



ONR GUIDE			
CIVIL ENGINEERING			
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LIST OF ABBREVIATIONS

ALARP	As Low as Reasonably Practicable
ASCE	American Society of Civil Engineers
BDB	Beyond Design Basis
BIM	Building Information Modelling
CDM2015	Construction (Design and Management) Regulations 2015
CIRIA	Construction Industry Research and Information Association
DCO	Development Consent Order
EIMT	Examination, Inspection, Maintenance and Testing
GDA	Generic Design Assessment
HSE	Health & Safety Executive
IAEA	International Atomic Energy Agency
LC	Licence Condition
ONR	Office for Nuclear Regulation
OPEX	Operating Experience
RGP	Relevant Good Practice
SAP(s)	Safety Assessment Principle(s)
SQEP	Suitably qualified and experienced person
SSC	Structure, System and Component
TAG	Technical Assessment Guide(s) (ONR)
TIG	Technical Inspection Guide(s) (ONR)
WENRA	Western European Nuclear Regulators' Association

GLOSSARY

Term	Definition	Source
Ageing	General process in which characteristics of a structure, system or component gradually change with time or use. It is most commonly used with a connotation of changes that are (or could be) detrimental to protection and safety (i.e. as a synonym of ageing degradation).	IAEA
Ageing Management	Engineering, operations and maintenance actions to control, within acceptable limits, the ageing degradation of structures, systems and components. Examples of engineering actions include design, qualification and failure analysis. Examples of operations actions include surveillance, carrying out operating procedures within specified limits, and performing environmental measurements.	IAEA
ALARA (as low as reasonably achievable)	See optimization of protection (and safety).	IAEA
ALARP (as low as is reasonably practicable) SFAIRP (So far as is reasonably practicable)	ALARP/SFAIRP is the balance between risk and the sacrifice to reduce it, (cost, time and trouble) (Within Decommissioning) the removal and/or immobilisation of the most active or mobile material to be carried out on the shortest timescale, with further actions following with timescales appropriate to the remaining hazards they address.	HSWA
Asset Management	Asset management considers the condition of civil engineering SSCs, and how the current (and likely foreseeable) condition may influence the way in which SSCs will respond to the anticipated design loading conditions (including design basis, beyond design basis and cliff edge effects). It also includes any associated EIMT actions required to ensure that SSCs remain capable of fulfilling their safety functions throughout the periods of construction, operation and decommissioning, including any period of deferred decommissioning.	For the purposes of this TAG and the associated annexes
Characterisation	Determination of the nature and activity of radionuclides present in a specified place.	IAEA
Clean Up	See remediation.	IAEA
Clearance	Removal of radioactive material or radioactive objects within authorised practices from any further regulatory control by the regulatory body. Removal from control in this context refers to control applied for radiation protection purposes.	IAEA Safety Glossary
Civil engineering works	“civil engineering works”, covers the totality of activities associated with such works, from concept, initial and final analysis and design through to, construction, maintenance, modification, demolition and site clearance. See Appendix A for full description	For the purposes of this TAG and the associated annexes
Commissioning	The process by means of which systems and components of facilities and activities, having been constructed, are made operational and verified to be in accordance with the design and to have met required performance criteria.	IAEA Safety Glossary
Construction	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
	“construction work” means the carrying out of any building, civil engineering or engineering construction work and includes—	CDM2015

	<p>(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;</p> <p>(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;</p> <p>(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;</p> <p>(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;</p> <p>(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</p>	
Decommissioning	Administrative and physical actions taken to allow removal of some or all of the regulatory controls from a nuclear facility.	SAPs definition:
Decommissioning Plan	A document containing detailed information on the proposed decommissioning of a facility.	IAEA Safety Glossary
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 glossary
Design	<p>This civil engineering TAG 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.</p> <p>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.</p>	For the purposes TAG 17 and all the associated annexes
	"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 Code	A standard with industry, national or international status, that defines the technical and possibly organisational rules by which an item or process can be described and realised.	SAPs glossary
Design Life	The period for which the designer intended an SSC to perform its safety function within the originally specified parameters. It is based upon a range of operating assumptions, including that the SSC will be subject to routine maintenance during its design life.	For the purposes TAG 17 and all the associated annexes
Design Report	The Design Report (also known by other names) includes the stress calculations and other data and information in sufficient detail to	SAPs glossary

	<p>demonstrate compliance with the appropriate codes and standards. This is done by showing that the applicable stress and other limits and requirements of the chosen design code are met when the system, component or item is subjected to the loading conditions defined in the design specification.</p> <p>The Design Report should be reconciled with all design changes, including deviations, which occur prior to the completion and acceptance of the items described in the Design Report.</p>	
Deviations	Deviations are unplanned departures from the intended requirements. Deviations can emerge at any stage of the construction or modification, including design, manufacturing, storage and transportation.	SAPs glossary
Disposal	Emplacement of waste in an appropriate facility without the intention of retrieval.	IAEA
Duty holder	For the purpose of this document and suite of associated annexes, 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 the purposes of this document and suite of associated annexes
End State	(In relation to decommissioning activities) the final state of decommissioning.	IAEA
	The end state is defined as a predetermined criterion defining the point at which a specific task or process (i.e. decommissioning) is to be considered completed. The actual end state is tailored to address the safety and environmental needs in each situation.	IAEA WS-R-5
Installation	"installation" means "nuclear installation" and has the meaning assigned thereto in the Nuclear Installations Act 1965; herein referred to also as 'facility'	LCs
Intelligent Customer	The capability of an organisation to understand where and when work is needed; specify what needs to be done; understand and set suitable standards; supervise and control the work; and review, evaluate and accept the work carried out on its behalf.	SAPs glossary
Items or services	Items or services referred to in this guidance are those that contribute to nuclear safety including those that provide the principal means of ensuring safety. Items include components, assemblies, vessels and civil structural components, structures and facilities whilst services include design, inspection, technical support and peer review.	SAPs glossary
Life Management (or lifetime management)	The integration of ageing management with economic planning: (1) to optimize the operation, maintenance and service life of structures, systems and components; (2) to maintain an acceptable level of performance and safety; and (3) to maximize the return on investment over the service life of the facility	IAEA
Manufacturer/ contractor/ vendor (see dutyholder)	The supplier organisation that designs, constructs and tests items or services in accordance with a purchaser's order. This term includes the main manufacturer and any sub-contractors in the supply chain. It also encompasses the scenario where design, manufacture, and installation might be carried out by different organisations.	SAPs glossary
Modification	"modification" means any alteration to buildings, plants, operations, processes or safety cases and includes any replacement, refurbishment or repairs to existing buildings, plants or processes and alterations to the design of plants during the period of construction;	LCs
Non-conformance	Items or services that do not meet their intended requirements. Non-conformances can emerge at any stage of the supply chain, including design, manufacturing, storage and transportation.	SAPs glossary
Nuclear installation / nuclear facility	Any facility that is within the bounds of a nuclear site licence and / or under the vires of ONR, including nuclear power plants, new build sites, potential new build sites and post operational facilities.	For the purposes of this document only

Nuclear Safety	The achievement of proper operating conditions, prevention of accident or mitigation of accident consequences, resulting in protection of workers, the public and the environment from undue radiation hazards. In this document safety means nuclear safety unless otherwise stated.	SAPs glossary
Optimisation of protection (and Safety)	The process of determining what level of protection and safety makes exposures, and the probability and magnitude of potential exposures, "as low as reasonably achievable, economic and social factors being taken into account" (ALARA), as required by the International Commission on Radiological Protection System of Radiological Protection.	IAEA
Optioneering	A process used to choose an option where more than one option exists, usually using a scoring system which should demonstrate risks are reduced in accordance with the ALARP principle.	For the purposes of this document only
Quality Management System	A management system to direct a unit and control an organisation with regard to quality; a combination of resources and means with which quality is realised.	SAPs glossary
Quality Plan	A document or set of documents setting out the specific quality practices, resources and sequence of activities relevant to realisation of a particular item or service. A quality plan is useful for formalising and co-ordinating the interactions of various organisations, including the IA and the ONR, through the identification of witness and hold points. Note: Quality Plans are called many different names within industry. The purchaser should identify in their contract their requirements and expectations for workface Inspection and test documents, including defining the meaning of inspection codes to be marked up in those documents.	SAPs glossary
Radioactive Materials, Radioactive waste	"radioactive material" has the meaning, disregarding the exception in paragraph 9 (contaminated articles or substances) of Part 2 of Schedule 23 to the Environmental Permitting (England and Wales) Regulations 2016, given in paragraph 3 of that Part of that Schedule to those Regulations (version to be attached to licensed sites in England and Wales); "radioactive material" has the meaning, disregarding section 1G of the Radioactive Substances Act 1993, given in section 1A of that Act (version to be attached to licensed sites in Scotland); "radioactive waste" has the meaning assigned thereto in paragraph 3 of Part 2 of Schedule 23 to the Environmental Permitting (England and Wales) Regulations 2016 (version to be attached to licensed sites in England and Wales); "radioactive waste" has the meaning assigned thereto in section 1A of the Radioactive Substances Act 1993 (version to be attached to licensed sites in Scotland);	Licence Condition Handbook definitions
Radioactive Waste Management	All administrative and operational activities involved in the handling, pre-treatment, treatment, conditioning, transport, storage and disposal of radioactive material.	IAEA
Safety	'safety' means the protection of people and the environment against radiation risks, and the safety of facilities and activities that give rise to radiation risks.	IAEA
	"safety" refers to the safety of persons whether on or off the site;	LCs
Safety Case	In this document, 'safety case' refers to the totality of a duty holder's documentation to demonstrate safety, and any sub-set of this documentation that is submitted to ONR.	SAPs glossary
	Note: Licence Condition 1 defines 'safety case' as the document or documents produced by the dutyholder in accordance with Licence Condition 14.	LCs
	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	For the purpose of this document only

	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.	
Safety Culture	The assembly of characteristics and attitudes in organisations and individuals, which establishes that, as an overriding priority, protection and safety issues receive the attention warranted by their significance.	IAEA Safety Glossary.
Siting	The process applied to choosing suitable location for a new nuclear licensed site, government policy.	For the purpose of this document only
Storage	The holding of radioactive sources, spent fuel or radioactive material in a facility that provides for their/it's containment, with the intention of retrieval.	IAEA
Supply Chain	The assembly of characteristics and attitudes in organisations and individuals, which establishes that, as an overriding priority, protection and safety issues receive the attention warranted by their significance (IAEA Safety Glossary).	SAPs glossary
Structure	A system of interconnected members assembled in a stable configuration and used to withstand a load or combination of loads.	derived
	<p>"structure" means—</p> <p>(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;</p> <p>(b) any structure similar to anything specified in paragraph (a);</p> <p>(c) any formwork, falsework, scaffold or other structure designed or used to provide support or means of access during construction work,</p> <p>and any reference to a structure includes part of a structure;</p>	CDM2015
Structure (Civil Engineering)	<p>The load resisting elements of non-mobile constructed systems, but not the non-load resisting elements.</p> <p>Non-load bearing components such as building cladding, roofing, rainwater goods, corrosion protection measures and windows and doors are often referred to as 'Civil, Structural and Architectural', but for the purposes of this TAG, if such a non-load bearing component provides a safety function, it is covered by 'civil engineering works'.</p>	For the purpose of this document only
Systems, Structures and Components important to safety (SSCs)	<p>Systems, structures and components important to safety (SSCs): A general term encompassing all the plant elements (items) of a facility or activity which contribute to protection and safety, except human factors.</p> <ul style="list-style-type: none"> - Structures are the passive elements: buildings, vessels, shielding, etc. - A system comprises several components and/or structures, assembled in such a way as to perform a specific (active) function. - A component is a discrete element of a system. <p>Examples of components are wires, transistors, integrated circuits, motors, relays, solenoids, pipes, fittings, pumps, tanks and valves.</p>	WENRA RHWG Safety of New NPPs
Technical Query	A question for approval prior to work stage commencement. Clarification of requirements. Care should be taken as some responses to TQ's may require a change to the specification or requirements and thus controlled as deviations to ensure the as built condition is captured.	SAPs glossary
Technical Specification	The Technical Specification defines the system, components and items, as applicable, in sufficient detail to provide a complete basis for the design, manufacture, testing and installation.	SAPs glossary

1 INTRODUCTION

1. ONR has established its Safety Assessment Principles (SAPs) [1] which are applied by ONR specialist inspectors during assessment of safety cases for nuclear installations across the different stages of site lifetime. The ONR assessment may be of the work of requesting parties, potential licensees, existing licensees, or other duty-holders, see glossary definition.
2. The principles presented within the SAPs are supported by a suite of guides to further assist ONR's inspectors in their technical assessment work supporting regulatory judgements. This technical assessment guide (TAG) is one of these guides.
3. The audience of this TAG is assumed to be experienced civil engineering specialist nuclear safety inspectors and those working to develop to achieve this role.

2 PURPOSE AND SCOPE

2.1 Purpose

4. The primary responsibility for safety of a nuclear installation rests with the dutyholder. This TAG provides guidance for inspectors on the interpretation of the ONR Safety Assessment Principles (SAPs) which relate to civil engineering works and structures at nuclear licensed sites. See Appendix B for the SAPs considered in this document.
5. TAGs contain guidance to advise and inform inspectors in the exercise of their regulatory judgment. They are also part of the demonstration on how ONR meets the Western European Nuclear Regulator's Association (WENRA) Reference Levels and how ONR links its guidance to that contained in the International Atomic Energy Agency (IAEA) safety standards, through the use of the SAPs.
6. TAGs are a suite of documents written as guidance to inspectors. TAGs are not written for duty holders, and although they may be used as a source of guidance or good practice, they are not a prescriptive set of legal requirements. Other relevant TAGs from the suite of documents are referenced herein, cited throughout and included as a table in the appendices.
7. This TAG encompasses the broad expectations on key points that inspectors may wish to consider during civil engineering assessment when judging adequacy of processes and arrangements, in order to provide confidence that:
 - the 'civil engineering works' (design or otherwise) are undertaken in accordance with appropriate design intent, with links through to, and as required by, the safety case, and,
 - design assumptions and safety case claims are not undermined by design or construction activities, modifications or other decisions including choices of materials and methodology used,
 - where the expectations of the SAPs are not met, proposed justification of the alternative arrangements are assessed on a case by case basis.
8. When using this TAG, the Inspector should:
 - exercise their own judgement and discretion in the depth and scope to which they apply the guidance, whilst,
 - not use the topics raised in this TAG as a checklist, but as a guide for important areas which may be addressed when undertaking an assessment,
 - be cognisant of what safety reliance is placed on Structures, Systems and Components (SSCs), and why,
 - be cognisant of how the safety functional requirements placed on SSCs are met throughout all stages of assessment.

2.2 Scope

9. The scope of 'civil engineering works' and structures is broad. For the purposes of this document, the term 'civil engineering works and structures' is defined in Appendix A.
10. This civil engineering TAG applies to nuclear licenced sites equally across all stages of a nuclear site lifecycle, including generic and/or concept design, licensing, site identification, site specific design, construction and installation, operation, modification, post-operation, decommissioning and demolition, 'care and maintenance' phase etc.
11. 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 as much a part of the safety case as the design.
12. This TAG:
 - identifies the relevant Safety Assessment Principles (SAPs) which relate to different topics of civil engineering and the relevant Licence Conditions,
 - is an interpretation of these principles related to each civil engineering topic with key elements which the Inspector may choose to consider in a safety case submission from a dutyholder,
 - demonstrates that the SAPs are aligned with international guidance,
 - makes reference to relevant TAGs, guidance documents and stakeholders.
13. This TAG is not intended to be a detailed civil engineering design guide; nor does it prescribe specific methods and approaches for assessing them or offer guidance on how to judge the adequacy of their technical content. Its main purpose is to highlight salient areas for consideration as part of the regulatory process through planned interventions and assessment of civil engineering nuclear significant structures systems and components (SSCs) as part of the civil engineering works and structures.
14. Although the contents of this TAG may be useful to all inspectors, liaison is encouraged for inspectors to discuss civil engineering topics with inspectors who specialise in civil engineering for advice.

2.3 Structure of this Technical Assessment Guidance (TAG)

15. As stated in IAEA SSR-2/1 [2], the safety of a nuclear installation is ensured by means of proper site selection, design, construction and commissioning, and the evaluation of these, followed by proper management, operation and maintenance of the facility. In a later phase, appropriate transition to de-commissioning and site clearance is required.
16. As a result, this TAG has been structured in a chronological order, from site selection and investigation through to decommissioning and demolition, identifying the relevant SAPs and key civil engineering assessment principles for each stage in the lifecycle. The stages of civil engineering works considered in this TAG are as follows:
 - Site selection,
 - Generic Design Assessment Step 1, 2,3 (and 4 if applicable),
 - Site Licensing, including site investigations,
 - Site Specific Design,
 - Construction,
 - Commissioning,
 - Operation/EIMT/Asset Management,
 - Decommissioning, Demolition, C&M Phase and Site clearance.

17. Section 2 sets out the purpose and scope of civil engineering works for use with this TAG [Appendix A].
18. Section 3 of this TAG discusses the relevant SAPs [Appendix B] and relevant licence conditions (LCs) [Appendix C] and other legislation considered as most applicable and relevant to safety related civil engineering works and structures on GB nuclear sites.
19. Section 4 forms part of the demonstration of how ONR links its guidance to that contained within the IAEA safety standards [Appendix D] and the WENRA Safety Reference Levels [Appendix E].
20. Section 5 of this TAG discusses ONR's approach to the assessment of civil engineering works and structures. TAGs are intended to provide guidance for inspectors to carry out their regulatory duties, in the exercise of their regulatory judgement, referencing relevant SAPs, IAEA and WENRA guidance and identifying cross references to other TAGs [Appendix F] and external interfaces [Appendix G].
21. The appendices to this document are:
 - Appendix A - Scope of 'civil engineering works' and structures,
 - Appendix B - SAPs relevant to civil engineering (ECE suite and others),
 - Appendix C – List of licence conditions relevant to civil engineering (with key principles),
 - Appendix D - International Atomic Energy Agency (IAEA) Standards, Guidance and Technical Documents related to civil engineering,
 - Appendix E - Western European Nuclear Regulators Association (WENRA) Reactor Safety, Decommissioning and Waste and Spent Fuel Storage Reference Levels related to civil engineering,
 - Appendix F - Internal interfaces civil engineering assessment has within ONR,
 - Appendix G - Interfaces civil engineering assessment has with external stakeholders.
22. Section 5 also makes reference to annexes, following the chronological order:
 - Annex 1 – Design,
 - Annex 2 – Building Information Modelling,
 - Annex 3 – Ground investigations, Geotechnics and Underground Structure Design,
 - Annex 4 – Construction Assurance,
 - Annex 5 – Ageing Management and Damaged Structures,
 - Annex 6 – Post Operation.

2.4 Exclusions

23. This TAG has not included detailed information related to the following; please see other relevant guidance for more information:

Topic	Relevant guidance
Structures not claimed in a nuclear safety case, such as office buildings and canteens that are not required for post-accident shelter and/or emergency response activities	Building Regs [3]
Conventional Health and Safety	ONR-NS-INSP-GD-051 'The Regulation of Conventional Health and Safety on UK Nuclear Sites'

Assessment of robustness of hazard assessments (the result of which provides inputs to be considered in the civil engineering design)	<p>ONR-NS-TAST-GD-013 'External Hazards'</p> <p>ONR-NS-TAST-GD-014 'Internal Hazards'</p>
Steel pressure vessels and their internal structures pipework and metal tanks	ONR-NS-TAST-GD-016 'Integrity of Metal Structures, Systems and Components'
Containment, including Pre-stressed concrete pressure vessels, reactor containment buildings, tension systems, fuel stores, waste stores, small modular reactors and other reactor types	<p>ONR-NS-TAST-GD-020 'Civil Engineering Containments for Reactor Plants'</p> <p>ONR-NS-TAST-GD-081 'Safety Aspects Specific to Storage of Spent Nuclear Fuel'</p> <p>ONR-NS-TAST-GD-035 'Limits and Conditions for Nuclear Safety (Operating Rules)',</p> <p>ONR-NS-TAST-GD-067 'Pressure Systems Safety',</p> <p>ONR-NS-INSP-GD-034 'LC34 Leakage and Escape of Radioactive Material and Radioactive Waste',</p> <p>ONR-NS-INSP-GD-023 'LC23 Operating Rules'.</p>
Disposal of radiological waste, design of deep geological disposal facilities	<p>ONR-NS-TAST-GD-101 'Geological Disposal'</p> <p>Annex 4 'Licensing and regulating a future geological disposal facility' of 'Licensing Nuclear Installations' [4]</p> <p>'Geological Disposal Facilities for Radioactive Waste' IAEA SSG-14 [5]</p> <p>'Site Investigations for Repositories for Solid Radioactive Wastes in Deep Continental Geological Formations' IAEA Technical Report No. 215 [6]</p>
Specific aspects of the nuclear defence programme outside the scope of 'civil engineering works and structures' as described in Appendix A of this document	<p>ONR-NS-INSP-GD-056: 'Regulation of GB's Defence Programme' [7]</p> <p>It is noted that the guidance provided herein apply to all aspects of civil engineering SSCs and will therefore apply to areas regulated by DNSR.</p>
Security measures associated with design information management and supply chain	<p>ONR-CNS-TAST-GD-4.3 'Oversight of Suppliers of Items or Services of Nuclear Security Significance'</p> <p>ONR-CNS-TAST-GD-7.1 'Effective Cyber & Information Risk Management'</p> <p>ONR-CNS-TAST-GD-7.2 'Information Security'</p> <p>ONR-CNS-TAST-GD-7.4 'Physical Protection of Information'</p>

Security aspects on a nuclear facility	<p>ONR-CNS-TAST-GD-6.6 'Nuclear Construction Sites'</p> <p>ONR-CNS-TAST-GD-5.2 'Examination, Inspection, Maintenance and Testing of Physical Protection Systems'.</p>
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Table 1 – Exclusions of scope within this TAG document

24. Whilst the Construction (Design and Management) Regulations 2015 (CDM2015) are not excluded from consideration in TAG 17, the roles and duties are not discussed in any detail. For information on the roles and duties of CDM2015 compliance, see:

- HSE publication: L153 'Managing health and safety in construction' [8]

2.5 Update of this TAG

25. This revision of this TAG is a reorganisation of the previous TAG in the interest of increased clarity. ONR's approach towards civil engineering has been established for some time and remains unchanged. Experience from using the previous TAG has shown that some aspects of civil engineering would benefit from more explicit presentation within our guidance, which this revision aims to provide.

