioning plans.

38. Progressive and disproportionate collapse during demolition must be avoided in design.

39. The Inspector may judge whether the design facilitates dismantling, considering:

- developing designs that will facilitate construction as well as dismantling (often by reversing the construction sequence),
- minimising the use of materials which could become activated during the operational stage,
- specifying surface finishes which aid decontamination and minimise absorption of contaminants,
- considering (where necessary) the use of advanced techniques to remove active items,
- where irreversible construction sequences are used, this should be justified, and the decommissioning consequences presented.

40. For further guidance on civil engineering design, see:

- TAG 17 Annex 1 ‘Civil Engineering – Design’,
- TAG 17 head document, section 5.9.5 ‘Modifications’.

2.3.2 Risk assessment

41. The Inspector may wish to consider whether hazards and resultant risks have been considered when assessing activities after cessation of operations. The Inspector may consider the:

- accuracy and adequacy of information in the health and safety file for the identification of hazards and resultant risks,
- adequacy of the arrangements in place to manage the risks associated with the proposed civil engineering works,
- load paths or transient and temporary conditions that may have not been necessary to have been considered during the operational phase of the structure,
- potential impact on adjacent facilities, especially referring to health and safety files and designers risk assessments of adjacent facilities that may have been built later in the site life,
- construction sequence risks for decommissioning and demolition and how this information is recorded,
- whether civil engineering design decisions facilitate and not preclude options for radioactive materials and waste management, including design decisions around material selection, considering ease of dismantling and disposal in the safest manner,
- whether the structure has been designed and detailed so that it can be easily decontaminated and dismantled,
- specific health and safety control measures identified and documented in the health and safety file for use at the decommissioning and dismantling phase, adequacy of information for advising constructors and future owners of assumptions associated with the design detail adopted and the as-built status of the structure.

42. The Inspector may wish to consider whether on-going risks associated with the facility have been reduced to a level that can be demonstrated to be as low as reasonably practicable. Where the potential consequences of an incident are significant, consideration of margins against failure due to extreme events and accidents should continue post operation.

43. All relevant sections of the civil engineering construction principles should be applied to the demolition activities. The temporary safety and stability of partly demolished structures shall be ensured. The Inspector is reminded to consider areas where embedded energy (e.g. pre-stress) may need to be relieved.

44. For guidance on deconstruction considerations, see also:

- TAG 17 Annex 4 “Civil Engineering – Construction Assurance”.

45. The Inspector may wish to consider how the effects of ageing and degradation have been adequately considered in the development of the demolition proposals, e.g. with reference to the evidence held in historical examination, inspection, maintenance and testing (EIMT) records, maintenance schedule records and the Health and Safety File. The Inspector is reminded of the expectations of ECE.18 (considering that ‘construction’ includes decommissioning activities), ECE.20 and ECE.26 (see also WENRA Safety Reference Level DE-43 and DE-44).

46. For guidance on ageing and damaged structures, see also:

- TAG 17 Annex 5 ‘Civil Engineering – Ageing Management and Damaged Structures’.

2.3.3 Duty holder Decision making

47. When an inventory of nuclear material is present on a site, the most significant risk that is considered during decision making (be it optioneering or ALARP arguments) is usually the radiological risk and the possible doses to employees and the public. If this inventory is reduced (by removing the fuel from a power reactor, for example) then it may not be appropriate to make decisions based on dose alone. On a de-fuelled power reactor site, asbestos might be the most significant hazard. The Inspector should consider SAP MS.3 when assessing decision making, which expects safety to be given a high priority which should be evident in all decision-making processes. For all phases after the facility has ceased operating, there should be an increase in optioneering and decision-making activities around civil engineering works that will impact safety.

48. The Inspector may wish to consider the decisions made regarding assessment and categorisation (SC.1) of decommissioning activities and the impact on safety e.g. timing of decommissioning activities which might adversely affect the safety of each other if undertaken in parallel. The Inspector may wish to seek assurance that assessment of faults or events that are included in the safety case were considered in the assessment. (see also WENRA Safety Reference Level DE-46 and 47). See also Section 2.7 regarding timing of decommissioning activities and considerations for deferment of activities.

49. The Inspector may wish to seek assurance that the dutyholder has included wider consequences of failure, beyond radiological dose, such as conventional health and safety factors, and the strategic factors of reputational risk, and remediation costs. The Inspector may wish to seek assurance that particular factors are not unduly weighted when considering options.

50. For further guidance on ALARP and risks in design optioneering, see:

- TAG 17 Annex 1 ‘Civil Engineering – Design’,
- ONR-NS-TAST-GD-005 ‘Demonstration of ALARP (As Low as Reasonably Practicable)’.

2.4 Management Arrangements and Systems

51. WENRA Safety Reference Level DE-13 states the requirement of management systems to achieve goals, with work being performed under controlled conditions, using approved current procedures, instructions, drawings or other appropriate means that are periodically reviewed to ensure their adequacy and effectiveness. WENRA Safety Reference Level DE-14 states the types of documentation a management system should include. SAP DC.8 expects a management system to be in place for decommissioning, reviewed periodically and modified as necessary prior to and during decommissioning. The Inspector may wish to seek assurance with the adequacy of the management of safety functions categorisation of SSCs and examination, inspection, maintenance and testing (EIMT) activities in particular SAP ECE.17 establishes the expectation that a quality management system will be in place for construction activities. In this context, ‘construction’ includes decommissioning activities.

52. Requirement 6 of IAEA GSR Part 2 (paragraph 4.8) [4] goes further still, by stating that processes of the management system will be “continuously improved”, which is captured in SAP MS.4 regarding lessons learnt to continually improve the management system. The Inspector may wish to seek assurance that the duty holder seeks learning, through collation of learning from a range of sources internal to the duty holder, active and systematic collation of information from external sources, and with suitable analysis to identify trends or issues. The Inspector may wish to seek assurance that the dutyholder is demonstrating learning lessons from the nuclear

industry and the wider civil engineering industry in all construction activities including decommissioning.

53. Decommissioning tasks can be standard practice in the wider industry, but it is the associated nuclear hazards that are unique to the nuclear industry. The Inspector may wish to seek assurance as to how relevant operational experience (OPEX) is used on the site, as learning from others can reduce risks if the relevant learning is implemented appropriately. There is limited industry experience in certain tasks associated with nuclear safety after sites have ceased operation, so the Inspector may wish to consider the risks and the ALARP principle when assessing works that are novel.

54. Further to this, the Inspector should expect a 'challenge culture' on the site, where the management arrangements facilitate a questioning attitude, in line with the expectations of:

- ONR-NS-TAST-GD-080 'Challenge Culture Capability (including an Internal Regulation function), and the provision of Nuclear Safety Advice'.