26. Comments on this guide and suggestions for future revisions should be recorded on a comment sheet held in the CM9 file noted for this record [9], with the civil engineering Professional Lead informed.

3 RELATIONSHIP TO LICENCE CONDITIONS & OTHER RELEVANT LEGISLATION

3.1 Licence Conditions

27. This TAG does not specifically address a single Licence Condition. The scope of 'civil engineering works and structures' cuts across all the phases of a site and the nature of the subject and potential effect on safety means there are many possible relevant licence conditions.

28. As such, the licence conditions (LCs) considered to be most applicable to civil engineering works and structures as covered in this TAG are as follows:

- LC 6: Documents, Records, Authorities and Certificates,
- LC 7: Incidents on site,
- LC 10: Training,
- LC 11: Emergency Arrangements,
- LC12: Duly authorised and suitably qualified and experienced persons,
- LC 14: Safety documentation,
- LC 15: Periodic review,
- LC 16: Site plans, designs and specifications,
- LC 17: Management systems,
- LC 19: Construction or installation of new plant,
- LC 20: Modification to design of plant under construction,
- LC 21: Commissioning,
- LC 22: Modification or experiment on an existing plant,
- LC 23: Operating Rules,
- LC 25: Operational Records,
- LC 27: Safety mechanisms, devices and circuits,
- LC 28: Examination, Inspection, Maintenance and Testing (EIMT),
- LC 29: Duty to carry out tests, inspections and examinations,
- LC 34: Leakage and escape of radioactive material and radioactive waste,
- LC 35: Decommissioning.

29. Appendix C lists a selection of civil engineering related topics for consideration for each of the relevant Licence Conditions.

3.2 Other Relevant Legislation

30. The Energy Act 2013 (TEA13) [10]: 'Relevant statutory provisions of The Energy Act' (TEA) 2013 include sections 1; 3-6; 22 and 24A of the Nuclear Installations Act (NIA) 1965 (as amended) [11] along with the following other Acts and Regulations:

31. The NIA [11] sets out that no site may be used in Great Britain (GB) for the purpose of installing or operating a nuclear reactor or prescribed nuclear installation unless a licence has been granted by ONR and is in force. The NIA makes provision for the attachment of licence conditions to construction and modification activities, these are therefore subject to TEA13 [10] arrangements for regulation and enforcement.

3.3 Health and Safety at Work etc. Act 1974 (HSWA)

32. The general duties under the Health and Safety at Work etc. Act 1974 (HSWA) [12] impose statutory requirements as follows:

- “2 (1) It shall be the duty of every employer to ensure, so far as is reasonably practicable, the health, safety and welfare at work of all his employees.
- 3 (1) It shall be the duty of every employer to conduct his undertaking in such a way as to ensure, so far as is reasonably practicable, that persons not in his employment who may be affected thereby are not thereby exposed to risks to their health or safety.
- 6 (1) It shall be the duty of any person who designs, manufactures, imports or supplies any article for use at work or any article of fairground equipment –
- (a) to ensure, so far as is reasonably practicable, that the article is so designed and constructed that it will be safe and without risks to health at all times when it is being set, used, cleaned or maintained by a person at work.”

33. The Health and Safety at Work Act 1974 (HSWA) [12] gives the powers to the regulator for regulating health and safety in the UK. HSWA allows for approved codes of practice (ACOPs) to be published by the HSE. If a dutyholder has followed the relevant ACOPs then this is regarded as following current good practice. ACOPs relevant to civil engineering in general and conventional health and safety are given on the HSE website, mainly under L series (Legal) and HSG series (Health & Safety Guidance). There are currently no ACOPs specifically written for nuclear licensed sites.

3.3.1 Legal Definition of ALARP

34. In particular, when considering the Health and Safety at Work Act, the Inspector should focus on standards and principles, the visibility of optioneering to demonstrate that the ALARP principle has been applied, as well as the adequacy of the design process and associated arrangements.
35. Operators of nuclear installations in Great Britain are required to comply with HSWA [12] and its relevant statutory provisions. As stated above, under Sections 2 & 3 of HSWA, employers are required to carry out duties in a manner which reduces risk So Far As Is Reasonably Practical (SFAIRP).
36. The concept of SFAIRP is generally expressed in terms of reducing risks to a situation that is considered ALARP. The terms SFAIRP and ALARP are considered synonymous in the extensive guidance documents provided by the HSE and ONR.
37. For the majority of instances, proving that risk levels have been reduced SFAIRP is achieved by applying established Relevant Good Practice (RGP) and standards.

38. The development of RGP and standards includes As Low as Reasonably Practicable (ALARP) considerations, so in many cases meeting them is sufficient. In other cases, either where standards and RGP are less evident or not fully applicable, the onus is on the dutyholder to implement measures to the point where the costs/delay/effort associated with any additional measures would be grossly disproportionate to the further risk reduction that would be achieved.
39. For further information on ALARP considerations for assessments, see:
- Paras 9-18 of the SAPs [1] which describe the ALARP principle,
 - ONR-NS-TAST-GD-005 'Guidance on the Demonstration of ALARP', provides a link back to HSE guidance and international nuclear specific guidance, with Annex 1 which provides a checklist of consideration for ALARP assessment,
 - Guidance for inspectors regarding regulatory decisions and the role of ALARP can be found in ONR document 'Risk Informed Regulatory Decision Making [13]
 - The concept and general approach to the regulation of safety risks in Great Britain is explained in 'Reducing Risks, Protecting People' [14],
 - HSE documents known as the HSE 'Six Pack' [15] provide guidance on the management of risks to health and safety at work.

3.3.2 Definition of Relevant Good Practice (RGP)

40. RGP is described in ONR-NS-TAST-GD-005 'Guidance on the Demonstration of ALARP' as:
- "...those standards for controlling risk which have been judged and recognised by HSE as satisfying the law when applied to a particular relevant case in an appropriate manner."
41. RGP is established by using the standards that would be applied to a new design as a benchmark and then subjecting any shortfalls to the test of reasonable practicability. Unless the sacrifice entailed in moving towards the benchmark is grossly disproportionate to the safety benefit, the dutyholder should make that move.
42. In general, ONR states that meeting RGP in engineering, operation and safety management leads to risks that are reduced SFAIRP and numerical risk levels that are at least tolerable, and in many cases broadly acceptable.
43. Acceptance criteria for RGP evolve over time; because of technological innovations, improvements in the degree of control, cost impact of improvements or knowledge about the hazard. ONR- NS-TAST-GD-005 'Guidance on the Demonstration of ALARP' provides specific sources for RGP in the nuclear industry as:
- Legal Requirements
 - Approved Codes of Practice (AcoP)
 - Current UK Engineering Standards
 - Standards and Guidance Documents from International Bodies
 - ONR Safety Assessment Principles (SAPs) [1]
 - ONR Technical Assessment Guides (TAGs)
 - ONR Technical Inspection Guides (TIGs)
 - Applicability on Similar installations
44. Specific relevant good practice, ACoPs and other standards are provided in Section 5 of the annexes as guidance, but the Inspector may wish to undertake their own research regarding the relevant good practice that applies to specific situations that they assess.

3.4 The Construction (Design and Management) Regulations 2015 (CDM2015)

45. The Inspector is reminded of Section 9 of CDM2015 [16], which places duties on designers. Further, the Principle Designer and Principal Contractors have additional duties in preparing pre-construction phase plan and health and safety files, which are information that are mandatorily required by CDM2015 for a construction project in Great Britain.
46. For civil engineering, this includes a requirement placed upon the designer to consider the risks during construction, operation, examination, inspection, maintenance and testing (EIMT), decommissioning and demolition.
47. As such, CDM2015 place duties on designers, as part of their design activities, to take due recognition of health and safety throughout the whole design life of the item they are designing. CDM2015 applies to construction projects in Great Britain and place specific legal duties and requirements on organisations and individuals who undertake specific roles e.g. Clients, Designers, Principal Designers, Principal Contractors, and Workers etc. It is the responsibility of the parties who hold duties to understand and comply with the legal duties and requirements placed on them.
48. For the purposes of CDM and the consideration of the civil engineering safety case, the designer duties may apply to the Intelligent Customer, Design Authority and/or in-house or supply chain designers, as well as those decision making parts of the organisation management throughout the life of the site, from design and construction through to decommissioning and delicensing. The Client duties remain with the Licensee, to ensure there are adequate resources available to complete the work. The Inspector is reminded that, when engaging with the dutyholder, the persons they engage with may hold duties under CDM, dependent on their role.
49. The Inspector may wish to undertake an exercise of mapping CDM duties to the relevant sections in their sample of assessment. The Inspector is reminded of the interface with the ONR conventional health and safety inspectors, and a technical inspection guide (TIG) is due to be available in 2021. In the interim, a mapping guide [17] has been provided referencing all ONR TAG documents for inspectors to consider.
50. The Inspector is directed toward these key principles related to CDM as part of nuclear safety civil engineering assessment:
 - managing the risks by applying the general principles of prevention during design,
 - appointing suitably qualified and experienced personnel (SQEP) and appointing organisations at the appropriate time, with all those who hold a CDM role understanding their responsibilities under CDM,
 - duty holders cooperating and communicating with each other and coordinating their work.
51. For more guidance on CDM2015, see:
 - L153 'Managing health and safety in construction' CDM2015 [8],
 - HSG150 Health and Safety in Construction [18],
 - INDG411 A quick guide for clients on CDM2015 [19],
 - CIRIA C756 "CDM2015 Workplace 'in-use' guidance for designers [20]
52. Those who hold roles under CDM2015 may also hold roles of Design Authority (DA) or Intelligent Customer (IC). Occasionally the responsibilities under CDM and Design Authority are similar in intent, with the DA and IC focused on nuclear safety and quality.

53. For guidance regarding responsibilities of DA and IC, see:
- ONR-NS-TAST-GD-079 'Licensee Design Authority Capability',
 - ONR-NS-TAST-GD-049 'Licensee Core Safety and Intelligent Customer Capabilities'

3.5 Other Legislation

3.5.1 The Nuclear Industries Security Regulations 2003.

54. Nuclear Industries Security Regulations 2003 (as amended) (NISR) [21] places obligations on the operators of civil licensed nuclear sites with regard to physical security measures for installations, nuclear material and the security of sensitive nuclear information (SNI). NISR also covers the vetting of permanent staff and contractors. This legislation requires all civil nuclear operators to produce and implement robust nuclear site security plans (NSSP). Developers of civil nuclear facilities have obligations for considering security during the design and construction stages.

3.5.2 The Ionising Radiations Regulations and REPPiR.

55. There are provisions for nuclear specific regulations under HSWA such as the Ionising Radiation Regulations (2017) [22] and Radiation (Emergency Preparedness and Public Information) Regulations (REPPiR 2001) [23]. These regulations are of particular interest to the civil engineering discipline when referring to any shielding, containment or confinement. Civil engineering structures, systems and components (SSCs) can provide the fundamental safety functional requirements. Engineering controls and design features that are the primary means of restricting exposure to ionising radiation are of interest to the civil engineering Inspector.
56. For more guidance on 'Fundamental Principles' regarding legislation, see:
- ONR-NS-TAST-GD-002 'Radiation Shielding',
 - ONR-ND-TAST-GD-004 'Fundamental Principles',
 - ONR-NS-TAST-GD-082 'The Technical Assessment of REPPiR Submissions',
 - ONR-NS-INSP-GD-054 'The Ionising Radiations Regulations 2017',
 - HSE Guidance ACOP L121 'Working with ionising radiation' [24]

3.5.3 Specialised HSE legislation

57. The nature of civil engineering is such that it interfaces strongly with plant and equipment on sites and hence there may be interfaces with other legislation, including but not limited to the following regulations:
- Lifting Operations and Lifting Equipment Regulations (LOLER) [25],
 - Provision and Use of Work Equipment Regulations (PUWER) [26],
 - Dangerous Substances and Explosive Atmospheres Regulations (DSEAR) [27],
 - Pressure Systems Safety Regulations (PSSR) 2000 [28].

3.5.4 Approved Codes of Practice

58. There are Approved Codes of Practice (ACOPs) associated with the specialised HSE legislation:
- L113 Safe Use of Lifting Equipment, Lifting Operations and Lifting Equipment Regulations (LOLER) [29],
 - L22 Safe use of Work Equipment (PUWER) [30]
 - L138 Dangerous Substances and Explosive Atmospheres (DSEAR) [31],
 - L122 Safety of Pressure Systems, Pressure Systems Safety Regulations (PSSR) [32].

59. These Approved Codes of Practice (ACoPs) have been approved by the Health and Safety Executive (HSE) with the consent of the Secretary of State. They give practical advice on how to comply with the law. It should be noted that ACoPs have a special legal status. If a dutyholder is prosecuted for a breach of health and safety law, and it is proved that the dutyholder did not follow the relevant provisions of the ACoP, the dutyholder will need to show that they complied with the law in some other way or the Court will find the dutyholder to be at fault.
60. It should be noted that ACoPs apply to all industry and are not written for the nuclear industry application specifically. Therefore, compliance with ACoPs for a relevant application in a nuclear context does not automatically ensure that all legal responsibilities have been complied with, as the nuclear context may require further work that is not necessarily captured in the ACoP.

3.5.5 Building Regulations

61. Under the Building Act 1984, the Building Regulations 2010 [8] apply to England and Wales and set out an exclusion that:
- “Buildings that are controlled under other legislation:...(ii) Any building (other than a building containing a dwelling or a building used for office or canteen accommodation) erected on a site in respect of which a licence under the Nuclear Installations Act 1965 is for the time being in force.”
62. The Building (Scotland) Regulations 2004 Technical Handbook 2019 – Non-Domestic [33] states the same exclusion and exemption due to their control by other legislation. “A building erected on a site which is subject to licensing under the Nuclear Installations Act 1965” with the exemption of “a dwelling, residential building, office, canteen or visitor centre.” Although there are no current nuclear installations in Northern Ireland, the Building Regulations (Northern Ireland) 2012 [34] state the same approach.
63. Therefore, the Building Regulations are not primarily used for regulating design and construction of nuclear safety significant structures on UK nuclear licensed sites. It is the site licence and associated licence conditions that ONR use to regulate the design and construction of nuclear safety significant structures on nuclear licensed sites, alongside the other legislation discussed in this TAG. Building Regulations still apply to buildings on the licensed site that are used for regular personnel occupancy, as stated in the exemptions. The Inspector should be aware that there are separate requirements under Licence Condition 7 (LC7) for buildings that also perform a function in an emergency, as stated in emergency preparedness plans.

4 RELATIONSHIP OF SAFETY ASSESSMENT PRINCIPLES (SAPS), WENRA REFERENCE LEVELS AND IAEA SAFETY STANDARDS

64. The Safety Assessment Principles are aligned with the IAEA and WENRA guidance and in undertaking the review of this TAG, the alignment to updates in the documentation have been checked and references have been updated.

4.1 Safety Assessment Principles (SAPs)

65. The SAPs 2014 edition is now at Revision 1 [1], having been updated in 2020.
66. The SAPs paragraphs 24-44 explain the way in which the SAPs should be applied, with proportionality, according to:
- the stage of the lifecycle,
 - the duration of the activity being assessed,
 - with consideration of security and adjacent structures with nuclear safety significance.

67. Since the SAPs are not prescriptive, the Inspector will need to judge the extent to which the safety submissions presented satisfy the principles. For many aspects, this will rely on the experience and judgement of the Inspector. In the case of existing installations, there may well be some areas where the principles may not be satisfied. The Inspector should judge the significance of the shortfall against the overall safety case for the installation and take into account the relevant ALARP considerations.
68. Reference should be made to the ONR's safety assessment principles (SAPs) [1] for nuclear installations and Security Assessment Principles (SyAPs) [35], together with other relevant technical assessment guides (TAGs) when assessing construction processes and arrangements.

4.2 Fundamental Assessment Principles

69. The other SAPs are aimed at ensuring that the fundamental principles are satisfied. If it is judged that the SAPs relevant to a particular nuclear facility are met, this should be sufficient to satisfy the Inspector that the installation meets the fundamental principles. The Inspector should be aware of the fundamental principles SAPs (FP.1-FP.8) to frame their assessment.
70. For further guidance on fundamental Principles, see:
- ONR-NS-TAST-GD-004 'Fundamental Principles'.

4.3 Civil Engineering SAPs

71. The civil engineering SAPs are principles ECE.1 –ECE.26 and are generally grouped as follows:
- Principles ECE.1-3
 - Site Investigation ECE.4,5
 - Design ECE 6-15
 - Construction ECE 16-19, 25
 - EIMT ECE 20-24
 - Decommissioning ECE 26

72. See Appendix B for the full wording of the suite of civil engineering SAPs.

4.4 Other SAPs relevant to Civil Engineering

73. Appendix B lists the key SAPs that are relevant and apply to civil engineering works and structures, that are not specific to civil engineering. The guidance in this document provides ONR's interpretation of the SAP's in a broader context for civil engineering.
74. Further, where the civil engineering structural design utilises 'integrity of metal components and structures', the following principle SAPs can apply, albeit these principles will be equally applicable to other materials with only a moderate amount of contextual interpretation (SAPs paragraph 326):

■ Design	EMC 4-10, EMC.11, EMC 13, EMC.14, EMC.16-20, EMC.21, EMC.22, EMC.25, EMC.26, EMC 27, EMC.28, EMC.29, EMC.32, EMC.33
■ Construction	EMC.5, EMC.6, EMC.13, EMC.14, EMC.17, EMC.19, EMC.20, EMC.27, EMC.30, EMC.31, EMC.34
■ EIMT	EMC.27, EMC.30

4.5 WENRA, IAEA guidance and links to the SAPs

75. As part of this TAG update, ONR has reviewed the WENRA reference levels and IAEA Safety Standards and concluded that expectations of international guidance in the area of civil engineering are aligned with the SAPs and this TAG.

4.6 IAEA Documentation

76. IAEA publishes several types of documents, grouped into 'Series'. The four Series of interest for civil engineering assessment are:
- Safety Standards Series – Safety Fundamentals, Safety Requirements and Safety Guides,
 - Safety Reports Series,
 - Technical Reports Series,
 - Nuclear Energy Series.
77. The principal relevant IAEA standards are identified in Appendix D, grouped into sub-headings dependant on their position within the life cycle of the installation, see section 4.8.

4.7 Safety Standards Series

78. IAEA Safety Standards Series comprises Safety Fundamentals, Safety Requirements and Safety Guides. These IAEA Safety Standards are applied by the IAEA and joint sponsoring organizations to their own operations, and are recommended for use by states and national authorities and by other international organizations in relation to their own activities.
79. IAEA documents not listed under the Safety Standards Series are not part of IAEA Safety Standards.
80. The IAEA documents apply only to nuclear power reactors and mostly to PWR and BWR type reactors. The remit of the ONR Safety Assessment Principles and this TAG is wider and covers all GB nuclear installations.

IAEA Safety Standards Series framework

81. The hierarchy of the IAEA Safety Standards Series suite of documents are as follows:

IAEA Safety Fundamentals

82. As the primary publication in the Safety Standards Series, Fundamental Safety Principles establishes the safety objectives and principles of protection and safety.

IAEA Safety Requirements

83. An integrated and consistent set of Safety Requirements publications establish the requirements that must be met to ensure the protection of people and the environment.
84. The requirements are governed by the objectives and principles of the Safety Fundamentals. If they are not met, measures must be taken to reach or restore the required level of safety. These use the word 'shall'.