2.5 Records for use in decommissioning

55. WENRA Safety Reference Level DE-09, Licence Condition 6 and SAP DC.6 set an expectation that adequate arrangements will be implemented for the acquisition, retention, storage and access to relevant information and records, with sufficient knowledge of the facility and technical expertise maintained for the life of the facility. Information is produced in the design phases as well as through construction and operational phases. The Inspector may wish to seek assurance of whether the design and modifications of the facility and its operating history are identified and incorporated into the decommissioning plan.

56. The Inspector should expect the following records are available for decommissioning:

- design basis,
- original design concept for decommissioning,
- design details and drawings,
- specifications,
- form, method and sequence of construction (and therefore deconstruction),
- construction materials and properties,
- design changes and concessions,
- construction records and photographs,
- as-built records; including non-conformance reports, especially where original design intent is challenged,
- inspection and testing records,
- modifications,
- ageing management programme records,
- change of use and configuration management records.

57. For end of life activities, the Inspector may wish to consider 'corporate memory' in line with the expectations of SAPs DC.6, DC.3 paragraph 841 (l), EMC.2, ENM.4, RL.1, RL.7, MS.2, RW.6, (see also WENRA Safety Reference Level DE-59). Whilst the Inspector may consider that the consideration of these SAPs stray outside civil engineering assessment regarding the corporate memory of nuclear waste inventory, the post-operational civil engineering SSCs that need to maintain their safety function are those that contain and protect residual nuclear inventory on site. Corporate memory regarding the location of wastes is a key consideration when considering continued safe storage of wastes on site, which can be in an existing structure that has a history of condition assessments. The Inspector is reminded of the expectations for adequately recording relevant information regarding EIMT and condition of structures

in line with ECE.20 (see also WENRA Safety Reference Level DE-44), which applies proportionally to phases that are during operation and post-operation.

58. In accordance with SAP MS.2 (paragraph 60), specific attention should be paid to the retention of information during handover between lifecycle phases that involve changes in the responsibility for records and information management. Key information transfer points include those between design and construction, construction and commissioning, commissioning to operation and operation to defueling and decommissioning. The Inspector should expect:

- detailed records define the extent, location and nature of all remaining civil engineering elements post operation, with all maintenance or inspection requirements for these remaining elements clearly defined,
- records are readily available for all potential future users of the site, with due consideration of the durability of such information management and storage for the full duration of Care and Maintenance and final site clearance timescales,
- awareness that records relating to the design, construction and maintenance of civil SSC may be lost or destroyed after operations have ceased, and loss of operator knowledge may lead to increased risks during post operational inspection, maintenance, and deconstruction of civil SSC. The Inspector should expect suitable provision to collect and safeguard information as is necessary for the safe implementation of the following phases,
- records of all structures and materials remaining on site, especially those not visible from the surface, must be collated and provided to the relevant authority at the end of demolition and site clearance.

59. There may be civil engineering SSCs, such as discharge pipelines, that extend beyond the boundary of the nuclear licensed site but are captured in the area of the environmental permit. The Inspector may wish to consider the interfaces with the relevant environmental regulator to ensure that inspection of the relevant arrangements is co-ordinated.

60. During the scope of a civil engineering assessment of structures that hold waste which has previously been undisturbed, the Inspector may wish to consider the processing of wastes for decommissioning in the activities of decommissioning and clear-out. For this assessment, the Inspector may wish to consider the potential for decomposition of wastes and / or different chemical processes which may have a detrimental impact on the ability to inspect the structure that is providing the containment, e.g. storage ponds or vaults.

61. For more information on civil engineering containment assessment, see:

- ONR-NS-TAST-GD-020 ‘Civil Engineering Containments for Reactor Plants’.

62. For more information on record keeping, see:

- ONR-NS-TAST-GD-033 ‘Dutyholder Management of Records’.

2.6 Decommissioning in stages across sites

63. If civil engineering works and structures have an ongoing role in the decommissioning of a nuclear facility, then the safety case should demonstrate their continuing safety for the periods required, in line with the principle SAP DC.5 for passive safe storage of radioactive material and waste, and DC.9 for an adequate decommissioning safety case. An assessment of the continuing safety of the nuclear facility involves

determining the current physical condition and establishing how it will change in the future.

64. As decommissioning progresses across a site, residual nuclear safety demands may be required of civil engineering SSC for many years after the end of operations. These demands may extend beyond the originally envisaged design life. During the post-operation phases, the residual nuclear safety functions usually include structural support to, and containment and shielding of, any remaining nuclear inventory, including contaminated or activated components. Structural integrity and a weatherproof envelope are examples of nuclear safety functions for nuclear waste store structures, which are often required in the post-operational phase.

65. For consideration of management of ageing and damaged SSCs, see:

- TAG 17 Annex 5, 'Civil Engineering – Ageing Management and Damaged Structures'.

66. Where structures are repurposed to become nuclear waste stores, see:

- TAG 17 head document section 5.9.5 'Modifications' .

67. When decommissioning has progressed and there are no longer nuclear safety functions required of a structure, civil SSCs may be re-classified as they change in importance to safety over the course of decommissioning activities. SAP DC.9 establishes the expectation that safety functions required to be fulfilled are to be captured in the decommissioning safety case. The SSCs may still be required to provide residual environmental or conventional safety functions, such as maintaining weatherproof envelope, confine hazardous substances such as asbestos or irradiated materials, or provide support for access and egress pathways. This is in line with the requirements of WENRA Safety Reference Level DE-30, following the expectations of SAP ECS.1.

68. SAP DC.3 requires the consideration of timing of decommissioning, including the interactions with and dependencies on other facilities or services and the technical practicability of activities. The Inspector may wish to consider the interactions between adjacent facilities, both for interdependencies and potential impact on adjacent facilities. This is discussed in WENRA Safety Reference Level DE-22.

2.7 Deferred decommissioning or demolition

69. SAP DC.3 establishes the expectation that facilities are decommissioned and demolished as soon as reasonably practicable after end of operations, so that risks can be reduced so far as is reasonably practicable. There may be valid reasons for the dutyholder to defer these actions, including, but not limited to:

- awaiting decay of radiological risk,
- to allow for development of lower risk methods (e.g. remote demolition),
- to allow for specialist resource to become available,
- waste route availability,
- to learn from pilot or experimental works on comparable facilities,
- resources required could achieve a greater benefit by attending to risks and hazards to other facilities. Note it would be inappropriate to defer actions simply for financial reasons.

70. The dutyholder should be able to justify decisions to defer actions on the basis that overall site risks have been reduced as low as reasonably practicable. The reasons must be balanced against the risks of deferred action, such as ongoing ageing and degradation effects, and the loss of knowledge and suitably qualified and experienced personnel (SQEP) resource.