IAEA Safety Guides

85. Safety Guides provide recommendations and guidance on how to comply with the Safety Requirements and reflect a consensus that it is necessary to take the measures recommended (or equivalent alternative measures).

86. The Safety Guides present international good practices and increasingly they reflect best practices to help users striving to achieve high levels of safety. These use the word 'should'.
87. ONR policy reflects this hierarchy by stating that:
- guidance in IAEA Safety Fundamentals and IAEA Safety Requirements should always be included in our SAPs and TAGs etc. (though this may need to be adapted to fit with the UK legal framework),
 - guidance contained in Safety Guides should normally be included (i.e. only omitted if there is a compelling reason),
 - guidance in lower tier Safety Standards (such as Technical or Safety Reports) should be considered for inclusion if viewed as particularly relevant,
 - Technical Documents (TECDOCS) are not included or considered within this TAG, reflecting the less rigorous regime of their approval.

4.8 Benchmarking

88. The benchmarking exercise between SAPs and IAEA guidance has been undertaken as part of this document update. Appendix D identifies the Safety Fundamentals, Requirements, Safety Guides (alongside the Safety, Technical and Nuclear Energy Reports) that are most relevant to the following civil engineering topic areas:

- Principles,
- Siting and Site investigation,
- Design/Modifications
- Internal and External Hazard Loadings,
- Construction and Commissioning,
- Operations and Maintenance,
- Decommissioning and Demolition.

89. The key IAEA Safety Requirements for reference to civil engineering are:

- SSR-2/1 'Safety for Nuclear Power Plant Design' [2],
- SSR-2/2 'Safety of NPP: Commissioning and Operation' [36],
- GSR-6 'Decommissioning of Facilities' [37].

4.9 WENRA Reference Levels

90. The objective of the Western European Nuclear Regulators Association (WENRA) Safety Reference Levels (SRLs) is to develop a common approach to nuclear safety in Europe by comparing national approaches to the application of the International Atomic Energy Agency (IAEA) safety standards.
91. The Safety Reference Levels (SRLs), which are primarily based on the IAEA safety standards, represent good practices in the WENRA member states and also represent a consensus view of the main requirements to be applied to ensure nuclear safety.
92. The WENRA reference levels were re-issued in 2014 to primarily update them with lessons learned from the Fukushima Dai-ichi accident and insights from the EU stress tests. Key expectations in this version were the revised expectations on natural hazards and combination of events, which are reflected in ONR-NS-GD-TAST-013 'External Hazards'.
93. Section 4 of ONR-NS-TAST-GD-005 identifies the WENRA SRLs as Relevant Good Practice for existing Civil Nuclear Reactors.
94. Section 5 and the annexes of this TAG references out to the relevant WENRA Safety Levels as appropriate.

Appendix E of this TAG identifies the WENRA reference levels which can be interpreted as applicable to civil engineering works and structures. The table also identifies the corresponding ONR SAPs which capture their intent, with a mapping to the relevant section of this TAG.

95. There are three WENRA documents stipulating Safety Reference Levels for:
- Existing Reactors [38],
 - Decommissioning Plants [39],
 - Fuel and Waste Plants [40].
96. Also, the WENRA report for the Safety of New Plant Designs [41] has been considered as part of this TAG update.

4.9.1 WENRA Existing Reactors Safety Reference Levels

97. The Safety Reference Levels for existing reactors [38] are the most developed and encompass a wide range of topics. The following are relevant to the civil engineering SAPs:
- ECE.1 (functional performance) relates to Issue E, Issue G and Issue Q,
 - ECE.3 (defects) relates to Issue I,
 - ECE.8 (inspectability) relates to Issue K,
 - ECE.18 (inspection during construction) relates to Issue K,
 - ECE.20 (inspection, testing and monitoring) relates to Issue D.

4.9.2 WENRA Decommissioning Plants Safety Reference Levels

98. WENRA also produce Reference levels for decommissioning plants [39]. The elements which specifically relate to civil engineering are:
- ECE.18 (inspection during construction) relates to DE-42,
 - ECE.19 (non-conformities) relates to DE-36, DE-37,
 - ECE.20 (inspection, testing and monitoring) relates to DE-43, DE-44,
 - ECE.26 (provision for decommissioning) relates to DE-15, DE-16, DE-17, DE-18, DE-20, DE-21, DE-54, DE-55, DE-56.

4.9.3 WENRA Fuel and Waste Plants Safety Reference Levels

99. WENRA also produce Reference levels for fuel and waste plants [40]. The elements which *specifically* relate to civil engineering are:
- ECE.1 (functional performance) relates to DI-23, DI-24, DI-25, DI-35, DI-38, DI-40, DI-53, DI-65,
 - ECE.5 (geotechnics) relates to DI-47,
 - ECE.8 (inspectability) relates to DI-43,
 - ECE.18 (inspection during construction) relates to DI-48, DI-50, DI-51,
 - ECE.25 (provision for construction) relates to DI-07, DI-22,
 - ECE.26 (provision for decommissioning) relates to DI-68.

4.9.4 WENRA RHWG Report Safety of New NPP Designs

100. The Reactor Harmonization Working Group RHWG report [41] presents the WENRA safety expectations for the design of new NPPs and covers selected key safety issues and Lessons Learnt from the Fukushima Dai-ichi accident. The intent of this report [40] is captured in ONR-NS-TAST-GD-013 'External Hazards' as it presents expectations around the derivation of hazard loading as an input to civil engineering.

5 ADVICE TO INSPECTORS

5.1 General Guidance

101. The following guidance has been ordered to align with the 6 annexes associated with this head document, with 'general guidance' and 'other topics' applying to all aspects of civil engineering assessment.
102. The scope of civil engineering works and assessment covers a wide range of topics and it is not expected that an inspector is an expert in all civil engineering assessment topic areas. The Inspector is expected to identify where there is a need to interface with others and obtain the necessary support required for them to undertake assessment activities.

5.1.1 Overall considerations for all Civil Engineering Assessments

103. For all scenarios, at all stages of the lifecycle, the ONR expectation is that design and assessment of structures will be procured, undertaken and overseen by competent organisations and persons, with the required safety functions and structural performance of the civil engineering structures under normal operating, fault and accident conditions specified.
104. The most detailed areas the Inspector may examine for civil engineering assessments are justifications that are presented in design substantiation reports, schedules, calculations, methodologies, inspection records and/or drawings or processes, procedures and other administrative controls.
105. It should be clear at the outset of examining such evidence what the Inspector is aiming to achieve; a speculative trawl through a large pile of documents is unlikely to be efficient or insightful.
106. Equally, simply focussing on examining what is presented without consideration of what is potentially missing will lead to an inadequate assessment.
107. For general guidance on undertaking regulatory activities, see:
 - ONR 'Licensing Nuclear Installations' [4],
 - ONR-NS-TAST-GD-096 'Guidance on the Mechanics of Assessment',
 - ONR-NS-PER-GD-001 'Purpose and Scope of Permissioning'
 - Technical Inspection Guides (TIGs) for the relevant Licence Condition(s),
 - ONR-NS-INSP-GD-059 'Intervention Planning and Reporting',
 - ONR-NS-INSP-GD-064 'General Inspection Guide',
 - ONR-RI-GD-001 'Regulatory Issues Database User Guide - for Inspectors',
 - ONR-RI-GD-003 'Management of Regulatory Issues – Guidance',
 - 'Risk Informed Regulatory Decision Making' [13]
 - ONR Regulators Code [42].
108. For general guidance regarding assessment writing, see:
 - HOW 2 guidance and tutorial T-series training courses,
 - ONR-NS-PER-GD-015 – 'Guidance on Production of Reports for Permissioning',
 - ONR-NS-PER-GD-016 – 'Guidance on Peer Review and acceptance of reports for permissioning',
 - ONR-COM-GD-002 – 'Editorial and Formatting Style Guide' [43],
 - Oxford Guide to Plain English [44].
 - ONR-NS-TAST-GD-096 'Mechanics of Assessment'

5.1.2 Site Phases

109. The stages of civil engineering works over a lifecycle of a nuclear facility can be generally summarised as follows:

- Site identification,
- Generic Design Assessment Step 1, 2,3 (and Step 4, where applicable),
- Site Licensing, including site investigations and site-specific considerations,
- Construction,
- Operation/EIMT/asset management of ageing sites,
- Post operation decommissioning, demolition, site clearance.
- (possibly) De-Licensing.

110. The purpose of ONR assessment of design for civil engineering works is to establish whether:

- the design arrangements,
- interfaces with procurement and construction/installation,
- operations and associated maintenance and inspection,

are adequate to fulfil the safety functions, and to establish if hazards created by such arrangements are both tolerable and ALARP, in compliance with legal requirements.

111. This TAG is to provide guidance for the Inspector when undertaking an assessment of civil engineering works related to:

- new build sites,
- new facilities on operational or decommissioning sites,
- EIMT activities on operational and post operational sites,
- change of use and/or modifications to existing structures on operational and decommissioning sites.

5.1.3 Sampling for Civil Engineering Assessment

112. Civil engineering assessments should focus upon activities which could result in the greatest hazard or where risks are least well controlled. This is achieved via proportionate sampling, see paragraph 82 of the SAPs [1] regarding sampling approach to the assessment of safety cases.

113. The sampling strategy deserves focused consideration before the start of an assessment, and review throughout the assessment. The sampling strategy should detail the areas to be considered, and the rationale for the selection. It should also justify those areas excluded from selection.

114. The depth of sampling should also be identified, broad across several areas or a deep dive into a specific area.

115. Key points which should inform the development of a sampling strategy are:

- Severity of the unmitigated consequences should the works (design, justification, workmanship, etc.) be inadequately conceived or executed,
- Novelty,
- Difficulty,
- Track record of the dutyholder,
- Precedence,
- Condition of the structure and/or the ground it stands on,
- Particular aspects not considered before (e.g. UK or site-specific context).

5.1.4 ONR Internal Interfaces

116. The assessment of civil engineering should not be an activity that is undertaken in isolation. There are interfaces and overlaps between civil engineering and other disciplines within ONR, e.g. several disciplines feed into civil engineering design.
117. The TAG documents are intended to be used as a suite of guidance which cross references internally to each other, covering the full suite of guidance across all disciplines of ONR assessment. The outcome of an assessment is a consequence of the regulatory judgment and opinion of a team of inspectors, within the framework of ONR's assessment process.
118. Appendix F identifies relevant ONR TAGs that should be used alongside this TAG for areas of common interest that often overlap with other disciplines.
119. There is a close relationship between the civil engineering works and internal and external hazard assessments, as these develop some of the loading functions against which civil structures provide resistance. Civil engineering assessment looks to seek assurance that the hazard and fault loading functions (including internal fire) are appropriate upstream of the civil engineering design.
120. The Inspector may wish to seek assurance that these loadings and functions cater for the various stages of the life of the site and are included into the design and designed for appropriately, considering the required serviceability state of SSCs post-event.
121. The Inspector is reminded of the importance of this interface between the disciplines, to understand each sample scope. Cross-cutting case studies or engagements can be employed to explore the demonstration of the robustness of hazard assessments and the subsequent flow of information into civil engineering design.
122. Further, the Inspector is specifically reminded of the benefit of joint engagements with external hazards when assessing geotechnical information required in order to support the civil engineering works design. This information may have been obtained to derive the applicable seismic hazard as part of external hazard assessments.
123. Other common areas of interest can overlap in assessment. Topics related to civil engineering assessments are SAPs and associated guidance including:
- Fault Studies, PSA and Severe Accident Analysis that are the basis for the fault scenarios that give rise to the hazards, including shielding considerations, understanding the derivation of hazard loadings for SSCs to withstand.
 - Structural Integrity, considering welding and leak-tightness requirements, embedded items, penetrations, construction sequencing and methodology.
 - Conventional Health and Safety and Human Factors disciplines when assessing design constructability and construction or decommissioning task analysis.
 - Joint inspections when assessing work that falls under specific CDM 2015 considerations when identifying roles (or confirming the absence of) and CDM 2015 arrangements.
 - Joint inspections with conventional safety when assessing temporary works activities that have the potential to impact on permanent nuclear safety significant civil engineering structures.
 - Joint inspections with conventional safety when assessing the exit routes for personnel and internal hazards when considering potential fire damage to the structure.
 - Mechanical Engineering, when civil engineering design includes metal components and structures or when civil engineering design supports mechanical equipment e.g. crane supports and base structures, floor response spectra for the mechanical equipment to resist including equipment racking,

- embedding plates for pipe supports or cable trays, penetrations for equipment in both design and retrospective fit post structure construction, boiler supports and dampers, duct hangars and other supporting equipment.
- Layout, including a collation of the requirements upon the structure that the civil engineering design accommodates, designing structures to withstand loading and provide support, shielding and/or containment/confinement.
 - Radioactive materials and radioactive waste, when designing facilities that process or store nuclear materials, or for assessing earthworks within potentially contaminated ground.
 - Decommissioning, regarding site design life civil engineering requirements and design life for sea defences taking into consideration waste storage timescales, or requirements for civil engineering decommissioning activities to be part of the funded decommissioning plan in line with government policy [45].
 - Organisational Capability, when considering the adequacy and competence of the Intelligent Customer and Design Authority functions, site design teams and construction workmanship and supervision, dutyholder site surveillance arrangements during construction and EIMT works, or when assessing decision making processes, e.g. optioneering, ALARP decisions, design changes and modifications, use of RGP. Considerations of training for personnel, processes and arrangements to manage competence, nuclear baselines, learning organisation and 'challenge culture', leadership for safety and quality reviews, interfaces with other departments including safety case production or updates, levels of qualification and experience required for a person to be considered competent and suitably qualified and experienced personnel (SQEP).
 - Supply Chain, when considering the construction or work of subcontractors, and the adequacy of the Intelligent Customer function when procuring items or services, offsite manufacture of items delivered to and used on a licensed site, site supervision and surveillance activities, welding and other construction workmanship, design and other consultant services for civil engineering works.
 - Quality Management and Assurance, when considering evidence of acceptance of work undertaken, records for construction, updates or revisions to information post-decisions regarding design changes or modifications, retention of information for the operation and decommissioning phases, including storage and access to such information,
 - Security, when considering design information and site security provisions, where civil engineering structures support or provide protection or withstand. Security provisions including aircraft crash or security fencing. Vulnerabilities during construction and within the supply chain.
 - Safeguards, when considering unauthorised access to construction records and other information retained or stored, use and storage of information with electronic tools such as Building Information Models or analysis tools.
124. The Inspector should consider, identify and understand the nature of scope overlap with other disciplines during an assessment. The Inspector should review interfaces throughout an assessment to establish where new and relevant interfaces emerge as the design develops, and to check that none have been overlooked.
125. The Inspector's sampling approach may seek depth where others do not, and the Inspector may identify an issue that interfaces with, but falls outside the scope of, civil engineering, but which also falls outside the sample scope of another discipline.
126. At an early stage in the assessment planning, the Inspector should agree interfaces with other planned assessment scopes, with engagement of the Project or Lead Inspector.

5.1.5 External Stakeholder Interfaces

127. There are often significant interfaces and overlaps with civil engineering topics and external stakeholders. Appendix G identifies the organisations and public bodies with which ONR have interactions, alongside the duty holder(s). It is a key consideration for the Inspector to establish the scope of the assessments undertaken by other agencies and agree the ways of working together.
128. For further information on ONR Regulatory Interfaces, see:
- Annex 1 of the SAPs [1],
 - ONR-NS-INSP-GD-061, ONR-NS-INSP-GD-062, ONR-NS-INSP-GD-063 'Guidance to Support the Joint Regulatory Memorandum of Understanding between ONR and EA on Matters of Mutual Interest in England/Scotland/Wales' (respectively),
 - ONR-GDA-GD-004 'Strategy for working with Overseas Regulators'.

5.1.6 Dutyholder Project Planning and Organisation

129. Licensed sites have management arrangements in place, as required by the Licence Conditions. The Inspector should focus assessment on the management arrangements that are in place, as well as the technical detail of the subject being assessed, to seek assurance that site processes and procedures allow civil engineering works to be undertaken safely. This applies across all technical civil engineering topics and includes the assessment of project resourcing and staff competence.
130. The applicable SAPs for this topic are:
- MS.1-4 state the expectations that the organisation and decisions are managed appropriately to achieve and sustain safety and that lessons are learned from experience.
 - SAP SC.8, which states the expectation that the ownership of the safety case should reside within the dutyholders organisation with those who have direct responsibility for safety.
131. For civil engineering assessment, the Inspector may consider the adequacy of dutyholders management systems and arrangements in place for the phase of the assessment being undertaken. The Inspector may wish to consider the applicable arrangements (processes, procedures, resources and management etc.) for the following:
- production, use and review of safety cases,
 - design services procurement, acceptance and approval of design submissions (including Design Authority and Intelligent Customer functions),
 - procurement, inspection and surveillance arrangements of physical work,
 - internal and independent challenge regarding decision making processes, classification and categorisation of modifications etc.,
 - change control of documentation and information management,
 - decision and associated approvals, including those for modifications,
 - change management, including asset management and defect management, damage or non-conformances and degradation over time, as well as contractor engagement with requests for changes or clarification of information,
 - recording information e.g. decisions, physical works and inspections etc.,
 - EIMT activities and the processes / procedures to sentence and implement recommendations,
 - learning lessons from experience (internal and external to the nuclear industry),
 - any change in phase e.g. from design through construction to operation,
 - the step changes in phases following cease of operations.

132. ONR key principles for assessment of management systems and organisational capability are provided in:
- ONR-NS-TAST-GD-048 'Organisational Change',
 - ONR-NS-TAST-GD-065 'Function and Content of the Nuclear Baseline',
 - ONR-NS-TAST-GD-080 'Challenge Culture Capability (including an Internal Regulation function), and the provision of Nuclear Safety Advice',
 - ONR-NS-TAST-GD-077 'Supply Chain Management Arrangements for the Procurement of Nuclear Safety Related Items or Services',
 - ONR-NS-TAST-GD-060 'Procedure Design and Administrative controls',
 - ONR-NS-TAST-GD-061 'Staffing levels and Task Organisation',
 - ONR-NS-TAST-GD-079 'Licensee Design Authority Capability',
 - ONR-NS-TAST-GD-051 'The Purpose, Scope and Content of Safety Cases',
 - ONR-NS-TAST-GD-057 'Design Safety Assurance',
 - ONR-NS-TAST-GD-094 'Categorisation of Safety Functions and Classification of Structures Systems and Components (SSCs)',
 - ONR-NS-TAST-GD-098 'Asset Management',
 - ONR-NS-TAST-GD-033 'Dutyholder Management of Records',
 - ONR-NS-TAST-GD-049 'Licensee Core Safety and Intelligent Customer Capabilities',
 - ONR-NS-TAST-GD-027 'Training and Assuring Personnel Competence',
 - ONR-NS-TAST-GD-009 'Examination Inspection Maintenance and Testing of Items Important to Safety',
 - ONR-NS-INSP-GD-070 Safety Culture Guide for Inspectors,
 - ONR-CNS-INSP-GD-4.0 Supply Chain Management (security),
 - Suite of Technical Inspection Guides for the phase at which the assessment is being undertaken to understand the expectations regarding arrangements in place, alongside particular consideration of ONR-NS-INSP-GD-010 - LC10 Training.

5.2 Civil Engineering Design Considerations (Annex 1)

5.2.1 Civil Engineering Safety Case Process

133. The safety case process involves parties from different disciplines who contribute to the overall safety case.
134. The Inspector may make reference to the SC suite of SAPs to check whether the safety case presented meets these expectations.
135. The applicable SAPs for this topic are available in the Appendix to Annex 1.
136. The key assessment topics for civil engineering safety cases are listed as follows:
- safety case golden thread including fault analysis, hazard Identification, and development into resultant loading cases,
 - civil engineering safety case claims,
 - the role of the Design Authority and Intelligent Customer functions,
 - Design Basis considerations,
 - fundamental safety functions and safety functional requirements,
 - safety measures,
 - categorisation and classification of civil engineering SSCs,
 - independent arguments, passive safety, and defence in depth,
 - safety case documents.
137. For the key civil engineering principles on assessment of the topics listed above, see:
- TAG 17 Annex 1 – 'Civil Engineering – Design'.

138. Further ONR expectations for assessments of safety cases are provided in:
- ONR-NS-TAST-GD-051 'Guidance on the Purpose, Scope and Content of Nuclear Safety Cases',
 - ONR-NS-TAST-GD-094 'Categorisation of Safety Functions and Classification of Structures Systems and Components (SSCs)'.

5.2.2 Design Process

139. The design process for civil engineering involves inputs from other disciplines e.g. for hazard derivation and hazard assessment. As such, there are many SAPs that are considered for design and these are listed in a table in Annex 1.
140. The Inspector may make reference to the applicable SAPs to check whether the design presented meets these expectations.
141. The key assessment topics for civil engineering design are listed as follows:
- Design philosophy,
 - Design codes and standards,
 - Conservatism in design,
 - The Intelligent Customer function and Independent checks
 - Concept design and design optioneering stages,
 - Layout,
 - ALARP Optioneering,
 - Novel, innovative and un-proven designs,
 - Loading,
 - Finite Element Modelling and numerical analysis,
 - Pre-stressed designs,
 - Investigation and data collection,
 - Design Verification and Validation,
 - Designing for hazard combinations,
 - Designing for emergencies,
 - Designing for construction,
 - Designing for operation and EIMT,
 - Designing for decommissioning,
 - Learning from previous experience,
 - Information control and Document management,
 - Change control,
 - The Interfaces between Design Disciplines,
 - The Interface with procurement,
 - Safety case production and interface,
 - Design substantiation reports,
 - Post design review,
 - Design process,
 - Design when construction activities are occurring in parallel.
142. For the key civil engineering principles on assessment of the topics listed above, see:
- TAG 17 Annex 1 – 'Civil Engineering – Design'.
143. Further ONR guidance for assessments of design process are provided in:
- ONR-NS-TAST-GD-057 'Design Safety Assurance',
 - ONR-NS-TAST-GD-002 'Safety Systems', regarding 'passive safety systems'.

5.2.3 Hazard identification and fault analysis

144. Many inputs to civil engineering nuclear safety design are derived from the fault studies and hazards analysis. When considering fault analysis and hazard identification as an input to civil engineering design, the Inspector could liaise with the inspectors who specialise in fault studies, internal hazards external hazards and human factors disciplines where necessary. The Inspector may wish to seek assurance that the inputs to the civil engineering design are accurate and adequately bounding for all scenarios considered. The Inspector is reminded of the close interface with the ONR disciplines who sample the hazard assessments in more detail that will be expected as part of the civil engineering assessment.
145. The key safety assessment principles for the civil engineering assessment of hazards and faults are:
- ECE.1 and ECE.2 state the functional performance under different conditions should be specified and evidenced with independent arguments where necessary for structures requiring the highest reliability,
 - ECE.9 states the expectation that climate change effects are to be considered when defining the flooding load cases,
 - EMC.7 and EMC.11 states there should be gradual and detectable failure based on conservative estimates for different loading conditions,
 - EKP.4 states the expectation that safety functions will be identified by a structured analysis, based on fault sequences and possible initiating faults, including those of internal and external hazards,
 - EHA.1-19, NT.1 and EDR.1 states the expectation that designs fail in a safe manner when considering the loading from internal and external load scenarios and various fault studies,
 - EHA.13-17 state expectations related to internal hazards,
 - EHF.10 (and paragraph 465), the suite of FA SAPs and SAPs Annex 2 'basis and derivation of numerical targets' describe the relationship between Design Basis Analysis, Probabilistic Safety Analysis and Severe Accident Analysis,
 - EHF.3 and EHF.6 state the expectation to identify interfaces between civil engineering design and areas of human interface where this has potential to impact on safety, ensuring workspaces are sufficient for operations and maintenance activities,
 - MS.1-4 state the expectations for the appropriate leadership and organisation to deliver the design,
 - ECS.1 and ECS.2 state the expectations for safety categorisation and classification,
 - ECS.3. ECS.4 and ECS.5 state the expectations around codes and standards,
 - SC4, SC.5, SC.6, SC.7 and SC.8 state the expectations around safety cases,
 - ERL.1 (and ECE.3, ECE.17, ECE.19, EMC.5 and EMC.6) state the expectations around reliability claims and defects,
 - EAD.1-4 states the expectation for the design to consider of the lifecycle duration required, establishing the proposed environment, clear understanding of the margins and ageing mechanisms throughout the projected design life, with EMT.2 stating the expectation for regular and systematic EIMT,
 - Where the structural design utilises Integrity of Metal Components and Structures, the following SAPs also apply: EMC 4-10, EMC 13-20, EMC 27, which the Inspector will need to include in their assessment,
 - SC.8 the persons responsible for safety have the ownership of the safety case,
 - ELO.1, ELO.4, EHF.1, EH5-6 and DC.1 state the expectation that the design will consider safety in construction, maintenance and decommissioning phases,
 - SAPs EMC.13, EMC.14, EMC.20, EMC.27 and EMC.30 for where a structural component also forms part of containment.

146. For the key civil engineering principles on assessment of hazard identification and fault analysis, see:
- TAG 17 Annex 1: 'Civil Engineering – Design'.
147. Further ONR expectations for assessments of hazards and faults are provided in:
- ONR-NS-TAST-GD-014 'Internal Hazards',
 - ONR-NS-TAST-GD-013 'External Hazards',
 - ONR-NS-TAST-GD-005 'Guidance on the demonstration of ALARP (As Low as Reasonably Practicable)',
 - ONR-NS-TAST-GD-017 'Severe accident analysis',
 - ONR-NS-TAST-GD-030 'Probabilistic safety analysis',
 - ONR-NS-TAST-GD-002 'Radiation Shielding',
 - ONR-NS-TAST-GD-075 'Safety Aspects Specific to Nuclear Fuel in Power Reactors',
 - ONR-NS-TAST-GD-004 'Fundamental Principles',
 - ONR-NS-TAST-GD-045 'Fault Conditions',
 - ONR-NS-TAST-GD-019 'Essential Systems'.

5.2.4 Related Accident and Emergency considerations

148. The anticipated performance during normal operation, fault and accident condition should be highlighted. The Inspector should be aware of when the performance requirement on civil engineering structures, systems and components (SSCs) differs when subject to different loadings. During an event, a different source of loading is applied. The Inspector may wish to understand the structural response to loading from an event, with clarity around whether the civil engineering SSC is to return to fully satisfy original safety function requirements post-event. Where structural collapse is considered as a tolerable structural response to a beyond design basis event, the Inspector may wish to seek assurance that progressive or disproportionate collapse is avoided by design.
149. The key safety assessment principles for the civil engineering assessment of accident or emergency response are:
- ECE.1 states the expectation that the safety functions and structural performance under fault and accident conditions should be specified, including control rooms and on-site and off-site emergency control centres,
 - AM.1 where civil engineering SSCs are used in accident management and emergency arrangements, e.g. fire escapes, control room structures or emergency control centre structures.
150. For the key civil engineering principles regarding assessment of accident and emergency response, see:
- TAG 17 Annex 1, 'Civil Engineering – Design'.
151. Further ONR guidance for assessments of emergency response are provided in:
- ONR-NS-TAST-GD-082 'the Technical Assessment of REPPiR Submissions',
 - ONR-NS-TAST-GD-019 'Essential Systems' including emergency supplies e.g. drainage and pipework (often underground),
 - ONR-NS-TAST-GD-045 'Radiological analysis for Fault Conditions',
 - ONR-NS-INSP-GD-067 'Offsite Emergency Arrangements'.

5.2.5 Categorisation and Classification

152. The categorisation of safety functions and classification of civil engineering structures should be consistent with the potential consequence of failure of the civil engineering structures, systems and components (SSCs).
153. The Inspector may wish to seek assurance that dutyholders have used appropriate processes to determine the safety categorisation and associated classification of civil engineering SSCs.
154. Unless justification is presented to the contrary, the civil engineering SSC should have a safety function categorisation and associated classification that is no lower than that claimed on any equipment that is reliant on the continued safety function(s) provided by the civil engineering SSC. For example, an SSC might be supported by a civil engineering component with a lower categorisation if failure of the lower categorised component does not have a significant adverse effect upon the SSC with a higher categorisation.
155. The key assessment principles for the civil engineering assessment of safety categorisation and classification are:
- SAPs ECS.1-ECS.5 state the expectations around safety categorisation, classification, use (and absence of) of codes and standards,
 - ECE.1 states the expectation that the safety function and associated structural performance (and required resilience) of civil engineering SSCs are specified,
 - ECE.2 states that the multiple, independent and diverse arguments should be provided for structures requiring the highest levels of reliability, and that for structures that are not of major safety significance, the list of factors in SAPs paragraph 337 remain relevant, though the stringency of their application should reflect the safety classification of the item,
 - ECE.9 states the expectation that earthworks are assigned the appropriate safety classification.
156. ONR expectations and further guidance on assessment of categorisation and classification is available in:
- TAG 17 Annex 1, 'Civil Engineering – Design'.
157. Further ONR expectations for assessments of categorisation and classification are provided in:
- ONR-NS-TAST-GD-094 'Categorisation of Safety Functions and Classification of Structures Systems and Components (SSCs)',
 - ONR-NS-TAST-GD-051 'The Purpose, Scope and Content of Safety Cases',
 - ONR-NS-TAST-GD-057 'Design Safety Assurance'.

5.2.6 Layout

158. The layout and orientation of features on the site or within a facility should minimise risks to nuclear safety. This is an area for multidisciplinary regulatory consideration with a cross-cutting method, with consideration from a team of inspectors who specialise in internal and external hazards, human factors, mechanical, electrical and control and instrumentation regarding whether inputs to architectural design have been adequately considered and interpreted.

159. There are differences in assessment of a facility layout and the assessment of a site structural layout, for which the following SAPs apply:
- ELO.1 states the expectation for design and layout to facilitate access without compromising security,
 - ELO.4 states the expectation for design and layout to minimise the effects of faults and accidents,
 - EMC.8 states the expectation for geometry and access arrangements to have regard for the need of examination,
 - EHF.6 states the expectation for workspaces to be designed to support task performance.
160. The principal civil engineering inspection assessment requirements regarding layout are considered in:
- TAG 17 Annex 1, 'Civil Engineering – Design'.
161. Further ONR expectations on general assessment of layout design is available in:
- ONR-NS-TAST-GD-036 'Diversity Redundancy Segregation and Layout of Mechanical Plant',
 - ONR-NS-TAST-GD-062 'Workplaces and Work Environment' which refers to layout and workplace spaces and ELO.4,
 - ONR-NS-TAST-GD-064 'Allocation of Function Between Human and Engineered Systems',
 - ONR-NS-TAST-GD-058 'Human Factors Integration',
 - ONR-NS-TAST-GD-059 'Human Machine Interface',
 - ONR-NS-TAST-GD-002 'Radiation Shielding'.

5.2.7 Numerical modelling and Analysis

162. Where modelling and analysis has been carried out on civil structures to derive static and dynamic structural loadings for the civil engineering design, the processes used should be adequately validated and verified.
163. The SAPs that apply to assessment of numerical modelling and analysis:
- AV.1-AV.8 state the expectations regarding assurance of validity of modelling,
 - ECE.12 to ECE.15 state the expectations on structural analysis and modelling,
 - EMC.32 and EMC.33 state the expectations regarding stress analysis of metal components when used for civil engineering structural design,
 - EMC 33 states the expectations that due consideration has been given to uncertainties in material properties and that the methodology and loading data have been verified to ensure that the analysis is demonstrably conservative. This can be significant when analysing safety critical reinforced or pre-stressed concrete or steel structures.
164. The principal civil engineering inspection assessment requirements regarding numerical modelling and analysis are considered in:
- TAG 17 Annex 1, 'Civil Engineering – Design',
 - TAG 17 Annex 3, 'Civil Engineering – Ground Investigation, geotechnics and sub-surface structure design'.
165. Further ONR expectations on assessment of computer modelling and analysis in design are provided in:
- ONR-NS-TAST-GD-042 'Validation of Computer Codes and Calculation Methods'.

5.2.8 Design Authority and Intelligent Customer functions

166. When assessing the Design Authority (DA) function for civil engineering works, the Inspector may need to consider the organisational capability of the dutyholder, regarding available resources, training and management arrangements in place. The Design Authority function should also act as Intelligent Customer (IC) when activities are not undertaken by the duty holder directly, but where the civil engineering activities related to nuclear safety are procured e.g. civil engineering contractor works or consultative services.
167. EIMT and other construction and maintenance-based activities are often managed using signature sheets with varying levels of acceptance. The DA and IC may have specific roles to undertake when accepting works as complete, and the Quality Control and Quality Assurance records are to be approved by the DA and IC in this instance to demonstrate that the DA and IC are signing off at the relevant witness points.
168. The SAPs applicable to Design Authority and Intelligent Customer functions are:
- ECE.1 and ECE.2 state the expectations that functional performance is specified with the use appropriate use of independent arguments in safety case, which is usually undertaken by the Design Authority function,
 - ECS.1 and ECS.2 states the expectation for appropriate identification of safety functions through hazard and fault analysis, with appropriate categorisation and classification of civil engineering works and structures,
 - SC.1 states the expectation that there is a definition of the training and qualifications needed for formal roles,
 - SC.4 state the expectation that the safety case will outline the requirements of suitably qualified and experienced personnel to be in post at the various stages of a site lifecycle, recognising that skills required for design and construction phases differ to those needed for civil engineering resource in the operation phase and then the decommissioning phase,
 - EHF.8 states the expectation that adequate competence will be demonstrated by those within the duty holder organisation and supply chain,
 - SC.8 states the expectation that the ownership of the safety case resides within the dutyholders organisation with those who have direct responsibility for safety,
 - ECE.18 states the expectation for the inspection and testing of construction work to demonstrate quality,
 - ECS.3 states the expectation that civil engineering works should be completed to the appropriate codes and standards,
 - ECS.4 and ECS.5 states the expectations that, where there are no appropriate codes or standards, an appropriate approach is adopted, with the use of experience, tests or analysis are applied as necessary.
169. For the principal civil engineering inspection assessment requirements regarding Design Authority, see:
- TAG 17 Annex 1, 'Civil Engineering – Design',
 - TAG 17 Annex 4, 'Civil Engineering – Construction Assurance'.
170. Further ONR expectations on assessment of Design Authority and Intelligent Customer are provided in:
- 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'.

5.2.9 Deviations and design changes

171. Design changes and deviations in design should be expected as the design develops. The Inspector should understand the processes in place for managing changes to the design and how decisions are made. Design changes can occur as a result of:

- design development and optioneering,
- design sensitivity analysis or modelling outputs,
- laboratory or site mock-ups and trials, including ground investigations,
- broken assumptions in the design or safety case,
- lack of material or product availability,
- shortfalls identified during review or assessment of the safety case,
- construction non-conformances and defects,
- installation of mechanical or other equipment, construction sequencing,
- legacy defects from construction quality, commissioning identifying errors,
- EIMT identifying damage, ageing or settlement,
- changes in environment and impact from other non-civil SSCs,
- modification and change of use,
- decommissioning or demolition activities,
- learning from experience and operational experience from wider industry.

172. The Inspector should understand the consequences of the change on the original design intent and consider what the consequences are if the proposed change is ill-conceived or executed. Design changes are categorised based on the safety function of the element being changed. The Inspector should expect the categorisation to be based on the state 'as is', not the remediated design once the change is implemented.

173. The SAPs applicable to design changes and deviations are:

- ECE.3 states the expectation that structures important to safety are sufficiently free of defects so that their safety functions are not compromised,
- ECE.8 states the expectation for the design to consider and allow inspection and maintenance, as lack of access can preclude future options for design change or deviation,
- ECE.17 states the expectation that the construction should use appropriate materials proven techniques and quality management system to minimise defects,
- ECE.19 states the expectation that should non-conformities or defects be identified, remediation should ensure the original design intent is still achieved, and that due account should be taken for the potential for an aggregation of design changes which may undermine original design intent,
- ECE.20 states the expectation that inspection, testing and monitoring should take account of changes in parameters assumed in the safety case.

174. For the principal civil engineering inspection assessment requirements regarding deviations and design changes, see:

- TAG 17 Annex 1, 'Civil Engineering – Design',
- 'Modification' Section 5.9.5 of this document,
- 'Non-conformances and defects' Section 5.5.3 of this document.

175. Further ONR expectations on assessment of Design Changes and deviations are provided in:

- ONR-NS-INSP-GD-020 'Modification to design of Plant under Construction',
- ONR-NS-INSP-GD-021 'Commissioning',
- ONR-NS-INSP-GD-022 'Modification or Experiment on Existing Plant',
- ONR-NS-INSP-GD-029 'Duty to Carry out Tests, Inspections and Examinations'.

5.3 Building Information Modelling (BIM) (Annex 2)

176. Civil engineering works are increasingly using electronic models alongside paper drawings, with some models also informing security and decommissioning strategies. The use of digital tools varies from the use of a 'point cloud' to collate data remotely to reduce time at risk in areas of high radiation, through to fully costed and scheduled civil engineering projects in a computerised model.
177. The UK civil engineering industry is currently in transition and computer models are not used consistently. As such, BIM is used by duty holders in many ways across civil engineering works, at varying levels of implementation and complexity. During civil engineering assessment, the Inspector may have 'early' sight of the BIM tools being used. If this is the case, the Inspector may consider any security or safeguarding issues regarding the availability of information on computer systems e.g. modelling whole systems and/or adjacent services, data storage and electronic information management.
178. The Inspector should base the depth of civil engineering assessment on the use of the model, intended and potential future use, considering the safety and security consequences of a situation where the computer model is not used appropriately. The Inspector may consider what the BIM system is designed for, what the inputs are, and how much confidence the Inspector has that the modelling system will deliver what it is intended to, to the appropriate level of accuracy. This consideration should also include the consequences of mismanagement for planned or foreseeable future uses of the model. If work associated with BIM is a procured activity, the Inspector may seek assurance that the Intelligent Customer function has been adequately.
179. The key safety assessment principles for the assessment of BIM are:
- MS.1 and MS.2 for management and MS.4 for learning from experience,
 - SC suite of SAPs where BIM is used for visibility of the adequate safety case,
 - ECE suite of SAPs where BIM is a tool used to manage civil engineering works,
 - EMT.1 and EMT.6 where BIM is used as a tool to inform arrangements for maintenance and asset care,
 - EHF.1 and EHF.9 where BIM integrates design, assessment and management systems with collaboration and cooperation with other disciplines around operational requirements,
 - ENM.4, ENM.6 and ENM.7 where BIM stores information about nuclear material locations e.g. where storage (controlled environments) are facilitated by civil engineering design and computer systems,
 - AM.1 where BIM is used to inform accident management and emergency arrangements, where emergency response is facilitated by civil engineering,
 - DC suite of SAPs where BIM is used to inform civil engineering activities as part of the decommissioning plans and strategies e.g. used as a tool to inform planning, sequencing and timing of civil engineering activities.
180. For the key civil engineering principles on assessment of the topics listed above, see:
- TAG 17 Annex 2, 'Building Information Modelling',
 - TAG 17 Annex 4, 'Civil Engineering – Construction Assurance'.
181. Further information regarding BIM information management are described in:
- ONR-NS-TAST-GD-049 'Licensee Core Safety and Intelligent Customer Capabilities',
 - ONR-CNS-TAST-GD-4.3 'Oversight of Suppliers of Items or Services of Nuclear Security Significance',
 - ONR-CNS-TAST-GD-7.2 'Information Security',
 - ONR-CNS-TAST-GD-7.4 'Physical Protection of Information'.

5.4 Ground Engineering, Geotechnics and Underground Structure Design (Annex 3)

5.4.1 Site investigations, ground investigations and geotechnical engineering

182. Fundamental to the design of any civil engineering structure is an understanding of the materials upon which it will be supported, cut through or constructed from.
183. The key safety assessment principles for the assessment of such assessment are:
- ECE.4 and ECE.5 identify the need to demonstrate stability of the soil and rock which provide support for the foundations and superstructure of a nuclear installation. To determine the suitability of these materials site investigations are undertaken,
 - ECE.7, ECE.9 and ECE.10 foundation design should meet the safety functional requirements placed upon them, with consideration of other earthworks activities and groundwater conditions,
 - ECE.15 refers to the expectations around the validation of the methods used in the structural analysis and models used,
 - ECE.16 establishes the expectations when assessing suitability of materials used on site,
 - ST.4 identifies the need for assessment of the suitability of a site to support safe nuclear operations, prior to a new site licence being granted,
 - ECE.24 refers to the expectations around the monitoring of settlement during and after construction, to check the validity of the design,
 - ECE.25 states the expectation that designs for structures important to safety will be designed so that they can be constructed in accordance with established processes that ensure the required level of safety, considering adjacent SSCs,
 - EHA.9 identifies the need for the evaluation of the seismology and geology of the area around the site and the geology and hydrogeology of the site in order to derive a design basis earthquake,
 - AV.1 and AV.2 state the expectations that theoretical models and the calculation methods will adequately represent the site and the physical processes that will take place,
 - AV.3, AV.4 and AV.5 refers to the expectations around the use of data, the computer modes used to process the data and the documentation of the analysis,
 - AV.6 refers to the expectations around sensitivity analysis,
 - AV.7 and AV.8 refer to the expectations around the collation of data through the life of the facility to check and update the safety analysis, with analysis reviewed and updated where necessary and reviewed periodically,
 - RL.5 and RL.8 are related to ground investigations associated with contamination.
184. The Inspector is reminded of the close interface with external hazards when considering the geotechnical information and data from ground investigations which, in many instances, will have been obtained to derive the applicable seismic hazard as part of the external hazard assessment.
185. For the key civil engineering principles on assessment of the topics listed above, see:
- TAG 17 Annex 3, 'Civil engineering – Ground Engineering, Geotechnics and Underground structure design', for ground condition considerations,
 - TAG 17 Annex 1, 'Civil engineering – Design' for early concept to site suitability.