71. SAP EMC.11 establishes the expectation that failure modes should be gradual and predictable, EAD.2 that there should be sufficient margin for the remaining life and EMT.6 that provision should be made for EIMT throughout the life of the structure, commensurate with the reliability required of each SSC. The Inspector may wish to consider the condition of the structure in line with the expectations of these SAPs as a means to avoid a situation where a structure has become unsafe to access, unstable or unacceptably vulnerable to external hazards events. When considering external hazard events for structures that are undergoing deferral, the Inspector may wish to seek assurance that the implication extended life may have on the consideration of loadings, is in line with the expectations of SAPs EHA.7, EHA.18 and ECE.6.

72. Risks created to adjacent facilities should be considered when considering deferral of demolition, in line with the expectations of SAP DC.3 and DC.5 where civil engineering SSCs are expected to act in a passively safe way (see also WENRA Safety Reference Level DE-22 and DE-48). Further to this, when considering deferment, the Inspector may wish to consider whether the appropriate categorisation has been applied to any modifications to the planned decommissioning activities to reflect whether the deferment could compromise the safety of the activities on site, (see also WENRA Safety Reference Level DE-47).

73. For information on design basis and beyond design basis and cliff edge effects when considering deferment or extended life, see:

- ONR-NS-TAST-GD-006 ‘Design Basis Analysis’.

2.8 Design life

74. For periods where the structures are intended to provide passive safety post-operation, the civil engineering SSCs are to be designed for an appropriate design life. The Inspector may wish to consider how the dutyholder is preventing conditions which could lead to accelerated deterioration of the structure, and an impingement on the anticipated design life. The Inspector may wish to seek assurance that the EIMT arrangements for civil engineering SSCs throughout the post-operation period are adequate to manage the factors that can deteriorate the SSC during this period.

75. If the civil engineering SSC is not newly constructed to perform the safety functions for the period required, the SSC may exceed its originally anticipated design life before entering, or during, the post-operation period. Where cessation of operation and / or demolition is deferred compared with the original periods assumed in the design, the civil engineering SSC may exceed its originally anticipated design life by decades before entering or during the post-operation period. In this situation, the Inspector may wish to seek assurance of the adequacy of the justification for continued provision of safety functions, with evidence of safety margins appropriate for the safety function and extended lifetime requirements.

76. During the post-operation period, there are fewer personnel accessing buildings than during operation, so defects and ageing effects may not be identified so readily. When considering passive safety in the post-operation phase, the assumptions in the design for achieving the design life are that the civil engineering SSC is adequately maintained. the Inspector may wish to consider the arrangements in place to:

- maintain flat roofs, gutters, and rainwater outlets,
- minimise internal condensation on metallic surfaces,
- prevent a build-up of water (penetrating ground water or leaking services).

77. The Inspector may wish to consider how the dutyholder is preventing accelerated deterioration of hazardous materials or the creation of new hazards. This might include:

- protection to asbestos containing (or other potentially hazardous) materials,
- removal of spring hangers or other components with embodied energy,
- distribution of residual activity or contamination,
- falls from height due to deteriorated roofing materials, edge protection or access ways,
- access for EIMT to structures that are performing safety functions.

78. If ongoing access for EIMT is required, safe means of access and egress must be maintained, including provision of fire escape, lighting and directional signage as appropriate. The Inspector may wish to consider where areas have become unsafe to access, whether these are clearly identified and suitable barriers maintained, considering how continued use is justifiable where access is not possible.

79. For further information on ageing of civil engineering structures, see:

- TAG17 Annex 5, 'Civil Engineering – Ageing Management and Damaged Structures'.

2.9 Security arrangements

80. The Inspector may wish to consider the potential ageing mechanisms of (physical) security systems in place for sites with deferred decommissioning. The civil engineering assessment should consider security systems that are provided by or supported by civil engineering SSCs. For more information on EIMT for physical security systems, see:

- ONR-CNS-TAST-GD-5.2 'Examination, Inspection, Maintenance and Testing of Physical Protection Systems'.

2.10 Emergency arrangements

81. The Inspector should expect a review of internal and external hazards throughout the phases of post-operation, to ensure that decisions made do not preclude options for access or egress, invalidate assumptions in the safety case or increase the risk of structural collapse during a (beyond) design basis event. For more information on EIMT for emergency arrangements, see:

- ONR-CNS-TAST-GD-5.2 'Emergency Preparedness and Response'.

82. For an event in the post-operational phase, either design basis or beyond design basis event or accident, the civil engineering SSCs should still respond in the way they were designed to. SAP EMC.11 establishes the expectation that failure models should be gradual and predictable. Demolition should be undertaken before the structure has become unsafe to access, unstable or unacceptably vulnerable to events considered within the design. For more information on (beyond) design basis events on ageing sites, and condition considerations for the deferral of decommissioning, see:

- TAG 17 Annex 5, 'Civil Engineering – Ageing Management and Damaged Structures'.

3. DECOMMISSIONING PLAN

3.1 Requirements

83. SAPs DC.2 and DC.4 explain the requirements for decommissioning strategies and plans, respectively. These include the requirement to produce a decommissioning plan for each site, including details of each facility. This is in line with Requirement 11 of IAEA GSR Part 6 'Decommissioning of Facilities' which states that:

> "Prior to the conduct of decommissioning actions, a final decommissioning plan shall be prepared and shall be submitted to the regulatory body for approval."

84. Licence Condition (LC) 35 requires that the dutyholder shall:

> "…make and implement adequate arrangements for the decommissioning of any plant or process which may affect safety".

85. The Inspector should be aware that a decommissioning plan is a requirement of the licensing of new nuclear sites, prior to construction, in line with the expectations stated by WENRA Decommissioning Safety Levels DE-20. For more guidance, see:

- 'Licensing Nuclear Installations' which is published on ONR's website.

3.2 Purpose of the Decommissioning Plan

86. The Inspector should be aware that the intent of the decommissioning plan is to demonstrate how the dutyholder intends to reduce nuclear and conventional risks to the point where the facility presents negligible risk to the public, workers and the environment. The dutyholder may not have all the relevant expertise to develop this plan in-house, and consultation is likely to be required with the Design Authority and specialist contractors. Where this is the case, the Inspector may wish to judge whether the Intelligent Customer function has been adequately applied to assess subcontractor proposals.

87. Once developed, a decommissioning plan may change as more information is made available, or in response to changing conditions. Whilst the Inspector should be aware of changes to the plan, it is not usual for ONR to formally approve decommissioning plans and subsequent changes to it.