5.4.2 Foundation Design

186. Where a structure is required to resist seismic loading, the soil and rock properties for use in dynamic analysis should be determined as input parameters for the foundation design solutions.
187. The Inspector is reminded of the interface with external hazards discipline when assessing geotechnical information and data from ground investigations which, in many instances, will have been obtained to derive the applicable seismic hazard as part of the external hazard assessment.
188. The key safety assessment principles for the assessment of such assessment are:
- SAPs ECE.1 and ECE.5 and ECE.6 regarding upstream references to schedules and safety functional requirements,
 - ECE.4, ECE.5, ECE.7, ECE.10, ECE.24 which state expectations for foundation design,
 - ECE.7 and ECE.10 which state expectations for foundation integrity.
 - ECE.12, ECE.13 and ECE.14 refer to the expectations around the structural analysis and model testing to demonstrate the structure can meet the safety functional requirements (SFRs) over the full range of loading for the lifetime of the facility, with the appropriate use of data and sensitivity studies to demonstrate this,
 - ECE.18 refers to the considerations of inspection during construction
 - EHA.18 and EHA.7 explain beyond design basis events and 'cliff-edge' effects and how a small change in design basis fault or event assumptions should not lead to a disproportionate increase in radiological consequences,
 - ECE.20 sets the expectations regarding examination, inspection, maintenance and testing,
 - EDR.1 refers to the expectation that designs will be designed to be inherently safe or to fail in a safe manner, identifying potential failure modes,
 - ERL.1 refers to the expectations around reliability of civil engineering SSCs.
 - EQU.1 states the expectations regarding processes for qualification to demonstrate SSCs will perform the intended function for the required duration,
 - ECS.1 sets the expectation that SSCs will be categorised appropriately,
 - ECS.3, ECS.4 and ECS.5 set the expectations of code use,
 - SC.5, ERL.4 and EAD.2 sets the expectations regarding optimism, uncertainty and conservatism and the associated margins across the required life of the SSC,
 - MS.2 outlines the expectation that there is adequate human resources and that the organisation has the capability to secure and maintain the safety of its undertakings,
 - DC.6 states that documents and records that may be required for decommissioning purposes should be identified, prepared, updated, retained and owned so that they will be available when needed.
189. For the key civil engineering principles on assessment of foundation design, see:
- TAG 17 Annex 3 'Civil Engineering – Ground Engineering, Geotechnics and Underground structure design',
 - TAG 17 Annex 4 'Civil Engineering – Construction Assurance' for construction considerations,
 - TAG 17 Annex 1 'Civil Engineering – Design' for other more generic design considerations
 - ONR-NS-TAST-GD-013 Annex 1, 'Seismic Hazards', for details on derivation of the seismic hazard and civil engineering design input parameters.

5.5 Construction Assurance (Annex 4)

5.5.1 Construction

190. The Inspector is reminded of the definition of 'Construction', see glossary in this document.
191. The Inspector may wish to seek assurance that the construction processes applied ensure that the civil engineering structures will satisfy their safety functional requirements throughout all stages of the facility and that the intended design life will be satisfied. The Inspector may wish to seek assurance that the process(es) ensure that all construction defects are identified so that their safety consequence can be quantified, and appropriate remedial action undertaken where necessary.
192. The SAPs applicable to construction depend on the stage at which the construction is occurring, including the following:
- ECE.3: It should be demonstrated that structures important to safety are sufficiently free of defects so that their safety functions are not compromised, that identified defects can be tolerated, and that the existence of defects that could compromise safety functions can be established through their lifecycle.
 - ECE.15 provides assessment principles in relation to verification activities,
 - ECE.16-19 establish the expectations that the consideration of choices of material are consistent with the design intent, using proven techniques and a quality management system and surveillance in place to minimise and identify any defects. Where defects are identified, to remediate to ensure the design intent is still met and to ensure adequate quality and original design requirements and design specification is achieved,
 - ECE.23 advises that any sea or river defences which protect a nuclear licensed site from flooding should have associated EIMT under LC28 arrangements, and for other earthworks embankments to be managed,
 - ECE.24 There should be arrangements to monitor civil engineering structures during and after construction to check the validity of predictions of performance made during the design and for feedback into design reviews ELO.1 for layout to allow for construction activities,
 - MS.1-4 for Leadership and Management for Safety,
 - ECS.1-3 for Safety Classification and Standards,
 - DC.1 establishes the expectation that the selection of the materials to consider replacement in design, shown to be appropriate for the required design life,
 - DC.6 establishes the expectation for documents to be kept for the whole life cycle,
 - ECV.1-3 for containment and Ventilation,
 - EMC.5 and EMC.6 advises as to the identification and management of defects to metal components and structures,
 - EMC.13 and EMC.15 states the expectation that all metal materials and components or structures are shown to be suitable and are suitably identified and stored e.g. reinforcement and steel sections,
 - EMC.14 states the expectation that proven techniques and approved procedures are used to minimise occurrence of defects
 - EMC.19 for non-conformities or significant defects on metal components and structures to be remediated,
 - EQU.1 establishes qualification process and procedures are required to ensure structures will perform their safety functions in line with the design intent,
 - EHF.1, EHF.5 and EHF.6 consideration of constructability and construction tasks and activities on site, regarding construction sequencing and access.
193. With the wide scope of 'construction' which interfaces across all the phases of the lifetime of a site, most of the Annexes to this TAG consider an element of construction.

194. The key civil engineering principles are presented in more detail in:
- TAG 17 Annex 4, 'Civil Engineering - Construction Assurance',
 - TAG 17 Annex 1 'Civil Engineering – Design',
 - TAG 17 Annex 3, Civil Engineering - Ground investigations, geotechnics and underground structure design',
 - TAG 17 Annex 2, 'Building Information Modelling',
 - TAG 17 Annex 5, 'Civil Engineering – Ageing Management and Damaged Structures',
 - TAG 17 Annex 6, 'Civil Engineering – Post Operation'.
195. Further ONR expectations on assessment of Construction are provided in:
- ONR-NS-INSP-GD-019 'LC19 - Construction and Installation of New Plant',
 - ONR-NS-INSP-GD-020 'LC20 - Modification to design of Plant under Construction',
 - ONR-NS-INSP-GD-021 'LC21 - Commissioning',
 - ONR-NS-INSP-GD-022 'LC22 - Modification or Experiment on Existing Plant',
 - ONR-NS-INSP-GD-028 'LC28 – Examination, Inspection, Maintenance and Testing'.
196. The Inspector is reminded of the function that Design Authority and Intelligent Customer provide in construction activities. For other associated guidance, see:
- ONR-NS-TAST-GD-079 'Licensee Design Authority Capability',
 - ONR-NS-TAST-GD-049 'Licensee Core Safety and Intelligent Customer Capabilities'.
197. The Inspector is reminded that CDM2015 applies across all civil engineering design and construction activities. For other associated guidance, see:
- L153 'Managing health and safety in construction' CDM2015 [8].

5.5.2 Materials selection, Manufacture and the Supply Chain

198. For any construction, (including modification, repurposing or decommissioning activities), the supply chain is a key area for civil engineering quality assurance. The Inspector is reminded that the Intelligent Customer (IC) performs a crucial function in the procurement of items and services.
199. The Inspector is reminded that for this topic there are some specific requirements placed upon the Client, the Principal Designer and the Principal Contractor under CDM2015.
200. The appropriate SAPs for consideration of materials selection and manufacture are:
- ECE.16 states the expectation for materials tests to confirm design intent is met
 - ECE.17 and ECE.18 state the expectation for the prevention of defects and the inspection during construction,
 - DC.1 establishes the expectation that the selection of the materials to consider replacement in design, shown to be appropriate for the required design life,
 - When assessing high integrity metal civil structures, the Inspector may similarly need to consider appropriate principles in the sub-section on Integrity of metal components and structures, in particular SAPs EMC.13, EMC.14, EMC.20, EMC.27 and EMC.30 for assessing supply chain especially when offsite operations are involved in manufacturing metal components,
 - Where a structural component also forms part of containment, the principles in SAP paragraph 519 ff. will also be relevant (see ONR-NS-TAST-GD-020 'Containment').

201. The key civil engineering principles for civil engineering assessment of material selection, manufacture and supply chain are in:
- TAG 17 Annex 1 'Civil Engineering – Design',
 - TAG 17 Annex 4 'Civil Engineering - Construction Assurance'.
202. Further ONR expectations on the assessment of materials selection and manufacture are provided in:
- ONR-NS-TAST-GD-077 'Supply Chain Management Arrangements for the Procurement of Nuclear Safety Related Items or Services'.

5.5.3 Non-conformances and defects

203. The Inspector may wish to seek assurance that, where construction non-conformities or identified defects are judged to have a significant detrimental effect on the safety function, adequate remedial action is undertaken to ensure the original design intent is still achieved. The Inspector should be aware that the dutyholder is responsible for the work of their consultants, contractors and supply chain to meet the design intent of the safety case. This is generally managed through the use of Design Authority and Intelligent Customer functions:
- ECE.3 requires structures important to safety are sufficiently free of defects, or where defects are identified, safety functions are not compromised,
 - ECE.17, ECE.18 and ECE.19 advises as to the prevention, identification and resolution of defects,
 - EMC.5 and EMC.6 advises as to the identification and management of defects to metal components and structures,
 - EMC.19 for non-conformities or significant defects on metal components and structures to be remediated.
204. For further information on non-conformances and defects, please see the appropriate reference for the phase of civil engineering these are being considered:
- TAG 17 Annex 4 'Civil Engineering - Construction Assurance',
 - TAG 17 Annex 1 'Civil Engineering – Design',
 - 'Modification' Section 5.9.5 of this document.
205. Further ONR expectations on assessment of non-conformances and defects are provided in:
- ONR-NS-TAST-GD-079 'Licensee Design Authority Capability',
 - ONR-NS-TAST-GD-049 'Licensee Core Safety and Intelligent Customer',
 - ONR-NS-TAST-GD-102 'General Guidance for Mechanical Engineering Specialism Group'.

5.5.4 Commissioning and testing

206. Suitable and sufficient verification activities should be undertaken to demonstrate key safety functional claims are substantiated:
- ECE.3 requires structures important to safety are sufficiently free of defects, or where defects are identified, safety functions are not compromised,
 - ECE.8 states designs should allow inspections and maintenance to be undertaken,
 - ECE.15 provides assessment principles in relation to verification activities,
 - ECE.18 states the expectation for inspection and testing to be completed during construction to demonstrate appropriate standards of workmanship etc. have been achieved.

207. Pre-stressed concrete pressure vessels and containment structures should be subjected to a proof pressure test, which may be repeated during the life of the site. Consideration should also be given to carrying out leak rate testing, e.g. when commissioning or as part of periodic inspections of containment structures.
208. Civil engineering structures that retain fluids should be tested for leak tightness prior to operation. Where appropriate, drainage systems should be provided and used to confirm continuing containment integrity, or to detect, locate, collect and quantify any leakage and, where possible, facilitate repair of leakage.
209. Other structural components, such as piles, post installed fixings and rock anchors, should be proof tested proportionate to the safety consequences of their failure or in accordance with uncertainties in their design and/or construction.
210. The key civil engineering principles for assessment of commissioning and testing are presented in:
- TAG 17 Annex 4 'Civil Engineering - Construction Assurance',
 - ONR-NS-TAST-GD-020 'Civil Engineering - Containments for Reactor Plants'.
211. Further ONR expectations on assessment of commissioning are provided in:
- ONR-NS-INSP-GD-021 'Commissioning'.
 - ONR-NS-TAST-GD-033 'Dutyholder Management of Records'.

5.6 Ageing Management and Damaged Structures (Annex 5)

5.6.1 Asset Management and Ageing sites

212. Suitable and sufficient activities should be undertaken to maintain and verify that safety functional requirements continue to be satisfied throughout all stages of the life of a structure. The following SAPs [1] are relevant:
- EAD.2, EMC.25, EMC.31, EMC.32, ECE.3, ECE.20 are related to lifetime margins, periodic measurements, in-service repairs, detecting and monitoring leakage, stress analysis for design life and degradation, and defect management,
 - SC.8 states the expectation that those who have direct responsibility for safety own the safety case,
 - EMC.11 establishes the expectations that failure models should be gradual and predictable,
 - ECS.3, ECS.4 and ECS.5 when applying codes and modern standards (or lack of them) to existing structure analysis,
 - EAD.3 and EAD.4 establishes the expectations for periodic measurement of material properties and parameters,
 - ECE.2 ECE.3, ECE.4 ECE.8, ECE.16, ECE.17, ECE.18, ECE.19, ECE.25 and ECE.26 apply at varying stages of a lifetime of a structure, but especially so when considering the impact ageing can have on lifetime safety functional requirements,
 - SC.6 establishes the expectation that the Safety Case should identify areas of maintenance to ensure continued safe operation and how these will be implemented,
 - EHA.12 refers to the prevention of flooding and an appropriate level of EIMT,
 - EHA.15 establishes the expectation that design should prevent water from adversely affecting SSCs,
 - EMT.2, EMT.6 and EMT.8 6 establishes the expectation that provision should be made for EIMT throughout the life, including after events that may compromise the structure,

- ERL.1 establishes the expectation that safety claims on reliability will be supported by case by case analysis,
- EDR.1 establishes the expectation that SSCs will 'fail safe', identifying potential failure modes using a formal analysis where appropriate.

213. For the key civil engineering principles for assessment of ageing sites, see:

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

5.6.2 INF1 Events on site

214. Incidents are notified under Licence Condition 7: Incidents on the site. Events are those that are classified in accordance with the International Nuclear Event Scale (INES). Not all incidents notified under LC7 constitute an event on the INES. During the operational and decommissioning phase, there are few INF1's raised on sites that are related to civil engineering. This may be related to the 'massive and passive' assumption; where civil engineering works and structures are assumed to continue to meet their nuclear safety functions regardless of age. Each structure has a potential vulnerability, be it joints of the weatherproof envelope, guttering blockages, windows with broken glass or concrete cover depths etc. Should a structure that has a safety requirement placed upon it be compromised (e.g. weatherproofing/structural), the early signs that the safety function may have been compromised should be raised as a civil engineering INF1 e.g. flora growing out of structures, broken glass in windows, corrosion to steelwork or rust staining/cracks in concrete (structures that still perform their function but are showing degradation), vehicle damage to structures etc.

215. For further guidance key civil engineering principles for assessment of damage, ageing and asset management are located in:

- For the consideration of damage and ageing, see Annex 5, 'Civil Engineering – Ageing Management and Damaged Structures',
- For the consideration of preventative actions to avoid defects, see Annex 4, 'Civil Engineering – Construction Assurance'.

216. Further ONR expectations on assessment of INF1 events are provided in:

- ONR-NS-INSP-GD-007 'LC7 – Incidents on the Site and Other Reporting and Operational Experience (OE) Processes',
- ONR-OPEX-IN-002 'Incident Notification and Reporting Process'
- ONR-NS-TAST-GD-098 'Asset Management',
- ONR-NS-INSP-GD-034 'LC34 – Leakage and Escape of Radioactive Material and Radioactive Waste'.

5.6.3 Periodic Safety Review

217. Licence condition 15 requires a Periodic Safety Review (PSR) to be undertaken at intervals to be proposed by the duty holder. There is an expectation that this interval will be at no more than 10 years.

- SC.7 states the expectation that safety cases will be actively maintained and reviewed regularly.

218. For the key civil engineering principles for assessment of PSRs, see:

- Where the assessment needs to consider the condition of a structure: Annex 5, 'Civil Engineering – Ageing Management and Damaged Structures',
- Where a PSR includes consideration of post operation processes, including clean out, decommissioning or any demolition; Annex 6, 'Civil Engineering – Post Operation'.

219. Further ONR expectations on assessment of Periodic Safety Reviews are provided in:

- ONR-NS-TAST-GD-050 'Periodic Safety Reviews (PSR)',
- ONR-NS-INSP-GD-015 'LC15 Periodic Review',
- ONR-NS-TAST-GD-098 'Asset Management',
- ONR-NS-TAST-GD-026 'Decommissioning'.

5.7 Post Operation (Annex 6)

5.7.1 Land Quality Management

220. Occasionally, the Inspector may wish to consider land quality management where contaminated ground is proposed to be remediated as part of civil engineering assessment. This activity can be part of new site construction or part of the decommissioning strategy for achieving the end state of the site, or at any time between. The relevant (non-civil engineering specific) SAPs for consideration are:

- SAPs 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.

221. It is likely that assessments of land quality and contaminated land remediation design proposals will be led by inspectors who specialise in the management of radioactive materials, with the support of civil engineering inspectors. For such an assessment, the key civil engineering principles for assessment of land quality management are:

- whether any optioneering studies have considered and reduced risks in accordance with the ALARP principle, including risks associated worker and public safety as well as reducing environmental impact now and in the future,
- whether the strategy caters for all known and suspected instances of contamination that need to be remediated,
- the reliability of the survey investigation work, considering the potential efficacy of the proposed design, understanding of the site geology and hydrogeology,
- the constructability of the proposed designs alongside conventional health and safety inspectors,
- future EIMT, (the inspector is reminded of designer duties under the CDM 2015 Regulations)
- potential impacts on achieving the future end state.

222. The related civil engineering principles for assessment of modifications are in:

- TAG 17 Annex 6 applies 'Civil Engineering – Post operation' Section regarding 'Site Remediation'.

223. Further ONR expectations on assessment of Land Contamination are provided in:

- 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'.

5.7.2 Decommissioning, Demolition and other activities for delicensing

224. Some safety functions must be maintained after the site has ceased operation to ensure the ongoing safety of the site. The Inspector should be aware of the risk of foreclosure, that safe options for future demolition are not limited un-necessarily in previous phases of site lifetime.
225. Periodic Safety Reviews can identify risks related to operational civil engineering structures, systems or components (SSCs) during the operational and decommissioning phases.
226. The post operation phases considered for civil engineering assessment are:
- Inactive quiescent storage,
 - Post operational clean out,
 - Care and maintenance,
 - Decommissioning,
 - Demolition,
 - Site remediation,
 - Delicensing.
227. The Inspector may wish to seek assurance that provision for decommissioning and dismantling of the nuclear facility is adequately addressed at concept design through to construction by the civil engineering Design Authority (DA) and Intelligent Customer as appropriate.
228. During site operation, the Inspector may wish to seek assurance that provision for decommissioning is continually refined, which can be significant after any change in use of a civil structure.
229. The relevant SAPs when assessing post operation site phases are:
- 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 SQEP 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.

230. The key civil engineering principles for assessment of decommissioning and demolition activities are presented in:

- TAG 17 Annex 6, 'Civil Engineering – post operations',
- TAG 17 Annex 5, 'Civil Engineering – Ageing Management and Damaged Structures',
- 'Modification' Section 5.9.5 of this document,
- TAG 17 Annex 2 'Civil Engineering – Building Information Modelling' for use of tools to inform decommissioning plans and strategies.

231. Further ONR expectations on assessment of Post Operation are provided in:

- ONR-NS-TAST-GD-026 'Decommissioning',
- ONR-NS-TAST-GD-098 'Asset Management',
- ONR-NS-TAST-GD-024 'Management of Radioactive Material and Radioactive Waste',
- ONR-NS-TAST-GD-079 'Licensee Design Authority Capability',
- Where contractors are utilised, ONR-NS-TAST-GD-049 'Licensee Core Safety and Intelligent Customer Capabilities',
- ONR-NS-INSP-GD-15 'LC15 – Periodic Reviews',
- ONR-NS-INSP-GD-22 'LC22 – Modification or Experiment on Existing Plant',
- ONR-NS-TAST-GD-033 'Dutyholder Management of Records',
- ONR-NS-INSP-GD-35 'LC35 - Decommissioning',
- ONR-NS-INSP-GD-051 'The Regulation of Conventional Health and Safety on UK Nuclear Sites'.

5.8 Other Topics that are relevant across all the site phases / Annexes

5.8.1 Construction (Design and Management) 2015 (CDM2015) considerations

232. The Inspector should note that CDM2015 applies at any stage of a site life cycle, including modifications to existing structures, new builds on existing sites and construction applies to any type of modification or installation, not just new build on new or existing sites. ONR expectations and further guidance on assessment of CDM2015 considerations in design and construction, is available in,

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

233. Further ONR expectations on general assessment of CDM2015 is available in:

- L153. 'Managing health and safety in construction' [8],
- HSG150 Health and Safety in Construction [18],
- INDG411 A quick guide for clients on CDM2015 [19].

5.8.2 Conventional Health and Safety on sites

234. On a site visit for civil engineering assessment, the Inspector is likely to visit areas where management arrangements fall under HSWA [12].
235. The regulation of conventional health and safety matters and applicable legislation during construction is excluded from this TAG. As such, the Inspector should refer to:
- ONR-NS-INSP-GD-051 “The Regulation of Conventional Health and Safety on UK Nuclear Sites”.
236. The civil engineering Inspector may attend site more frequently than other engineering disciplines within ONR, especially during the early phases of construction works. The Inspector should have an appreciation that they may be on site more often than the inspectors who specialise in conventional health and safety. As such, any identified issues regarding conventional health and safety and/or CDM2015 should be discussed with the dutyholder and relevant conventional health and safety Inspector and the Site Inspector at the earliest opportunity.
237. The Inspector should avoid making generalised statements about conventional safety when undertaking civil engineering assessments and site inspections, interventions or other engagements.
238. For any Matters of Evident Concern (MoEC) or Risk of Serious Personal Injury (RoSPI), the Inspector should be cognisant of their warranted status and that of their colleagues, inspection team or visitors.
239. For unwarranted visitors, the Inspector may wish to put an arrangement in place prior to the site visit to enable them to raise concerns that may be related to a MoEC or RoSPI with the Site Inspector and inspectors who specialise in conventional health and safety.
240. Should the Inspector and/or other ONR visitors witness a MOEC or ROSPI on site, or have any conventional health and safety concerns regarding an activity that has the potential to cause harm or injury on site, the Inspector should follow this guidance:
- ONR-NS-INSP-GD-051 ‘The Regulation of Conventional Health and Safety on UK Nuclear Sites’ Rev 4, in particular, paragraph 7,
 - OC 18/12 ‘Matters of Evident Concern and Potential Major Concern’, [46] in particular, paragraph 8 and 9,
 - ONR-INSP-GD-064 ‘General Inspection Guide’ Rev 2, in particular paragraph 5.34.

5.8.3 Security on sites

241. The Inspector should have an appreciation that they may be on site more often than the inspectors who specialise in security. As such, any identified issues regarding site security should be discussed with the dutyholder and relevant security inspector and the site inspector at the earliest opportunity.
242. The regulation of security aspects in relation to the construction of installation of a new facility is excluded from this TAG. As such, the Inspector should refer to the relevant Security Assessment Principles (SyAPs) for guidance on security requirements in relation to the construction or installation of new plant, of particular relevance is:
- SyDP 6.6 - Nuclear Construction Sites.

5.8.4 Examination, Inspection, Maintenance and Testing (EIMT)

243. During operation, the majority of civil engineering works require periodic EIMT to ensure the continued fulfilment of the safety functional requirements:

- ECE.8 states the expectation that designs should allow for inspection,
- ECE.18 and EMC.17 state the expectation that provision is made for inspection and testing during construction to demonstrate that appropriate standards of workmanship etc. have been achieved,
- ECE.20 requires that provision is made for EIMT operations,
- ECE.21 states the expectation that pre-stressed concrete should be subjected to proof pressure tests, repeatable during the operational life,
- ECE.22 states the expectation that structures that retain or prevent leakage are tested prior to operation,
- ECE.23 states the expectation that sea and river flood defences are routinely inspected to determine their condition,
- ECE.24 states the expectation that structures will be monitored to check validity of design assumptions, during and after construction,
- EAD.2 and EAD.4 state the expectation for adequate margins to exist in design and for measurement and monitoring of parameters that could change in time,
- SAP SC.6, paragraph 106 (c) establishes the expectation that the safety case justifies the requirements and how to implement these effectively e.g. (EIMT),
- EKP.4 and EKP.5 apply when identifying what the safety functions are, and what safety measures will deliver the safety functions, as the inspection and maintenance of 'massive and passive' safety measures is key to ensure that SSCs act in a way that is anticipated under fault conditions,
- EMC.21 states the arrangements to detect, locate and manage leakage,
- EMC.25 states the need for adequate margin to exist on safety related metal structures or components to ensure the plant remains within its operating envelope throughout its operating life,
- EMC.27-30 to consider whether there are arrangements in place for in service inspection to demonstrate fitness for purpose, consider the need for diversity in inspection and testing techniques, proof testing where codes require or otherwise are deemed essential for the safety case,
- When assessing high integrity metal civil structures, the Inspector may similarly need to consider appropriate principles in the sub-section on Integrity of metal components and structures (paragraph 280 ff.) with SAPs EMC.13-14, EMC.20, EMC.27 and EMC.30 are to be considered for inspections of offsite manufacturing operations involving metal components,
- Where a structural component also forms part of containment, the principles in SAP paragraph 519 ff. will also be relevant (see ONR-NS-TAST-GD-020 'Containment').

244. The key civil engineering principles for assessment of EIMT are in:

- TAG 17 Annex 1, 'Civil Engineering - Design',
- TAG 17 Annex 5, 'Civil Engineering – Ageing Management and Damaged Structures',
- ONR-NS-TAST-GD-020 'Civil Engineering Containments for Reactor Plants'.

245. Further ONR expectations on assessment of EIMT are provided in:

- ONR-NS-TAST-GD-098 'Asset Management',
- ONR-NS-TAST-GD-009 'Examination Inspection Maintenance and Testing of Items Important to Safety',
- ONR-NS-INSP-GD-028 'LC28 – Examination, Inspection, Maintenance and Testing (EIMT)',
- ONR-NS-INSP-GD-034 'LC35 – Leakage and Escape of Radioactive Material and Radioactive Waste'.

5.8.5 Modifications and other changes

246. The continued function of any structures, systems and components providing an ongoing safety function and any nuclear matter remaining within a structure must be protected during modification or alteration works. The key civil engineering principles for assessment of modifications are:
- SC.8 states the expectation that those who have direct responsibility for safety own the safety case,
 - DC.1, DC.4, DC.5 and RL.2 state the design should facilitate decommissioning and dismantling, with 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.8 states that any modifications should be substantiated before implementation,
 - EMC.11 failure models should be gradual and predictable.
247. Modifications can be identified by the duty holder for many reasons, at any stage in the design process. These modifications could be considered necessary by the duty holder in order to (but not limited to):
- update installations with the newest technology,
 - to increase efficiency,
 - to amend unforeseen errors in design or construction,
 - to make designs more cost efficient to build,
 - for whole structures to undergo a change of use.
248. When assessing any modification of a civil engineering structure, the Inspector may wish to seek assurance that the duty holder has considered the potential impacts or consequences of the activities required to implement the modification or change.
249. The Inspector should understand the consequences if the modification was ill-conceived or executed. To do this, the Inspector may wish to have sight of both the risk assessment where such risks are identified and of any arrangements in place to manage the risks. The Inspector may judge whether the risks associated with any civil engineering works have been considered and whether they are in line with the ALARP principles e.g. time at risk.
250. For more information on ALARP considerations, see:
- ONR-NS-TAST-GD-005 'Guidance on the Demonstration of ALARP'.
251. There are often situations where nuclear facilities are considered as 'post-operation', where nearby facilities are still operating. Where this is the case, the Inspector may consider the risk of any potential impacts on adjacent facilities and how these will be mitigated or protected against.
252. There may be optioneering studies to identify the most suitable option for a modification or change, which might include appropriateness of location, methodology or facility to accommodate the change. The Inspector may wish to have sight of such studies to understand the thought process behind the decisions made for the modification, to inform their assessment. Changes to the design and plant modifications should incorporate provision for decommissioning which should be included in decommissioning plans.
253. When proposing a change of use or extension of life for a nuclear facility, the structure should be inspected for evidence of deterioration or distress. The design of the facility should be compared against the most relevant current design practice, and any shortfalls against current standards highlighted and duly considered. The Inspector

- may wish to seek assurance that, upon identifying whether any degradation has occurred, the proposed remediation to ensure the structure(s) will meet the new design intent following the change of use of the building, for the new desired lifetime of the change. This can include considerations of CDM 2015 including the use of the health and safety files, alongside other historical documents that record the condition (and any trending of degradation) from civil engineering maintenance schedule records.
254. Where a structure is proposed for a change of use and no modifications are proposed to repair or enhance the civil engineering structure(s), the Inspector may seek assurance that a full and complete consideration of the current structural condition has been undertaken. The Inspector may wish to consider whether there are adequate arrangements in place to check the condition of the structure upon completion of the internal modifications, e.g. internal processes may be 'refurbished' or otherwise modified, and these may require no physical change to the structure, but previously hidden ageing mechanisms may be exposed, or damage incurred during the internal modification work.
255. Assessment of a modification or change can include ensuring that arrangements are in place for revised maintenance when a structure has a change of use or change to its required design life. The Inspector may consider whether the choice of structure is appropriate and whether maintenance schedules, health and safety file, decommissioning strategies and decommissioning plans have been updated in a timely manner.
256. Where the seismic capacity of existing installations is proposed to be enhanced, this proposal must not compromise the safety function of existing structures, systems and components. Modifications must attempt to reduce the overall risks so far as is reasonably practicable for the remaining life cycle of the site.
257. The related key civil engineering principles for assessment of modifications are also presented in:
- Where the modification impacts design intent, or where design changes may occur, see TAG 17 Annex 1, 'Civil Engineering – Design',
 - Where the modification needs to change layout, which is included in a BIM model, or where 3D data capture is used, TAG 17 Annex 2 applies: 'Building Information Modelling',
 - Where the modification needs to consider the condition of a structure, TAG 17 Annex 5 applies 'Civil Engineering – Ageing Management and Damaged Structures',
 - Where the modification includes clean out, decommissioning or partial demolition, TAG 17 Annex 6 applies 'Civil Engineering – Post Operation',
 - 'Non-conformances and defects' Section 5.5.3 of this document.
258. Further ONR expectations on assessment of modifications are provided in:
- ONR-NS-TAST-GD-026 'Decommissioning',
 - ONR-NS-TAST-GD-033 'Dutyholder Management of Records',
 - ONR-NS-TAST-GD-098 'Asset Management',
 - ONR-NS-INSP-GD-020 'LC20 – Modification to Design of Plant Under Construction',
 - ONR-NS-INSP-GD-022 'LC22 – Modification or Experiment on Existing Plant',
 - ONR-NS-INSP-GD-035 'Decommissioning'.

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7 APPENDICES

7.1 APPENDIX A: SCOPE OF CIVIL ENGINEERING WORKS AND STRUCTURES

The term 'civil engineering works and structures' refers to:

- the production, acceptance, approval and issuance of design or documentation,
- decision making around the design intent,
- physical works,
- or other activities that have the potential to impact design intent of nuclear safety related structures, systems and components (SSCs);

associated with these safety related functions:

- supporting safety related plant and equipment,
- provision of shielding,
- containment of nuclear matter,
- retaining liquids or gases (e.g. ponds, concrete pressure vessels, vaults and silos),
- protection of nuclear safety related plant from external hazards,
- provision of protection from malicious threat, or
- or whose failure threatens nuclear safety related structures, systems and components (SSCs) or threatens their ability to fulfil their safety functional requirements;

as performed by either:

- Nuclear safety related structures; including:
 - structural steel-framed,
 - concrete, sub- and super-structures,
 - masonry,
 - crane and plant supports;

or:

- Site infrastructure on a GB nuclear site; including but not limited to:
 - bridges, roads, railways, dockyards and other transportation links,
 - pavements and above-ground storage areas,
 - street furniture e.g. supports to lighting, storm water drainage,
 - pipe-bridges or other supports to safety related structures systems and components (SSCs),
 - earthworks, soil and rock that support SSCs,
 - over and underground routes for services and power supplies,
 - water outfalls and intakes, water management zones, lagoons and other naturally fed water storage areas,
 - foundations, basements, vaults, underground storage structures,
 - engineered slopes, embankments and ground support,
 - coastal erosion, coastal flooding, or river flooding defences / protection,
 - culverts and river entrainment structures,
 - containments/confinement, including storage ponds, vaults and silos,
 - provision for protection to buildings from accidental or malicious crashes,
 - cladding, doors, windows, boundary fences etc. including supporting structures to nuclear safety related security equipment,
 - waste stores for nuclear inventory or activated or irradiated items,
 - leak detection pits and other structures and building services that perform a safety function requirement;

where nuclear safety functional requirements continue to be satisfied as needed across all stages of the required life cycle.

7.2 APPENDIX B: LIST OF RELEVANT SAFETY ASSESSMENT PRINCIPLES

CITATION OF CIVIL ENGINEERING SAPs IN §5 OF THIS TAG

Safety Assessment Principles for Civil Engineering			
Safety case area	Subject	Identity	Wording
Engineering principles: civil engineering	Functional performance	ECE.1	The required safety functions and structural performance of the civil engineering structures under normal operating, fault and accident conditions should be specified.
	Independent arguments	ECE.2	For structures requiring the highest levels of reliability, multiple independent and diverse arguments should be provided in the safety case.
	Defects	ECE.3	It should be demonstrated that structures important to safety are sufficiently free of defects so that their safety functions are not compromised, that identified defects can be tolerated, and that the existence of defects that could compromise safety functions can be established through their lifecycle.
	Natural site materials	ECE.4	Investigations should be carried out to determine the suitability of the natural site materials to support the foundation loadings specified for normal operation and fault conditions.
Engineering principles: civil engineering: investigations	Geotechnical investigation	ECE.5	The design of foundations and sub-surface structures should utilise information derived from geotechnical site investigation.
	Loadings	ECE.6	Load development and a schedule of load combinations, together with their frequencies, should be used as the basis for structural design. Loadings during normal operating, testing design basis fault and accident conditions should be included.
Engineering principles: civil engineering: design	Foundations	ECE.7	The foundations and sub-surface structures should be designed to meet their safety functional requirements specified for normal operation and fault conditions with an absence of cliff edge effects beyond the design basis.
	Inspectability	ECE.8	Designs should allow key load-bearing elements to be inspected and, where necessary, maintained.
	Earthworks	ECE.9	The design of embankments, natural and excavated slopes, river levees and sea defences close to the facility should not jeopardise the safety of the facility.
	Groundwater	ECE.10	The design should be such that the facility remains stable against possible changes in the groundwater conditions.
	Naturally occurring gases	ECE.11	The design should take account of the possible presence of naturally occurring explosive, asphyxiant or toxic gases or vapours in underground structures such as tunnels, trenches and basements.
	Structural analysis and model testing	ECE.12	Structural analysis and/or model testing should be carried out to support the design and should demonstrate that the structure can fulfil its safety functional requirements over the full range of loading for the lifetime of the facility.
	Use of data	ECE.13	The data used in structural analysis should be selected or applied so that the analysis is demonstrably conservative.
Engineering principles: civil engineering: structural analysis and model testing	Sensitivity studies	ECE.14	Studies should be carried out to determine the sensitivity of analytical results to the assumptions made, the data used, and the methods of calculation.
	Validation of methods	ECE.15	Where analyses have been carried out on civil structures to derive static and dynamic structural loadings for the design, the methods used should be adequately validated and the data verified.
	Materials	ECE.16	The construction materials used should comply with the design methodologies employed, and be shown to be suitable for enabling the design to be constructed and then operated, inspected and maintained throughout the life of the facility.
	Prevention of defects	ECE.17	The construction should use appropriate materials, proven techniques and a quality management system to minimise defects that might affect the required integrity of structures
Engineering principles: civil engineering: construction	Inspection during construction	ECE.18	Provision should be made for inspection and testing during construction to demonstrate that appropriate standards of workmanship etc. have been achieved.
	Non-conformities	ECE.19	Where construction non-conformities or identified defects are judged to have a significant detrimental effect on integrity, remedial measures should be

			applied to ensure the original design intent is still achieved.
	In-service inspection and testing	ECE.20	Provision should be made for inspection, testing and monitoring during normal operations aimed at demonstrating that the structure continues to meet its safety functional requirements. Due account should be taken of the periodicity of the activities.
	Proof pressure tests	ECE.21	Pre-stressed concrete pressure vessels and containment structures should be subjected to a proof pressure test, which may be repeated during the life of the facility.
Engineering principles: civil engineering: in-service inspection and testing	Leak tightness	ECE.22	Civil engineering structures that retain or prevent leakage should be tested for leak tightness prior to operation.
	Inspection of sea and river flood defences	ECE.23	Provision should be made for the routine inspection of sea and river flood defences to determine their continued fitness for purpose.
	Settlement	ECE.24	There should be arrangements to monitor civil engineering structures during and after construction to check the validity of predictions of performance made during the design and for feedback into design reviews.
	Provision for construction	ECE.25	Items important to safety should be designed so that they can be manufactured, constructed, assembled, installed and erected in accordance with established processes that ensure the achievement of the design specifications and the required level of safety. The effects of construction hazards on any nearby safety related SSCs should be taken into account.
	Provision for decommissioning	ECE.26	Special consideration should be given at the design stage to the incorporation of features to facilitate radioactive waste management and the future decommissioning and dismantling of the facility.

CITATION OF OTHER RELEVANT SAPs IN §5 OF THIS TAG

Safety Assessment Principles applicable to Civil Engineering outside ECE. suite			
Safety case area	Subject	Identity	Wording
Leadership and management for safety	Leadership	MS.1	Directors, managers and leaders at all levels should focus the organisation on achieving and sustaining high standards of safety and on delivering the characteristics of a high reliability organisation
	Capable organisation	MS.2	The organisation should have the capability to secure and maintain the safety of its undertakings
	Decision making	MS.3	Decisions made at all levels in the organisation affecting safety should be informed, rational, objective, transparent and prudent.
	Learning	MS.4	Lessons should be learned from internal and external sources to continually improve leadership, organisational capability, the management system, safety decision making and safety performance.
The regulatory assessment of safety cases	Safety case characteristics	SC.4	A safety case should be accurate, objective and demonstrably complete for its intended purpose.
	Optimism, uncertainty and conservatism	SC.5	Safety cases should identify areas of optimism and uncertainty, together with their significance, in addition to strengths and any claimed conservatism.
	Safety case content and implementation	SC.6	The safety case for a facility or site should identify the important aspects of operation and management required for maintaining safety and how these will be implemented.
	Safety Case maintenance	SC.7	A safety case should be actively maintained throughout each of the lifecycle stages, and reviewed regularly
	Safety case ownership	SC.8	Ownership of the safety case should reside within the dutyholder's organisation with those who have direct responsibility for safety.