3.3 Expected features of the decommissioning plan

88. WENRA Decommissioning Safety Level DE-21 provides expectations for the decommissioning plan, which are reflected in the expectations of SAP DC.4. Features of an effective decommissioning plan from a civil engineering perspective include:

- the objective of the decommissioning plan (e.g. a clear definition of the end states and conditions, residual radiological limits, and provisions for on-going monitoring and assurance),
- definition of responsibility for each element of the plan,
- identification of all the significant risks and hazards that are to be addressed,
- order and timing of actions to be undertaken to minimise risk,
- requirements for suitably qualified and experienced personnel (SQEP) to undertake identified tasks (potentially including training requirements or external resources),
- investigation or survey works to be undertaken to inform the decommissioning strategy and reduce uncertainty and risk,
- evaluation of the need for any research, decommissioning trials and demonstrations prior to implementation of high-risk activities,

- actions to be initiated in the event of any unexpected occurrence or finding (including incident reporting system criteria),
- any changes in risk to adjacent or co-dependant facilities (including temporary risks created by demolition activities, security implications, interruption to on-going operations etc.),
- specific maintenance instructions for elements where demolition is to be deferred, including the assumptions made on projected rates of deterioration or ageing,
- details of waste separation and segregation measures and waste routes for each identified type of waste,
- assumptions made regarding the end-state environment (outside the control of the duty holder),
- interim or end-state criteria to be monitored, recorded and, if appropriate, trended (including frequency, action levels, and availability and limits of instrumentation),
- measures to ensure appropriate collection and dissemination of learning (e.g. lessons learned for subsequent decommissioning projects),
- identification and inclusion of any new permanent or temporary construction works needed.

89. Records relating to the design, construction and maintenance of civil SSCs may be lost or destroyed after operations have ceased, and loss of operator knowledge may lead to increased risks during post operational inspection, maintenance, and deconstruction of civil SSCs. The dutyholder should make suitable provision in its decommissioning plan to collect and safeguard such information as is necessary for the safe implementation of the follow-on phases.

4. POST OPERATION PHASES

90. The phases after the cessation of operations may be identified in the decommissioning plan. Not all phases need to be included in the decommissioning plan, depending upon the strategy being adopted, and the sequencing of activities may differ between facilities.

91. Potential phases include, but are not limited, to the following; (these are expanded upon in the sections that follow)

- **Inactive quiescent storage**. - A period where no nuclear operations are undertaken, but all radiological inventory remains present,
- **Post operational clean out**. – An activity during which all practicably retrievable radiological inventory is removed and contamination which presents a potential risk to ongoing health and safety is addressed (potentially by in-situ encapsulation). Other hazardous materials (e.g. asbestos, mineral oils, etc.) might be removed during this stage,
- **Care and maintenance**. – A period where no nuclear operations are undertaken, but most of the contaminated and activated plant and equipment remains present. The main purpose of this phase is to allow radionuclides to naturally decay to a level where remote removal can be substituted by manual removal, producing a reduction in risks and costs,
- **Decommissioning**. – Strip-out and disposal of plant, equipment and other non-building fabric components associated with radiological inventory. Remaining contaminated or activated materials presenting a significant risk should be removed during this stage,
- **Demolition**. – Removal of the building fabric to achieve a predefined end state. Some structures (e.g. foundations, concrete bases, and below-ground services) may remain in-place if the risks and hazards presented by these elements are considered acceptable,
- **Site remediation**. – Treatment (preferably removal) of contamination (radiological or otherwise) of the land associated with the facility,

- **Delicencing**. – Administrative process by which the Nuclear Site Licence is withdrawn from the facility. Only at this stage can fencing, signage and access controls required by the Licence Conditions be reduced. This stage may include landscaping and works to comply with planning requirements. ONR is no longer the Enforcing Authority once a site has been delicenced but may provide support at the request of other authorities regarding the on-going management of the site.

4.1 Inactive quiescent storage

92. The Inspector should be aware that safety functions required of civil engineering SSCs are likely to remain during periods of quiescent storage. Dutyholders would be expected to undertake the appropriate examination, inspection, maintenance and testing (EIMT) activities throughout storage periods.

93. For guidance on current condition assessments of ageing or damaged structures that continue to perform safety functional requirements, see:

- TAG 17 Annex 5, 'Civil Engineering – Ageing management and damaged structures.

4.2 Post operational clean out (POCO)

94. The Inspector may wish to consider the following for assessment of POCO activities on or within civil engineering SSCs:

- increased potential for internal hazards and changes to loading during defueling operations, with increased or modification to use of material handing or retrievals equipment, including dynamic effects and potential for dropped loads (cranes, hoists, fuelling machines, etc.), within the site fuel route and associated equipment,
- potential modifications to civil engineering SSCs to gain access to radiological inventory, which may compromise the functions of structural support, containment, fire boundaries, protection from external hazards or impact,
- potential loads beyond those experienced during operations, or changes in loading pattern during retrieval of the radiological inventory. Loads may be created by temporary additional radiological shielding materials or civil engineering SSCs or mechanical equipment required for retrieval of wastes,
- floatation or heave of below ground structures as heavy equipment or large volumes of material (including water) are removed from civil engineering SSCs.

95. If a dutyholder is proposing to reduce radioactivity from the civil engineering SSC surfaces e.g. surface scabbling, the Inspector may wish to consider how these activities could impact on the durability of the structure for the required lifetime. The Inspector may wish to seek assurance of the dutyholder's alternative strategy and associated justification, should the strategy for cleaning not achieve the required levels to satisfy environmental requirements.

4.3 Care and maintenance (C&M) phase

96. SAP DC.5 establishes the expectation that the site is passively safe before entering the care and maintenance phase. While post-operational facilities presenting a potential nuclear risk will be required to undertake a periodic review of safety (Licence Condition 15), these may not be sufficient to manage all risks post-operation e.g. conventional health and safety risks. The Inspector may wish to consider undertaking joint planned interventions to consider conventional risks and hazards alongside

conventional health and safety colleagues, especially where areas of uncertainty arise from the decommissioning strategy, such as rates of corrosion of internal steelwork. This meets the WENRA Safety Reference Level requirements in DE-23.

97. The Inspector should expect the objective of the care and maintenance (C&M) preparations is to have no active systems on site during C&M. This may not always be possible, e.g. an unavoidable active system could be a pumping system to remove (clean) groundwater ingress to a basement of a structure. The Inspector may wish to seek assurance of the adequacy of the proposed or in place regime for ongoing EIMT of civil engineering SSCs, and whether it is designed to minimise the need for active safety systems (including monitoring systems) in the interests of safety, and preventing the need for prompt intervention to maintain the facility in a safe condition. SAP DC.5 establishes the expectations regarding passive safety, including adequate access for EIMT activity to be controlled with entry points provided for response to incidents and provision to prevent access by flora and fauna etc.

98. If ongoing access for inspection is required, the Inspector should expect safe means of access and egress to be maintained, including provision of fire escape, lighting and directional signage as appropriate.

99. For the C&M phase, the safety case should describe the arrangements for the continued surveillance, maintenance and monitoring of the facilities that will ensure that any unexpected degradation will be detected. Similarly, the Inspector may seek assurance that there are adequate arrangements in place for detecting leakage of radioactivity and to ensure that unforeseen incidents are detected (for example, damage caused by natural events, failure of systems, intrusion). Where earthworks or excavation are required, the Inspector is reminded of the possibility of contaminated land or spoil presence. SAP DC.8 expects a management system for decommissioning regarding examination, inspection, maintenance and testing (EIMT) and these EIMT activities should be provided in a decommissioning safety case as expected in DC.9.

100. A reduced scope of examination, inspection, maintenance and testing (EIMT) may be appropriate due to the reduced hazard presented by the facility. A reduced frequency of inspection may result in more unrevealed defects. The Inspector may need to consider the following for assessment of dutyholder proposals to enter care and maintenance:

- civil engineering SSC may provide residual nuclear safety functions (containment and shielding) to a residual inventory, including contaminated or activated waste items. The Inspector may wish to consider the justification for continued use of a structure if it is beyond the original design life, including current condition assessments and evidence of available margin to withstand the design loading for the C&M phase, including the proposals for waste retrieval at the end of C&M,
- conventional health and safety risks might increase during this period due to ageing and degradation of internal and external structural material. The Inspector may wish to consider the activities required for adequate EIMT and how the risks associated with these activities are reduced to a level that is as low as reasonably practicable,
- the rate of deterioration of the building fabric may accelerate due to a change in the environment within the facility (e.g. reduced temperature, increased humidity). The Inspector may wish to consider the arrangements proposed or in place for undertaking remediation to civil engineering SSCs, both internally and externally to a structure, should an inspection identify damage or corrosion to parts of the civil engineering SSC which require repair,

- proposals for wholescale replacement of civil engineering SSC if this is deemed necessary, including how the safety function will continue be met during replacement during the C&M duration, e.g. cladding.

101. If the consequences of an extreme external hazards event would be limited, it may be acceptable for dutyholders to reduce the severity of external hazard events which the facility needs to be demonstrated to withstand. In this situation, an appropriate update of the facility safety case should be undertaken to justify this.

102. For guidance on the consideration of external hazards for ageing or damaged structures, see:

- TAG 17 Annex 5, 'Civil Engineering – Ageing Management and Damaged Structures'.

4.4 Decommissioning

103. The Inspector may wish to seek assurance of the adequacy of the processes and arrangements in place for decision making associated with decommissioning activities on the site. The civil engineering specific considerations for decommissioning are similar to those for POCO projects, including whether the proposed activity will:

- change the load paths and how will this impact the civil engineering SSC, including impact on external and internal load cases e.g. wind uplift on the roof following removal of suspended services,
- increase the hazard presented to the structure by removal of structural support or making roof areas vulnerable,
- make the structure vulnerable due to the existing condition of the civil engineering SSC, and how any ageing effects or damage could make the SSC particularly vulnerable to collapse,
- make the structure vulnerable to collapse when considering construction and the associated deconstruction sequence required e.g. pre-stressed structures,
- impede ability for the dutyholder to undertake EIMT, e.g. when moving waste (under water) that has not previously been disturbed, storing large items close together,
- increase the risks associated with managing radiological and conventional health and safety hazards, e.g. location of (irradiated) stored waste items within a civil engineering SSC that increase dose uptake or obscure or prevent adequate internal civil engineering EIMT, creation of confined spaces, asbestos, etc.
- impede access or egress (especially those for emergency exit),
- increase the potential for internal hazards,
- breach any containment barriers or increase the potential for leakage or water egress, especially for that of contaminated waste,
- increase the consequence of the effect of external hazards, design basis, beyond design basis or other events, including the consideration of cliff-edges.

4.5 Demolition

104. SAP EMC.11 establishes the expectation that all failure should be gradual and detectable. Progressive and disproportionate collapse must be avoided in design, including the dutyholder's demolition arrangements.

105. Demolition should be undertaken by safe means; with expediency being a consideration, especially if the structure is unsafe in its existing condition. The Inspector should also be mindful that dutyholders take into account other factors; such as cost, programme, waste segregation and minimisation, and environmental

protection when considering the optioneering and selecting the methodology. The Inspector may wish to seek assurance that particular factors are not unduly weighted when considering options. For more consideration of ALARP assessment when undertaking optioneering, see

- ONR-NS-TAST-GD-005 “Guidance on the Demonstration of ALARP”,

106. SAP DC.3 establishes the expectation that demolition should be undertaken before the structure has become unsafe to access, unstable or unacceptably vulnerable to external hazards events. Risks created to adjacent facilities should be assessed when considering the sequencing and timing of demolition activities.

107. Methods of demolition include, but are not limited to:

- disassembly – construction process in reverse, generally only applicable to metal and timber structures, but might include precast concrete components,
- deconstruction – cutting, breaking, crushing, hydro demolition or other insitu methods,
- dismantling - taking apart of a structure, or a substantial part of the structure, including dismantling for re-erection or re-use,
- due to the potential consequences or impact on adjacent nuclear safety related structures, the use of explosives are rarely used on nuclear sites.

108. SAP DC.7 establishes the expectation that there is suitable and sufficient capability for the Intelligent Customer function, where work is carried out by contractors. Where the duty holder has employed a demolition contractor, it is the responsibility of the contractor to develop a safe system of demolition work, justifying the choice of method and demonstrating that risks have been reduced so far as is reasonably practicable. The dutyholder (through the Intelligent Customer function) is responsible for ensuring that the contractor’s proposals or their own arrangements include for command and control, a robust system of change control and accident response plans. The Inspector may wish to seek assurance that the proposals have been subject to appropriate levels of peer and independent review, where necessary.

109. The Intelligent Customer (IC) function is responsible for ensuring that the specification adequately identifies the activities that need to be completed as part of demolition, and that the specification requirements have meet an adequate standard. The Inspector may wish to seek assurance that the decommissioning and demolition activities have been undertaken adequately, and that records are available to demonstrate this. The Inspector is reminded of the expectations of DC.6. There may be a requirement for an end-state survey to be undertaken as evidence that the final demolition and decommissioning activities are complete. (see also WENRA Safety Reference Level DE-58 and DE-60).

110. SAP DC.8 requires for management systems to be in place to control decommissioning activities. The Inspector may wish to consider:

- implications of the surrounding physical environment in terms of adjacent facilities, services and infrastructure, access restrictions, etc.,
- verifying that the dutyholder understands the structure to be demolished, including its load carrying capacity, structural condition, the effects of any defects, all potential load paths and methods of providing stability, connection types and characteristics of the construction materials,
- measures to verify assumed material properties,
- risks resulting from inadequate or out-of-date structural information or unrecorded structural alterations,
- measures to ensure stability at each stage of the demolition,

- potential for concentrated, unbalanced or lateral loads due to a build-up of demolition materials,
- loads created by demolition plant, including jacking and lifting forces,
- loads created by access or lifting equipment e.g. scaffolds on suspended slabs, self-climbing platforms, wind loads on scaffolds or cranes, crash decks and protective structures, back propping, etc.,
- hazards created by underground or hidden structures, below ground services or the potential for ground instability,
- hazards created by pre-stressed components,
- hazards created by large panel or in-situ jointed prefabricated structures,
- hazards created by cutting and sawing techniques, including control of potentially contaminated slurry or dust,
- risks associated with lifting of cut elements (temporary stability, weight estimation, centre of gravity, wind sailing effects, lay down areas, rigging, slinging and geometry of the lifting equipment,
- potential shortfalls due to the codes of practice and standards of detailing used in the original design and construction e.g. design methodologies, safety factors, load combinations, reinforcement embedment or lap lengths,
- the properties of historic materials e.g. mild steel or un-ribbed reinforcement. The implications and risks of using modern design codes for checking older structures. Possible degradation of the strength of materials,
- temporary works designs, particularly if failure of the temporary works could have significant consequences,
- surface water run off or infiltration,
- implications of unusual or specialist techniques such as tandem lifts, dewatering, ground freezing, hydro demolition, river and coastal works and pre-weakening of structures.