Siting	Development control planning advice	ST.1	Development control planning advice provided by ONR should align with siting criteria set by Government policy.
	Suitability of the site	ST.4	The suitability of the site to support safe nuclear operations should be assessed prior to granting a new site licence
Engineering principles: key principles	Defence in depth	EKP.3	Nuclear facilities should be designed and operated so that defence in depth against potentially significant faults or failures is achieved by the provision of multiple independent barriers to fault progression.
	Safety function	EKP.4	The safety function(s) to be delivered within the facility should be identified by a structured analysis
	Safety Measures	EKP.5	The safety function(s) to be delivered within the facility should be identified by a structured analysis
Engineering principles: safety classification and standards	Safety Categorisation	ECS.1	The safety functions to be delivered within the facility, both during normal operation and in the event of a fault or accident, should be identified and then categorised based on their significance with regard to safety.
	Safety classification of structures, systems and components	ECS.2	Structures, systems and components that have to deliver safety functions should be identified and classified on the basis of those functions and their significance to safety.
	Codes and standards	ECS.3	Structures, systems and components that are important to safety should be designed, manufactured, constructed, installed, commissioned, quality assured, maintained, tested and inspected to the appropriate codes and standards.
	Absence of established codes and standards	ECS.4	Where there are no appropriate established codes or standards, an approach derived from existing codes or standards for similar equipment, in applications with similar safety significance, should be adopted.
	Use of experience, tests or analysis	ECS.5	In the absence of applicable or relevant codes and standards, the results of experience, tests, analysis, or a combination thereof, should be applied to demonstrate that the structure, system or component will perform its safety function(s) to a level commensurate with its classification.
Engineering principles: equipment qualification	Qualification procedures	EQU.1	Qualification procedures should be applied to confirm that structures, systems and components will perform their allocated safety function(s) in all normal operational, fault and accident conditions identified in the safety case and for the duration of their operational lives.
Engineering principles: design for reliability	Failure to safety	EDR.1	Due account should be taken of the need for structures, systems and components to be designed to be inherently safe, or to fail in a safe manner, and potential failure modes should be identified, using a formal analysis where appropriate.
	Redundancy, Diversity and segregation	EDR.2	Redundancy, diversity and segregation should be incorporated as appropriate within the designs of structures, systems and components.
	Common cause failure	EDR.3	Common cause failure (CCF) should be addressed explicitly where a structure, system or component employs redundant or diverse components, measurements or actions to provide high reliability.
	Single failure criterion	EDR.4	During any normally permissible state of plant availability, no single random failure, assumed to occur anywhere within the systems provided to secure a safety function, should prevent the performance of that safety function.
Engineering principles: reliability claims	Form of claims	ERL.1	The reliability claimed for any structure, system or component should take into account its novelty, experience relevant to its proposed environment, and uncertainties in operating and fault conditions, physical data and design methods
	Margins of conservatism	ERL.4	Where safety-related systems and/or other means are claimed to reduce the frequency of a fault sequence, the safety case

			should include a margin of conservatism to allow for uncertainties.
Engineering principles: maintenance, inspection and testing	Identification of requirements	EMT.1	Safety requirements for in-service testing, inspection and other maintenance procedures and frequencies should be identified in the safety case.
	Frequency	EMT.2	Structures, systems and components should receive regular and systematic examination, inspection, maintenance and testing as defined in the safety case.
	Type-testing	EMT.3	Structures, systems and components should be type tested before they are installed to conditions equal to, at least, the most onerous for which they are designed.
	Reliability claims	EMT.6	Provision should be made for testing, maintaining, monitoring and inspecting structures, systems and components (including portable equipment) in service or at intervals throughout their life, commensurate with the reliability required of each item.
Engineering principles: ageing and degradation	Safe working life	EAD.1	The safe working life of structures, systems and components that are important to safety should be evaluated and defined at the design stage.
	Lifetime margins	EAD.2	Adequate margins should exist throughout the life of a facility to allow for the effects of materials ageing and degradation processes on structures, systems and components.
	Periodic measurement of parameters	EAD.3	Where material properties could change with time and affect safety, provision should be made for periodic measurement of the properties.
		EAD.4	Where parameters relevant to the design of plant could change with time and affect safety, provision should be made for their periodic measurement.
	Obsolescence	EAD.5	A process for reviewing the obsolescence of structures, systems and components important to safety should be in place.
Engineering principles: layout	Access	ELO.1	The design and layout should facilitate access for necessary activities and minimise adverse interactions while not compromising security aspects.
	Minimisation of the effects of incidents	ELO.4	The design and layout of the site, its facilities (including enclosed plant), support facilities and services should be such that the effects of faults and accidents are minimised.
Engineering principles: external and internal hazards	Identification and characterisation	EHA.1	An effective process should be applied to identify and characterise all external and internal hazards that could affect the safety of the facility.
	Data sources	EHA.2	For each type of external hazard either site-specific or, if this is not appropriate, best available relevant data should be used to determine the relationship between event magnitudes and their frequencies.
	Design basis events	EHA.3	For each internal or external hazard which cannot be excluded on the basis of either; low frequency or insignificant consequence (see Principle EHA.19), a design basis event should be derived.
	Frequency of initiating event	EHA.4	For natural external hazards, characterised by frequency of exceedance hazard curves and internal hazards, the design basis event for an internal or external hazard should be derived to have a predicted frequency of exceedance that accords with Fault Analysis Principle FA.5. The thresholds set in Principle FA.5 for design basis events are 1 in 10 000 years for external hazards and 1 in 100 000 years for man-made external hazards and all internal hazards (see also paragraph 629).
	Design basis event operating states	EHA.5	Analysis of design basis events should assume the event occurs simultaneously with the facility's most adverse permitted operating state (see paragraph 631 c) and d)).
	Analysis	EHA.6	The effects of internal and external hazards that could affect the

			safety of the facility should be analysed. The analysis should take into account hazard combinations, simultaneous effects, common cause failures, defence in depth and consequential effects.
	'Cliff-edge' effects	EHA.7	A small change in design basis fault or event assumptions should not lead to a disproportionate increase in radiological consequences.
	Aircraft crash	EHA.8	The total predicted frequency of aircraft crash, including helicopters and other airborne vehicles, on or near any facility housing structures, systems and components should be determined.
	Earthquakes	EHA.9	The seismology and geology of the area around the site and the geology and hydrogeology of the site should be evaluated to derive a design basis earthquake (DBE).
	Electromagnetic interference	EHA.10	The facility design should include preventative and/or protective measures against the effects of electromagnetic interference.
	Weather conditions	EHA.11	Facilities should be shown to withstand weather conditions that meet design basis event criteria. Weather conditions beyond the design basis that have the potential to lead to an accident should also be analysed.
	Flooding	EHA.12	Facilities should be shown to withstand flooding conditions up to and including the design basis event. Severe accidents involving flooding should also be analysed.
	Use, storage and generation of hazardous materials	EHA.13	The on-site use, storage or generation of hazardous materials should be minimised, controlled and located, taking due account of potential faults
	Fire, explosion, missiles, toxic gases etc. – sources of harm	EHA.14	Sources that could give rise to fire, explosion, missiles, toxic gas release, collapsing or falling loads, pipe failure effects, or internal and external flooding should be identified, quantified and analysed within the safety case.
	Hazards due to water	EHA.15	The design of the facility should prevent water from adversely affecting structures, systems and components
	Fire detection and fighting	EHA.16	Fire detection and fire-fighting systems of a capacity and capability commensurate with the worst-case design basis scenarios should be provided.
	Appropriate materials in case of fires	EHA.17	Non-combustible or fire-retardant and heat-resistant materials should be used throughout the facility (see Principle EKP.1).
	Beyond design basis events	EHA.18	Fault sequences initiated by internal and external hazards beyond the design basis should be analysed applying an appropriate combination of engineering, deterministic and probabilistic assessments.
	Screening	EHA.19	Hazards whose associated faults make no significant contribution to overall risks from the facility should be excluded from the fault analysis
Engineering principles: human factors	Integration within design, assessment and management	EHF.1	A systematic approach to integrating human factors within the design, assessment and management of systems and processes should be applied throughout the facility's lifecycle.
	Task analysis	EHF.5	Proportionate analysis should be carried out of all tasks important to safety and used to justify the effective delivery of the safety functions to which they contribute.
	Workspace design	EHF.6	Workspaces in which operations (including maintenance activities) are conducted should be designed to support reliable task performance. The design should take account of the physical and psychological characteristics of the intended users and the impact of environmental factors.
Engineering principles: containment and ventilation:	Prevention of leakage	ECV.1	Radioactive material should be contained and the generation of radioactive waste through the spread of contamination by leakage should be prevented.

containment design	Minimisation of releases	ECV.2	Containment and associated systems should be designed to minimise radioactive releases to the environment in normal operation, fault and accident conditions.
	Means of confinement	ECV.3	The primary means of confining radioactive materials should be through the provision of passive sealed containment systems and intrinsic safety features, in preference to the use of active dynamic systems and components.
	Leakage monitoring	ECV.7	Appropriate sampling and monitoring systems should be provided outside the containment to detect, locate, quantify and monitor for leakages or escapes of radioactive material from the containment boundaries.
Fault Analysis	Fault tolerance	FA.4	DBA should be carried out to provide a robust demonstration of the fault tolerance of the engineering design and the effectiveness of the safety measures.
	Initiating faults	FA.5	The safety case should list all initiating faults that are included within the design basis analysis of the facility.
	Consequences	FA.7	Analysis of design basis fault sequences should use appropriate tools and techniques, and be performed on a conservative basis to demonstrate that consequences are ALARP.
Numerical targets and legal limits	Assessment against targets	NT.1	Safety cases should be assessed against the SAPs numerical targets for normal operational, design basis fault and radiological accident risks to people on and off the site.
Radioactive waste management	Strategies for radioactive waste	RW.5	A strategy should be produced and implemented for the management of radioactive waste on a site
Decommissioning	Design and operation	DC.1	Facilities should be designed and operated so that they can be safely decommissioned.
	Timing of decommissioning	DC.3	The safety case should justify the continuing safety of the facility for the period prior to its decommissioning. Where adequate levels of safety cannot be demonstrated, prompt decommissioning should be carried out and, where necessary, prompt remedial and operational measures should be implemented to reduce the risk.
	Planning for decommissioning	DC.4	A decommissioning plan should be prepared for each facility that sets out how the facility will be safely decommissioned.
	Passive safety	DC.5	Facilities should be made passively safe before entering a care and maintenance phase.
	Records for decommissioning	DC.6	Documents and records that may be required for decommissioning purposes should be identified, prepared, updated, retained and owned so that they will be available when needed.
	Management system	DC.8	The management system should be reviewed periodically and modified as necessary prior to and during decommissioning.
	Decommissioning safety case	DC.9	A safety case should be provided to demonstrate the safety of the decommissioning plan and its associated decommissioning activities and then kept up to date as the work progresses.
Land quality management	Strategies for radioactively contaminated land	RL.1	A strategy should be produced for the control and remediation of any radioactively contaminated land on the site.
	Identifying radioactively contaminated land	RL.2	Steps should be undertaken to identify any areas of radioactively contaminated land on or adjacent to the site.
	Characterisation of radioactively contaminated land	RL.4	Radioactively contaminated land should be characterised to facilitate its safe and effective control and remediation.
	Plan for control and remediation	RL.6	A plan should be prepared and implemented for the safe control and remediation of radioactively contaminated land and should be subject to appropriate stakeholder engagement.
	Construction on radioactively contaminated	RL.8	Radioactively contaminated land should be remediated and controlled as appropriate before any construction of new facilities upon it.

	land		
Radiation Protection	Shielding	RP.6	Where shielding has been identified as a means of restricting dose, it should be effective under all normal operation and fault conditions where it provides this safety function.
Engineering Principles: Safety Systems	Failure independence	ESS.18	No design basis event should disable a safety system.
Engineering Principles: Control of Nuclear Matter	Accumulation	ENM.3	Unnecessary or unintended generation, transfer or accumulation of nuclear matter should be avoided.
	Retrieval and Inspection	ENM.7	Storage of nuclear matter should be in a form and manner that allows it to be retrieved and, where appropriate, inspected.

- CITATION OF SAPs IN DESIGN OF METAL COMPONENTS AND STRUCTURES

Where the civil / structural engineering design utilises Integrity of Metal Components and Structures, the relevant SAPs from the “Engineering principles: integrity of metal components and structures” suite are:

Design	Loadings	EMC.7	The schedule of design loadings (including combinations of loadings) for components and structures, together with conservative estimates of their frequency of occurrence should be used as the basis for design against normal operation, fault and accident conditions. This should include plant transients and tests together with internal and external hazards.
	Failure modes	EMC.11	Failure modes should be gradual and predictable.
Operation	Material compatibility	EMC.22	Materials compatibility for components should be considered for any operational or maintenance activity.
Manufacturing, pre and in-service examination and testing	Margins	EMC.28	An adequate margin should exist between the nature of defects of concern and the capability of the examination to detect and characterise a defect.
	Redundancy and diversity	EMC.29	Methods of examination of components and structures should be sufficiently redundant and diverse.
Analysis	Stress analysis	EMC.32	Stress analysis (including when displacements are the limiting parameter) should be carried out as necessary to support substantiation of the design and should demonstrate the component has an adequate life, taking into account time-dependent degradation processes.
	Use of data	EMC.33	The data used in analyses and acceptance criteria should be clearly conservative, taking account of uncertainties in the data and their contribution to the safety case.
Monitoring	Leakage	EMC.25	Means should be available to detect, locate, monitor and manage leakages that could indicate the potential for an unsafe condition to develop or give rise to significant radiological consequences.
	Forewarning of failure	EMC.26	Detailed assessment should be carried out where monitoring is claimed to provide forewarning of significant failure.
Manufacture and installation	Materials	EMC.13	Materials employed in manufacture and installation should be shown to be suitable for the purpose of enabling an adequate design to be manufactured, operated, examined and maintained throughout the life of the facility.
	Techniques and procedures	EMC.14	Manufacture and installation should use proven techniques and approved procedures to minimise the occurrence of defects that might affect the integrity of components or structures.
	Records	EMC.20	Detailed records of manufacturing, installation and testing activities should be made and be retained in such a way as to allow review at any time during subsequent operation.
Manufacturing, pre and in-service examination and testing	Examination	EMC.27	Provision should be made for examination that is capable of demonstrating with suitable reliability that the component or structure has been manufactured to an appropriate standard and will be fit for purpose at all times during future operations.
	Qualification	EMC.30	Personnel, equipment and procedures should be qualified to an extent consistent with the overall safety case and the contribution of examination to structural integrity aspects of the safety case.
in-service repairs and	Repairs and modifications	EMC.31	In-service repairs and modifications should be carefully controlled through a formal procedure for change.

modifications			
General	Defects	EMC.5	It should be demonstrated that components and structures important to safety are both free from significant defects and are tolerant of defects.
	Defects	EMC.6	During manufacture and throughout the full lifetime of the facility, there should be means to establish the existence of defects of concern.
Manufacture and installation	Non-conformities	EMC.19	Where non-conformities with procedures are judged to have a detrimental effect on integrity or significant defects are found and remedial work is necessary, the remedial work should be carried out to an approved procedure and should apply the same standards as originally intended.
Analysis	Defect sizes	EMC.34	Where high reliability is needed for components and structures and where otherwise appropriate, the sizes of crack-like defects of structural concern should be calculated using verified and validated fracture mechanics methods with verified application.
Manufacturing, pre and in-service examination and testing	Examination	EMC.27	Provision should be made for examination that is capable of demonstrating with suitable reliability that the component or structure has been manufactured to an appropriate standard and will be fit for purpose at all times during future operations.
EIMT / operational / ageing sites			
Operation	Safe operating envelope	EMC.21	Throughout their operating life, components and structures should be operated and controlled within defined limits and conditions (operating rules) derived from the safety case.
Manufacturing, pre and in-service examination and testing	Examination	EMC.27	Provision should be made for examination that is capable of demonstrating with suitable reliability that the component or structure has been manufactured to an appropriate standard and will be fit for purpose at all times during future operations.
	Redundancy and diversity	EMC.29	Methods of examination of components and structures should be sufficiently redundant and diverse.
	Qualification	EMC.30	Personnel, equipment and procedures should be qualified to an extent consistent with the overall safety case and the contribution of examination to structural integrity aspects of the safety case.

7.3 APPENDIX C: LIST OF LICENCE CONDITIONS RELEVANT TO CIVIL ENGINEERING

Licence Conditions	Technical issues relevant to Civil Engineering
Licence Condition 6: Documents, Records, Authorities and Certificates	
The licensee shall make adequate records to demonstrate compliance with any of the conditions attached to this licence.	Design, construction, modification or EIMT records to show how decisions made related to design intention, implementation and change are executed.
Licence Condition 7: Incidents on the Site	
The licensee shall make and implement adequate arrangements for the notification, recording, investigation and reporting of such incidents occurring on the site	The use of structures as part of the emergency arrangements or response on site, including vehicle garages, muster points or control rooms, on and off the site, and the offsite infrastructure that offsite services are reliant on.
Licence Condition 10: Training	
<p>The licensee shall make and implement adequate arrangements for suitable training for all those on site that have responsibility for any operations which may affect safety.</p> <p>The licensee shall submit to ONR for approval such part or parts of the aforesaid arrangements as ONR may specify.</p> <p>The licensee shall ensure that once approved no alteration or amendment is made to the approved arrangements unless ONR has approved such alteration or amendment.</p>	Training and competence of dutyholders, their contractors and those within the supply chain are required to be SQEP – suitably qualified and experienced personnel. The Inspector should consider training and competence of those who hold key roles during engagements. The Inspector may wish to seek assurance of SQEP by undertaking checks of training and competence.
Licence Condition 11: Emergency Arrangements	
Without prejudice to any other requirements of the conditions attached to this licence the licensee shall make and implement adequate arrangements for dealing with any accident or emergency arising on the site and their effects.	Provision and appropriate classification and maintenance of plant control rooms, on-site emergency control centres and off-site emergency centres, including off site provisions or civil engineering SSCs e.g. highway bridges if the site is not self-sufficient to respond to all design basis demands.
Licence Condition 12: Duly authorised and suitably qualified and experienced persons	
The licensee shall make and implement adequate arrangements to ensure that only suitably qualified and experienced persons perform any duties which may affect the safety of operations on the site or any other duties assigned by or under these conditions or any arrangements required under these conditions.	This relates to the SQEP and training records of staff that are undertaking roles associated with nuclear safety. This extends to those making the decisions around design and design change, and can have an interface with CDM requirements on role holders.
Licence Condition 14: Safety documentation	
The licensee shall make and implement adequate arrangements for the production and assessment of safety cases consisting of documentation to justify safety during the design, construction, manufacture, commissioning, operation and decommissioning phases of the installation.	This relates to the way in which safety cases are produced and assessed, as well as how this information is communicated and interpreted by those working on site construction or modification of civil engineering structures and works.
Licence Condition 15: Periodic review	

The licensee shall make and implement adequate arrangements for the periodic and systematic review and reassessment of safety cases.	The periodic review must include review and assessment of civil engineering structures and works, including condition assessments with consideration to the lifetime requirements on structures, given their present condition, and any cliff edge failures. Also, code changes should be reviewed – both changes since the last periodic review and anticipated changes between current and next review.
Licence Condition 16: Site plans, designs and specifications	
The licensee shall submit to ONR an adequate plan of the site (hereinafter referred to as the site plan) showing the location of the boundary of the licensed site and every building or plant on the site which might affect safety.	It is the responsibility of civil engineering to consider the impacts of changes to the site plan on adjacent facilities and plant. Further, the licenced site boundary is considered a civil engineering structure under the TAG definition of 'civil engineering structures and works'.
Licence Condition 17: Management systems	
The licensee shall establish and implement management systems which give due priority to safety. The licensee shall, within its management systems, make and implement adequate quality management arrangements in respect of all matters which may affect safety.	Throughout the lifecycle of a site, dutyholder management systems are required to be in place to coordinate and configure the processes and procedures in place to ensure consistent quality is achieved and ensured throughout the design. The Inspector is reminded of the benefits of early engagement when processes may be immature and developing.
Licence Condition 19: Construction of new plant	
Where the licensee proposes to construct or install any new plant which may affect safety the licensee shall make and implement adequate arrangements to control the construction or installation.	Construction Assurance annex covers this in more detail, but civil engineering interfaces between the design and safety case and the site undertaking construction is covered in this TAG.
Licence Condition 20: Modification to design of plant under construction	
The licensee shall ensure that no modification to the design which may affect safety is made to any plant during the period of construction except in accordance with adequate arrangements made and implemented by the licensee for that purpose.	Modification to design of plant under construction can include new build sites and construction or modification of a new facility on an existing site. This can also include changes to structures with no safety classification, if there is a potential for this work to impact on an adjacent nuclear safety significant structure.
Licence Condition 21: Commissioning	
<p>The licensee shall make and implement adequate arrangements for the commissioning of any plant or process which may affect safety.</p> <p>The arrangements shall include a requirement for the provision of adequate documentation to justify the safety of the proposed commissioning and shall where appropriate provide for the submission of this documentation to ONR.</p> <p>The licensee shall appoint a suitably qualified person or persons for the purpose of controlling, witnessing, recording and assessing the results of any tests carried out in accordance with the requirements of the aforesaid commissioning arrangements.</p> <p>The licensee shall ensure that full and accurate records are kept of the result of every test and operation carried out in pursuance of this condition.</p>	<p>Commissioning is the demonstration that the construction of the civil engineering structures, systems and components satisfy the adequate works information or construction requirements.</p> <p>The Inspector should be aware of the potential for aggregation of minor issues over time, defect management and record keeping, retrofit of MEH, timing, snagging, damage during other activities, asset management, records prior to burying constructed elements, appropriate record storage, acceptance criteria, SQEP of staff for workmanship, supervision and surveillance, resources available, process maturity, contractor experience and competence.</p>
Licence Condition 22: Modification or experiment on an existing plant	
The licensee shall make and implement adequate arrangements to control any modification or experiment carried out on any part of the existing plant or processes which may affect safety.	Modification to existing plant can include new build sites and construction or modification of facilities on existing sites. This can also include modification or experiment on plant with no safety classification, if there is a potential for this work to impact on an adjacent nuclear safety significant structure.

Licence Condition 23: Operating Rules	
The licensee shall, in respect of any operation that may affect safety, produce an adequate safety case to demonstrate the safety of that operation and to identify the conditions and limits necessary in the interests of safety. Such conditions and limits shall hereinafter be referred to as operating rules.	Construction and operational considerations e.g. temporary loading on partially constructed or buried structures, or if a temporary operation requires assessment of dominant openings.
Licence Condition 25: Operational Records	
The licensee shall ensure that adequate records are made of the operation, inspection and maintenance of any plant which may affect safety. The aforesaid records shall include records of the amount and location of all radioactive material, including nuclear fuel and radioactive waste, used, processed, stored or accumulated upon the site at any time.	Records of LC28 asset management inspections, including as-built records and 'golden thread' to safety functional requirements placed upon civil engineering SSCs. Record keeping, retention and storage for ease of access, including records of areas not accessed, as well as areas that have been accessed for inspection.
Licence Condition 27: Safety mechanisms, devices and circuits	
The licensee shall ensure that a plant is not operated, inspected, maintained or tested unless suitable and sufficient safety mechanisms, devices and circuits are properly connected and in good working order.	Doors, blast panels, flood barriers and/or mobile shielding, plus non civil engineering SSCs which interact with or protects civil engineering SSCs
Licence Condition 28: Examination, Inspection, Maintenance and Testing (EIMT)	
The licensee shall make and implement adequate arrangements for the regular and systematic examination, inspection, maintenance and testing of all plant which may affect safety.	LC28 inspections on civil engineering structures and infrastructure are required on a regular basis, the frequency to be informed by the present condition and the lifetime requirements. The records regarding EIMT decision making are particularly key for ongoing knowledge management.
Licence Condition 29: Duty to carry out tests, inspections and examinations	
The licensee shall carry out such tests, inspections and examinations in connection with any plant (in addition to any carried out under Condition 28 above) as ONR may, after consultation with the licensee, specify and The licensee shall furnish the results of any tests, inspections and examinations carried out in accordance with paragraph 1 of this condition to ONR as soon as practicable.	ONR may specify tests, inspections or examination of particular civil engineering elements on site when there is a concern regarding their capacity to fulfil their safety functional requirements for the duration of the required lifetime. This is in relation to all phases of civil engineering, including design or site mock-ups and trials, or to provide confidence around resolving non-conformances or defects during construction or modification. This also applies to existing plant when considering ageing management, fault scenarios or defects.
Licence Condition 34: Leakage and escape of radioactive material and radioactive waste	
The licensee shall ensure, so far as is reasonably practicable, that radioactive material and radioactive waste on the site is at all times adequately controlled or contained so that it cannot leak or otherwise escape from such control or containment.	Some facilities have a safety functional requirement for structures to be leak-tight or water-tight. It is key for the dutyholder, when specifying requirements, to seek assurance that safety functional requirements related to leakage and escape are achievable, in early design stages avoiding generic statements such as 'leak tight' or 'watertight'. Facilities should be designed that any leakage or release can be detected, monitored and collected. The containment TAG (ONR-NS-TAST-GD-020) covers watertight and leak tightness considerations in more detail.
Licence Condition 35: Decommissioning	
The licensee shall make and implement adequate arrangements for the decommissioning of any plant or process which may affect safety.	In the design of a new civil engineering structure or facility, how to maintain and decommission a facility must be considered. It is also a requirement under CDM for designers to consider the whole life of a structure, including consideration of demolition as part of the Designers Risk Assessment.