4.6 Site Remediation

111. SAP RL.2 establishes the expectation for dutyholders to update decommissioning strategies and plans to include identification and remediation of any contaminated land, to ensure the site is passively safe before entering the care and maintenance phase.

112. Site remediation is a specialist activity. If ONR needs to consider ground contamination issues which present a potential ongoing hazard to workers or the public, it is likely that the ONR regulation will be led by inspectors with a waste and decommissioning specialism. Civil engineering inspectors may be able to provide support regarding the geological and hydrological conditions.

113. Where earthworks or excavation are required, the Inspector is reminded of the need to consider SAPs expectations presented in RL.1 and RL.2 when there is a possibility of contaminated land or spoil.

114. SAP ECE.9 establishes the expectation that the risk of flooding (including allowances for climate change predictions and other uncertainties) should be considered when demonstrating the safety of earthworks. The potential for external hazards to adversely affect remediation activities should be considered. This might include the potential for spread of contaminants, temporary stability of earth mounds or excavations, the continued function of cut-off barriers and the capacity of any rainwater bunds or other water retention structures.

115. For more information on site contamination, see:

- ONR-NS-TAST-GD-083 ‘Land Quality Management’,
- ONR-NS-TAST-GD-024 ‘Management of Radioactive Material and Radioactive Waste’,
- ONR-NS-TAST-GD-081 ‘Safety Aspects Specific to Storage of Spent Nuclear Fuel’,
- ONR-NS-INSP-GD-032 ‘LC32 – Accumulation of Radioactive Waste’,
- ONR-NS-INSP-GD-034 ‘LC34 – Leakage and Escape of Radioactive Material and Radioactive Waste’.

4.7 Delicencing

116. During the delicencing phase, the Inspector may wish to consider:

- the regime for monitoring any residual civil engineering structures, such as foundations, filled tanks, concrete bases or below ground services which have not been removed,
- the potential safety consequences of landscaping proposals, including slope stability and surface water run-off,
- the records available regarding completion of works.

117. Note that every conventional hazard does not necessarily need to have been addressed at the point a facility is delicenced, in agreement with the relevant environmental regulatory body. Residual hazards that exist post delicencing should be clearly recorded and provided to future users of the site. The Inspector may wish to consider the adequacy of the records regarding the location of such residual hazards.

118. Records of all structures and materials remaining on site, especially those not visible from the surface, must be collated and provided to the relevant enforcing authority and future users at the end of demolition and site clearance.

119. ONR’s processes for the delicensing of nuclear sites, are set out in the document ‘Licensing Nuclear Installations’ which is published on ONR’s website.

5. RELEVANT STANDARDS AND GOOD PRACTICE

120. Inspectors are advised to check whether these guides are the most up to date given the review period of the TAG.

121. Note the lists provided are not full and comprehensive lists. The Inspector should only use the guidance that is relevant to the scenario being assessed and seek other appropriate guidance to suit the circumstances.

5.1 ONR Technical Assessment Guides (TAGs) and Technical Inspection Guides (TIGs)

122. Those relating to decommissioning and demolition include, but are not limited to:

- ONR-NS-TAST-GD-026 ‘Decommissioning’,
- ONR-NS-TAST-GD-005 ‘Demonstration of ALARP (As Low as Reasonably Practicable)’,
- ONR-NS-TAST-GD-079 ‘Licensee Design Authority Capability’,
- ONR-NS-TAST-GD-049 ‘Licensee Core Safety and Intelligent Customer Capabilities’,
- ONR-NS-TAST-GD-020 ‘Civil Engineering Containments for Reactor Plants’,
- ONR-NS-TAST-GD-077 ‘Supply Chain Management Arrangements for the Procurement of Nuclear Safety Related Items or Services’,
- ONR-NS-TAST-GD-048 ‘Organisational Change’,

- ONR-NS-TAST-GD-027 ‘Training and Assuring Personnel Competence’,
- ONR-NS-TAST-GD-033 ‘Dutyholder Management of Records’,
- ONR-NS-TAST-GD-009 ‘Examination Inspection Maintenance and Testing of Items Important to Safety’,
- ONR-NS-TAST-GD-013 ‘External Hazards’,
- ONR-NS-TINS-GD-011 ‘LC 11 – Training’,
- ONR-NS-TINS-GD-021 ‘LC22 – Modification or experiment on existing plant’,
- ONR-NS-TINS-GD-035 ‘LC 35 - Periodic Safety’,
- ONR-NS-TINS-GD-036 ‘LC 36 – Organisational Capability’.

5.2 UK Regulations

123. Those relating to decommissioning and demolition include, but are not limited to:

- Construction (Design and Management) Regulations 2015 (CDM2015),
- Section 34 of the Environmental Protection Act 1990,
- UK Building Act 1984 and Building Regulations 2010,
- Lifting Operations and Lifting Equipment Regulations 1998 (LOLER 1998),
- Provision and Use of Work Equipment Regulations (PUWER 1998),
- The Electricity at Work Regulations 1989,
- Control of Substances Hazardous to Health Regulations (as amended) (COSHH 2002),
- Working at Height Regulations 2005,
- Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR 2002),
- The Confined Spaces Regulations 1997,
- The Waste (England and Wales) Regulations 2011 (as amended), the Hazardous Waste Regulations 2005 and the Controlled Waste Regulations 2012 and the Special Waste Regulations 1996 (for Scotland, SEPA),
- Control of Asbestos Regulations 2012 (CAR2012) and the Health and Safety at Work (Asbestos) regulations 2016,
- Explosives Regulations 2014.

124. Joint ONR / environment regulator guidance

- EA / SEPA / NRW / ONR ‘Joint Regulators’ Statement of Common Understanding: Disposal of radioactive waste on nuclear sites by deposit or burial”, Nov 2016 http://www.onr.org.uk/documents/2016/joint-regulators-statement.pdf

5.3 Associated UK HSE Guidance (L Series, HSG Series, INDG Series, RR Series)

Legal (L) Series

- L153 Managing Health and Safety in Construction Approved Code of practice for CDM 2015 (supersedes L144 Managing Health and safety in construction ACoP for CDM2007),
- L101 Safe work in confined spaces. Confined Spaces Regulations 1997 Approved Code of Practice, Regulations and guidance,
- L113 Safe use of Lifting Equipment 2014 (LOLER),
- L22 Safe use of Work Equipment 2014 (PUWER), INDG291 Providing and using work equipment safely: a brief guide,
- L5 Control of substances hazardous to health 2013 (COSHH), HSG97 A step by step guide to COSHH Assessment and INDG136 Working with Substances hazardous to health: a brief guide to COSHH 2012,

- L143 Control of Asbestos Regulations 2012 Approved Code of Practice, Regulations and guidance, HSG210 Asbestos Essentials,
- L140 Hand-arm vibration 2005, HSG170 Vibration solutions 1997 Practical ways to reduce hand-arm vibration,
- L150 Explosives Regulations 2014 Safety provisions and L151 Explosives Regulations 2013 Security provisions,
- L138 Dangerous substances and explosive atmospheres (DSEAR), HSG168 Fire safety in Construction, INDG370 Controlling fire and explosion risks in the workplace.

Health and Safety Guide (HSG) Series

- HSG85 Electricity at Work Safe Working Practices 2013 and HSR25 the Electricity at Work Regulations 1989,
- HSG65 Managing for Health and Safety 2013, HSG 159 Managing Contractors,
- HSG268 The health and safety toolbox: how to control risks at work 2014,
- HSG264 Demolition and Refurbishment surveys.

Industrial Guidance (INDG) Series

- HSE Industrial Guidance INDG401 Working at Height, a brief guide.

Research Report (RR) Series

- HSE Research Report RR834 preventing catastrophic events in construction.

5.4 International Guidance (IAEA and WENRA)

125. Nuclear decommissioning specific IAEA international guidance can be found in:

General Safety Requirement

- IAEA GSR Part 6 “Decommissioning of Facilities”.

Safety Guide

- IAEA SSG-47 “Decommissioning of Nuclear Power Plants, Research Reactors and other Nuclear Fuel Cycle Facilities”,
- IAEA Safety Guide No. WS-G-5.1 “Release of Sites from Regulatory Control on Termination of Practices”.

WENRA Safety Reference Levels

- Decommissioning Safety Reference Levels, (see table in Appendix A)
- Waste and Spent Fuel Storage Safety Reference levels.

126. Nuclear decommissioning specific IAEA reports can be found in:

Technical Report

- IAEA Technical Reports Series No. 395 “State of the Art Technology for Decontamination and Dismantling of Nuclear Facilities”,
- IAEA Technical Reports Series No. 439 “Decommissioning of Underground Structures, Systems and Components”,
- IAEA Technical Reports Series No. 440 “Dismantling of Contaminated Stacks at Nuclear Facilities”.

Nuclear Energy Series

- IAEA Nuclear Energy Series No. NW-G-2.1 “Policies and Strategies for the Decommissioning of Nuclear and Radiological Facilities”,
- IAEA Nuclear Energy Series No. NW-T-2.6 “Decommissioning of Pools in Nuclear Facilities”,
- IAEA Nuclear Energy Series No. NW-T-2.10 “Decommissioning after a Nuclear Accident: Approaches, Techniques, Practices and Implementation Considerations”.

5.5 Design standards and industrial guidance

127. Those relating to decommissioning and demolition include:

Design standards

- BS 6187:2011 Code of Practice for Full and Partial Demolition,
- BS 5607:2017 Code of Practice for the Use of Explosives in the Construction Industry,
- BS EN 1991-1-4:2005 +A1 2010 Eurocode 1 Actions on structures: wind loads e.g. considering dominant openings for demolition activities,
- BS 8560:2012 Code of Practice for the design of buildings incorporating safe working at height,
- Historical Codes of Practice used for original design and construction such as BS449, CP 110, CP114, CP115, BS 8110, BS 5950 and GS29/Part 1,
- IStructE guide Appraisal of existing Structures 3rd edition 2010,
- ACI 318, Building code requirements for structural concrete,
- ACI 349, code requirements for nuclear safety related concrete structures, special provision for impulsive and impactive effects.

Industrial Guidance

- “Practical guide to structural robustness and disproportionate collapse in buildings” IStructE October 2010, but nuclear safety related structures may require more details and specific consideration on a case by case basis.

128. Additional normative references to the above, including but not limited to:

Industrial information available on the websites of:

- Institute of Explosives Engineers (IExpE),
- Institute of Demolition Engineers (IDE),
- National Federation of Demolition Contractors (NFDC),
- Standing Committee on Structural Safety (SCOSS),
- Construction Plant Association Guidance (CPA).

6. REFERENCES

7. ONR, ‘Safety Assessment Principles for Nuclear Facilities’, 2014 Edition, Rev 0, November 2014, www.onr.org.uk/saps/saps2014.pdf.

1. WENRA Decommissioning Safety Reference Levels

2. IAEA Safety Standards SSG-47 ‘Decommissioning of Nuclear Power Plants, Research Reactors and other Nuclear Fuel Cycle Facilities’ 2018 www.iaea.org (Last accessed November 2020)

3. IAEA General Safety Requirements No. GSR Part 2 ‘Leadership and Management for Safety’ 2016 www.iaea.org (Last accessed November 2020)

4. IAEA GSR Part 6 ‘Decommissioning of Facilities’ 2014 www.iaea.org (Last accessed November 2020)

TABLE 1: WENRA DECOMMISSIONING SAFETY REFERENCE LEVELS

Written by the WENRA WGWD (Working Group on Waste and Decommissioning)

Ref	Subject	SAP	Section Ref
DE-03	The ultimate responsibility for safety shall remain with the licensee, although it is permissible to delegate the performance of specific tasks to subcontractors. The licensee shall ensure that the work of contractors is appropriately controlled so that it is conducted safely.	SC.8, MS.2, DC.7	2.3
DE-05	The licensee shall establish an organizational structure for the management and implementation of decommissioning, with the responsibility to ensure that decommissioning will be conducted safely.	MS.2	2.3
DE-07	The licensee shall ensure that there is a clear allocation of authorities and responsibilities, together with the interfaces and communication routes that will be used especially when contractors or outside organizations are used.	MS.2, DC.7	2.3
DE-08	The licensee shall evaluate the skills needed for safe decommissioning and shall determine the minimum number and qualification requirements of staff responsible for safety at the various stages of decommissioning.	MS.2, SC.1, EHF.8, DC.7	2.3
DE-09	The licensee shall ensure that sufficient knowledge of the facility and technical expertise is maintained during lifetime of the facility. The licensee shall ensure that appropriate records and reports that are relevant to decommissioning (e.g. records on the use of the facility, events and incidents, radionuclide inventories, dose rates and contamination levels) shall be retained during lifetime of the facility. In this way, the design and modifications of the facility and its operating history will be identified and factored into the decommissioning plan.	DC.6, DC.3 EMC.2, ENM.4, RL.1, RL.7, MS.2, RW.6	2.5
DE-12	The licensee shall ensure that the management system is applied to all phases of decommissioning taking into account the continuous change during decommissioning.	MS.2, DC.3	2.3
DE-13	The licensee shall ensure, that processes of the management system that are needed to achieve the goals, provide the means to meet all requirements and deliver the products of the organization are identified, and their development are planned, implemented, assessed and continually improved. The work performed in each process shall be carried out under controlled conditions, by using approved current procedures, instructions, drawings or other appropriate means that are periodically reviewed to ensure their adequacy and effectiveness	DC.8, ECE.17	2.4
DE-14	The licensee shall ensure that the documentation of the management system includes the following: - The policy statements of the licensee; - A description of the management system; - A description of the organisational structure of the licensee; - A description of the functional responsibilities, accountabilities, levels of authority and interactions of those managing, performing and assessing work; - A description of the interactions with relevant external organisations; - A description of the processes and supporting information that explain how work is to be prepared, reviewed, carried out, recorded, assessed and improved.	DC.2	2.4
DE-15	The licensee shall take account of the need to decommission a facility at the time it is being planned, designed, constructed and operated. Measures, including design features, contamination and activation control, shall be described and justified.	DC.1	2.3
DE-17	The licensee shall establish a decommissioning strategy for its facility. This decommissioning strategy shall be consistent with existing related national	DC.2	2.1

	strategies and regulatory requirements, e. g. on decommissioning or radioactive waste management.		
DE-18	The decommissioning strategy shall be documented including a description of the options, overall timescales for the decommissioning of the facility and the end-state after completion of all decommissioning activities. The reasons for the preferred option shall be explained, and options not involving immediate dismantling shall be rigorously justified.	DC.2	2.1
DE-19	Based on the established decommissioning strategy the licensee shall establish an initial decommissioning plan for the facility. The details of the plan shall be commensurate with the type and status of the facility (graded approach).	DC.2	2.2
DE-20	The licensee shall submit the initial decommissioning plan to the regulatory body in support of the licence application for construction for a new facility.	DC.4,	2.2, 3.1,
DE-21	The initial decommissioning plan shall: (a) take into account major safety issues; (b) support the fact that decommissioning can be safely conducted using proven techniques or ones being developed; (c) include a generic study showing the feasibility of decommissioning; (d) include consideration of environmental aspects of decommissioning, such as management of waste and radioactive effluents; (e) provide a basis to assess the costs of the decommissioning work and the means of financing it.	DC.4, DC.5	2.2, 3.3
DE-22	If several facilities are located at the same site it shall be ensured that in each facility decommissioning plan any interactions and interdependencies between the facilities are taken into account.	DC.3	2.6
DE-23	During operation the decommissioning plan shall be reviewed by the licensee regularly, at least as frequently as the periodic safety review, and shall be updated as required. These reviews of the decommissioning plan shall consider, in particular, changes in the facility operation experiences or regulatory requirements, and advances in technology to further evolve the decommissioning plan.	DC.5	4.3
DE-24	The decommissioning plan shall be supported by an appropriate safety assessment for the decommissioning activities the details of which are commensurate with the type and status of the facility (graded approach).	SAPs para 826	2.2
DE-25	The decommissioning plan shall identify major existing systems and equipment that may be used during decommissioning to ensure that they are available when needed. The decommissioning plan shall also identify necessary changes or replacements of these existing systems. The decommissioning plan shall also identify the need for existing and new facilities to carry out decommissioning and waste management.	DC.4	2.2
DE-26	As soon as it has been decided to permanently shut down a nuclear facility, the licensee shall inform the regulatory body.	DC.4	ONR-NS-TAST-GD-026 para 5.9.19 2.2
DE-27	If a facility is shut down and no longer used for its intended purpose, a final decommissioning plan shall be submitted to the regulatory body not later than two years after the shutdown of the facility, unless an alternative schedule for the submission of the final decommissioning plan is specifically authorized by the regulatory body.	DC.4	2.2
DE-28	A final decommissioning plan shall - be consistent with the decommissioning strategy proposed for the facility, - be consistent with the safety case for decommissioning (ref. DE-50),	DC.4	2.2

	- describe the decommissioning activities, including the timeframe and the end-state of the decommissioning project, and the content of the individual phases, if a phased approach is applied, - describe the facilities, systems and equipment needed to perform the decommissioning project, - describe the organisational structure, skills and qualifications required for safe decommissioning, - describe the management of residual material and waste in accordance with the national waste strategy, and - describe the program of the final radiation survey of the end-state of decommissioning.		
DE-29	Depending on the timeframe of decommissioning, the decommissioning plan shall be reviewed regularly by the licensee during decommissioning operations and shall be updated as required. These updates of the decommissioning plan are to reflect, in particular, changes in the decommissioning strategy, deviations from the scheduled program, experiences from ongoing decommissioning or changes of regulatory requirements and advances in technology.	DC.9	2.2
DE-30	SSCs may be re-classified as they change in importance to safety in the course of decommissioning activities. The licensee shall reflect this re-classification in the safety case.	ECS.1	2.6
DE-43	The licensee shall address the ageing of SSCs and other equipment significant to safety by establishing, if necessary, provisions for their maintenance, testing and inspection.	ECE.18 ECE.20 ECE.26	2.3.2
DE-44	The licensee shall record, store, analyse and review data on maintenance, testing, surveillance, inspection of SSCs and other equipment relevant for safety. Where necessary corrective measures such as repair, replacement or changes in the maintenance programme shall be implemented.	DC.6, DC.3, ECE.20	2.3.2, 2.5
DE-46	No decommissioning activity shall be 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. Due consideration shall be given to different decommissioning activities executed in parallel which might adversely affect safety of each other.	ECS.1	2.6, 2.3.3
DE-47	The licensee shall control modifications of planned decommissioning activities according to their safety significance thereby ensuring that they do not compromise the safety of decommissioning activities.	ECE.18 ECE.20 ECE.26	2.3.2
DE-48	In case of deferred dismantling the licensee shall make the facility passively safe as far as it is reasonably practicable before entering the period of deferment, so as to minimize the need for active safety systems, monitoring, and human intervention in order to ensure safety.	EHA.7, EHA.18 ECE.6 DC.5	2.7
DE-58	The licensee shall prepare a final decommissioning report to demonstrate, that the decommissioning has been completed and the proposed end state of the facility or site has been achieved.	DC.6	4.5
DE-59	The licensee shall ensure that relevant records and the final decommissioning report are available and accessible at the end of decommissioning according to the national regulatory system.	ECE.20 DC.6 DC.3	2.5
DE-60	Before a facility or site can be released from regulatory control, the licensee shall perform a final survey to demonstrate that the end-state, as approved by the regulatory body, has been met.	DC.6	4.5