7.4 APPENDIX D: IAEA GUIDANCE RELATED TO THE CIVIL ENGINEERING SAPs

Topic / SAPs	IAEA Standards
Principles	
Safety Fundamentals	SF-1 "Fundamental Safety Principles"
Safety Requirements	SSR-4 "Safety of Nuclear Fuel Cycle Facilities"
Safety Guides	GSR-2 "Leadership and Management for Safety" (Supersedes GSR-3)
	GSR-4 "Safety Assessment for Facilities and Activities"
	SSG-25 "Periodic Safety Review for NPP"
Siting and Site investigation	
Safety Requirements	SSR-1 "Site Evaluation for Nuclear Installations" [Error! Reference source not found.] (supersedes NS-R-3 Rev1)
Safety Guides	SSG-35 "Site Survey and Site Selection for Nuclear Installations"
	SSG-9 "Seismic Hazards in Site Evaluation for Nuclear Installations"
	NS-G-3.6 "Geotechnical Aspects of Site Evaluation and Foundations for Nuclear Power Plants"
	WS-G-3.1 "Remediation Process for Areas Affected by Past Activities and Accidents"
Technical Reports	No. 1791 "Considerations on the Application of the IAEA Safety Requirements for the Design of Nuclear Power Plants"
	No. 139 "Earthquake Guidelines for Reactor Siting"
	No. 216 "Site Investigations for Repositories for Solid Radioactive Wastes in Shallow Ground"
Design / Modifications	
Safety Requirements	SSR-2/1 "Safety of Nuclear Power Plants: Design"
Safety Guides	SSG-30 "Safety Classification of Structures, Systems and Components in Nuclear Power Plants"
	SSG-53 "Design of the Reactor Containment and Associated Systems for Nuclear Power Plants"
	NS-G-1.6 "Seismic Design and Qualification"
	NS-G-1.10 "Design of Reactor Containment Systems for NPP"
	NS-G-1.13 "Radiation Protection Aspects of Design for Nuclear Power Plants"
	NS-G-2.3 "Modifications to Nuclear Power Plants"
	NS-G-2.13 "Evaluation of Seismic Safety for Existing Nuclear Installations"
	NS-G-4.6 "Radiation Protection and Radioactive Waste Management in the Design and Operation of Research Reactors"
	NS-G-1.11 "Protection against Internal Hazards other than Fires and Explosions in the Design of Nuclear Power Plants"

Technical Reports	No. 382 “Methodology for the Management of Ageing of Nuclear Power Plant Components Important to Safety”
	No. 314 “Guidebook on Design, Construction and Operation of Pilot Plants for Uranium Ore Processing”
Internal and External Hazard Loading	
Safety Requirements	SSR-2/2 “Safety of NPP: Commissioning and Operation” [36]
Safety Guides	IAEA SSG 3 Development and Application of Level 1 PSA for Nuclear Power Plants
	Safety Guide NSG 3.3 Evaluation of Seismic Hazards for Nuclear Power Plant)
	IAEA SSG 9 Specific safety guide: Seismic Hazards in Site Evaluation for Nuclear Installations. (Supersedes IAEA
	IAEA SSG-18 Meteorological and Hydrological Hazards in Site Evaluation for Nuclear Installations. (replaces NS-G-3.4 and NS-G-3.5)
	NS-G-1.5 “External Events Excluding Earthquakes in the design of NPP”
	NS-G-1.6 “Seismic Design and Qualification for NPP”
	NS-G-1.7, “Protection against Internal Fires and Explosions in the Design of NPP” [Error! Reference source not found.];
	NS-G-2.1, “Fire Safety in the Operation of Nuclear Power Plants” [Error! Reference source not found.]
	NS-G-2.13 “Evaluation of Seismic Safety for Existing Nuclear Installations”
	NSG 3.1 External Human induced events in site evaluation
	RS-G-1.4 “Building Competence in radiation protection and the safe use of radiation sources “
Construction/Commissioning	
Safety Requirements	SSR-2/2 “Safety of NPP: Commissioning and Operation”
Safety Guides	SSG-38 “Construction for Nuclear Installations”
	SSG-28 “Commissioning for Nuclear Power Plants”
N Energy Series	NP-T-2.5 “Construction Technologies for Nuclear Power Plants”
Operations/Maintenance	
Safety Requirements	SSR-2/2 “Safety of NPP: Commissioning and Operation”
Safety Guides	SSG-48 “Ageing Management and a Development of a Programme for Long Term Operation of NPP” (Supersedes NS-G-2.12)
	SSG-10 “Ageing Management for Research Reactors”
	NS-G-2.6 “Maintenance, Surveillance and in-service inspection”
	NS-G-2.12 “Ageing Management for Nuclear Power Plants”
Technical Reports	No. 338 “Methodology for the Management of Ageing of Nuclear Power Plant Components Important to Safety”

Nuclear Energy series	NP-T-3.1 “Risk Informed In-service Inspection of Piping Systems of Nuclear Power Plants: Process, Status, Issues and Development”
	NP-T-3.5 “Ageing Management of Concrete Structures in NPPs”
	NP-T-3.14 “Advanced Surveillance, Diagnostic and Prognostic Techniques in Monitoring Structures, Systems and Components in Nuclear Power Plant”
	NP-T-3.20 “Buried and Underground Piping and Tank Ageing Management for Nuclear Power Plants”
	NP-T-3.24 “Handbook on Ageing Management for NPPs”
Decommissioning and Demolition	
Safety Requirements	GSR-6 “Decommissioning of Facilities”
Safety Guides	SSG-47 “Decommissioning of NPP, Research Reactors and other nuclear fuel cycle facilities” (supersedes WS-G-2.1 and WS-G-2.4)
	SSG-49 “Decommissioning of Medical, Industrial and Research Facilities”
	WS-G-2.1 “Decommissioning of Nuclear Power Plants and Research Reactors”
	WS-G-2.2 “Decommissioning of Medical, Industrial and Research Facilities”
	WS-G-2.4 “Decommissioning of Nuclear Fuel Cycle Facilities”
	WS-G-5.2 “Safety Assessment for the Decommissioning of Facilities Using Radioactive Material”
Technical Reports	No. 373 “Decommissioning Techniques for Research Reactors”
	No. 375 “Safe Enclosure of Shutdown Nuclear Installations”
	No. 386 “Decommissioning of Nuclear Facilities Other Than Reactors”
	No. 439 “Decommissioning of Underground Structures, Systems and Components”
	No. 440 “Dismantling of Contaminated Stacks at Nuclear Facilities”
	No. 446 “Decommissioning of Research Reactors: Evolution, State of the Art, Open Issues”
	No. 448 “Decommissioning of Medical, Industrial and Research Facilities”
Safety Report Series	No. 97 “Management of Project Risks in Decommissioning”
Nuclear Energy Series	NW-T-2.6 “Decommissioning of Pools in Nuclear Facilities”
	NW-T-2.10 “Decommissioning after a Nuclear Accident: Approaches, Techniques, Practices and Implementation Considerations”

7.5 APPENDIX E: WENRA PRINCIPLES RELATED TO THE CIVIL ENGINEERING SAPs

Safety Assessment Principles			WENRA Principles		
Safety case area	Subject	Identity	SRL existing reactors	DECOM SRL	WASTE SRL
Engineering principles: civil engineering	Functional performance	ECE.1	E4.1, E9.3, E9.4, E9.5 G1.1, G2.1, G2.2 G3.1, G3.2, G4.1, G4.2 Q1.1 Q2.1 S2.1, S2.2, S2.3, S2.4		DI-23, DI-24, DI-25, DI-35, DI-38, DI-40, DI-53, DI-65
	Independent arguments	ECE.2			
	Defects	ECE.3	11. Objective 11.1, 12, 12.2, 12.3, 12.4, 12.5. 13.1, 13.2.		
	Natural site materials	ECE.4			
Engineering principles: civil engineering: investigations	Geotechnical investigation	ECE.5			DI-47
	Loadings	ECE.6	WENRA RHWG Safety of NPPs for consideration of external hazard loading		
Engineering principles: civil engineering: design	Foundations	ECE.7			
	Inspectability	ECE.8	K1.1, K1.2, K2.1, K2.2, K2.3, K2.4, K2.5 K3.1, K3.2, K3.3, K3.4, K3.5, K3.6, K3.7		DI-43
	Earthworks	ECE.9			
	Groundwater	ECE.10			
	Naturally occurring gases	ECE.11			
	Structural analysis and model testing	ECE.12			
	Use of data	ECE.13			
Engineering principles: civil engineering: structural analysis and model testing	Sensitivity studies	ECE.14			
	Validation of methods	ECE.15			
	Materials	ECE.16			
	Prevention of defects	ECE.17			
Engineering principles: civil engineering: construction	Inspection during construction	ECE.18	K3.8, K3.9, K3.10, K3.11, K3.12, K3.13	DE-42	DI-48, DI-50, DI-51
	Non-conformities	ECE.19		DE-36, DE-37	
	In-service inspection and testing	ECE.20	D4.3	DE-43, DE-44	
	Proof pressure tests	ECE.21			
Engineering principles: civil engineering: in-service inspection and testing	Leak tightness	ECE.22			
	Inspection of sea and river flood defences	ECE.23			
	Settlement	ECE.24			
	Provision for construction	ECE.25			DI-07 DI-22
	Provision for decommissioning	ECE.26		DE-15, DE-16, DE-17, DE-18, DE-20, DE-21, DE-54, DE-55, DE-56	DI-68

7.6 APPENDIX F: INTERNAL INTERFACES

Civil engineering interacts with a wide number of disciplines as it needs the input (loadings) from other disciplines to design the civil engineering structures that provide support to other SSCs, and the decisions made in civil engineering design impact on other disciplines.

Key common interfaces (not limited to) the following TAGs and TIGs:

Topic	TAG Interfaces
Principles	
Design phases	ONR-NS-TAST-GD-057 'Design Safety Assurance'
Safety Cases	ONR-NS-TAST-GD-051 'The Purpose, Scope and Content of Safety Cases' , in particular paragraph 10 and table 1, Appendix 1
RGP & ALARP	ONR-NS-TAST-GD-005 'Demonstration of ALARP' , in particular paragraph 6.1 and Annex 1
Safety Functions	ONR-NS-TAST-GD-004 'Fundamental Principles'
Passive safety functions	ONR-NS-TAST-GD-003: "Safety Systems": , in particular paragraph 5.1
	ONR-NS-TAST-GD-035 'Limits and Conditions for Nuclear Safety (Operational Rules)', in particular paragraph 5.9
Design Authority Capability	ONR-NS-TAST-GD-079 'Licensee Design Authority Capability', in particular paragraphs 50, 66
Intelligent Customer arrangements	ONR-NS-TAST-GD-049 'Licensee Core Safety and Intelligent Customer Capabilities', in particular paragraphs 4, 12, 52, 2.3
Organisational Capability	ONR-NS-TAST-GD-027 'Training and Assuring Personnel Competence'
	ONR-NS-INSP-GD-010 'LC10 – Training'
	ONR-NS-TAST-GD-048 'Organisational Change'
	ONR-NS-TAST-GD-061 'Staffing Levels and Task Organisation'
	ONR-NS-TAST-GD-065 'Function and Content of the Nuclear Baseline'
	ONR-NS-TAST-GD-060 'Procedure Design and Administration Controls'
	ONR-NS-TAST-GD-072 'Function and Content of a Safety Management Prospectus'
	ONR-NS-TAST-GD-080 'Challenge Culture Capability (including an Internal Regulation function), and the provision of Nuclear Safety Advice'
	ONR-NS-INSP-GD-070 'Safety Culture Guide for Inspectors'
Learning from Experience	ONR-NS-INSP-GD-007 'LC7 – Incidents on the site and Other Report and Operational Experience (OE) Processes'
Fundamental Safety Functions	ONR-NS-TAST-GD-075 'Safety Aspects Specific to Nuclear Fuel in Power Reactors'
Retention of documentation	ONR-NS-TAST-GD-033 'Duty Holder Management of Records' A3.1.6
	ONR-NS-INSP-GD-006 'LC6 - Documents, Records, Authorities and Certificates'

Siting and Site investigation	
Ground investigations	ONR-NS-TAST-GD-101 'Geological Disposal' in particular paragraph 5.49 and 5.62
	ONR-NS-TAST-GD-013 'External Hazards'
Design / Modifications	
Categorisation and Classification, including Seismic classification	ONR-NS-TAST-GD-094 "Categorisation of safety functions and classification of SSCs", in particular paragraphs 165, 178-183
Integrity of metal structures systems and components	ONR-NS-TAST-GD-016 'Integrity of Metal Structures, Systems and Components', in particular paragraphs 2.2 A2.12 and A2.15
Design to reduce waste arising, contaminated land	ONR-NS-TAST-GD-083 'Land quality management', in particular paragraph 5.29
Validation of computer codes and calculation methods	ONR-NS-TAST-GD-042 Validation of computer codes sections 2, 53, 65
Layout for workplace accessibility	ONR-NS-TAST-GD-062 Workplaces and work environment in particular, paragraphs 5.16, 5.6, 5.7
	ONR-NS-TAST-GD-058 'Human Factors Integration'
	ONR-NS-TAST-GD-059 'Human Machine Interface'
	ONR-NS-TAST-GD-062 'Workplaces and Work Environment'
	ONR-NS-TAST-GD-064 'Allocation of Function Between Human and Engineered Systems'
Security of Design information	ONR-CNS-TAST-GD-4.3 'Oversight of Suppliers of Items or Services of Nuclear Security Significance'
	ONR-CNS-TAST-GD-7.1 'Effective Cyber & Information Risk Management'
	ONR-CNS-TAST-GD-7.2 'Information Security'
	ONR-CNS-TAST-GD-7.4 'Physical Protection of Information'
Civil Engineering Containments	ONR-NS-TAST-GD-020 'Civil Engineering Containments for Reactor Plants' for information on: PCPVs, reactor containment buildings, fuel stores and waste stores, construction, reliability and EIMT, unpressurised containments, hazards and safety functional requirements.
Fault Studies	
Layout / segregation / separation, storage of spent fuel	ONR-NS-TAST-GD-081 'Safety aspects specific to storage of spent nuclear fuel', Appendix 1 - FA.3, Appendix 2, section 5.73
	ONR-NS-TAST-GD-036 'Diversity Redundancy Segregation and Layout of Mechanical Plant'
Fault schedules	ONR-NS-TAST-GD-030 in particular, paragraphs: 5.3, 4.6-3)ii, 5.8-2)viii

Probabilistic Safety Analysis	ONR-NS-TAST-GD-030 'Probabilistic Safety Analysis', in particular, paragraphs: 9, 26.3)iii, 28, 29, 31, Table A1-1.4 and 2.4.1, 2.6.2, 2.7.3-4, 3.3-3.4, 54 and Table A1 – 2.7.2
Severe Accident Analysis	ONR-NS-TAST-GD-43 'Severe Accident Analysis', in particular, paragraphs: 13 - 14 structural response to low frequency hazard events
Internal Hazards	
Derivation of hazards loading for design substantiation	ONR-NS-TAST-GD-014 'Internal Hazards' in particular paragraphs: 5.11, 5.14-15, 5.17, 5.19, 5.22, 5.24, 5.34, 5.78, 5.227
Structural collapse of lifting systems	ONR-NS-TAST-GD-056 'Nuclear Lifting Operations': page 6 – EHA sections 1, 5, 6, 7, 10,13-18, Page 16 – section 21, page 47 LOLER Reg 8
Essential services / drainage / flooding	ONR-NS-TAST-GD-019 'Essential Services', in particular, paragraphs 2.3, and 5.2
Initiating events, Probability of structural analysis	ONR-NS-TAST-GD-034 'Transient Analysis for DBA in Nuclear Reactors', in particular, paragraphs 25 and 27
Safe working life	ONR-NS-TAST-GD-081 'Safety Aspects Specific to Storage of Spent Nuclear Fuel' in particular, Appendix 1 – EAD 1 & EAD 2, Appendix 2 table, paragraph 5.73
Leakage and leak monitoring	ONR-NS-TAST-GD-081 'Safety Aspects Specific to Storage of Spent Nuclear Fuel' in particular, paragraphs 3.1, 5.11, Appendix 1: ECV 1, EVC 7, 5.73
	ONR-NS-TAST-GD-083 'Land Quality Management', in particular, paragraphs: 4.1, 5.13, 5.14, 5.16, 5.17, 5.22, 5.47
	ONR-NS-INSP-GD-034 'LC34 – Leakage and Escape of Radioactive Material and Radioactive Waste'
Shielding	ONR-NS-TAST-GD-002: 'Radiological Shielding' in particular, paragraphs: 11, Appendix 1: 8, 5.37-38, 5.52, 5.67
	ONR-NS-TAST-GD-045 'Radiological analysis for Fault Conditions'
Pressure systems	ONR-NS-TAST-GD-067 'Pressure Systems Safety' in particular, paragraphs 4.2.2
Accumulation of material (fire hazard)	ONR-NS-TAST-GD-033 'Dutyholder Management of Records' in particular, paragraph A3.1.6
External Hazard Loading	
Protection by Structure or Equipment Withstand Capability	ONR-NS-TAST-GD-013 'External Hazards' in particular; paragraphs 188-190,
Aircraft Crash Loadings	ONR-NS-TAST-GD-013 External Hazards, section 178, appendix 6
	ONR-CNS-TAST-GD-6.4
Large lifting operations	ONR-NS-TAST-GD-056 'Nuclear Lifting Operations' section A2.39 and A2.41 and EHA page 6
Emergency power generation / int/ext hazard event	ONR-NS-TAST-GD-103 'Emergency Power Generation' in particular, paragraphs 5.32, 5.56, 5.58, table 1, table 3,

Construction (including Commissioning)	
Construction activities	ONR-NS-INSP-GD-019 'LC19 – Construction and Installation of New Plant'
	ONR-NS-INSP-GD-020 'LC20 – Modification to Design of Plant Under Construction'
	ONR-NS-INSP-GD-021 'LC21 – Commissioning'
	ONR-NS-INSP-GD-022 'LC22 – Modification or Experiment on Existing Plant'
	ONR-NS-INSP-GD-051 'The Regulation of Conventional Health and Safety on UK Nuclear Sites'
Supply chain management	ONR-NS-TAST-GD-077 'Supply Chain Management Arrangements for the Procurement of Nuclear Safety Related Items or Services'
Suitable tests on civil structures during construction phase	ONR-NS-TAST-GD-057 'Design Safety Assurance', in particular paragraph 6.14
Keeping structural drawings and calculations up to date	ONR-NS-TAST-GD-079 'Design Authority Capability', in particular paragraphs 50 and 66
Assessing ageing facilities suitability to maintain operation	ONR-NS-TAST-GD-082 'The Technical Assessment of REPIR Submissions and the Determination of Detailed Emergency Planning Zones (DEPZ)', in particular, paragraph A24
Presence of gasses or vapours in underground structures	ONR-NS-TAST-GD-013: Appendix 6 – Section 5
Defects to metal structures	ONR-NS-TAST-GD-102 'General Guidance for Mechanical Engineering Specialism Group'
Security consideration for construction activities	ONR-CNS-TAST-GD-6.6 'Nuclear Construction Sites'
	ONR-CNS-TAST- GD-6.6 'Vulnerabilities During Construction'
	ONR-CNS-TAST-GD-4.4 'Commissioning'
	ONR-CNS-TAST-GD-4.3 'Oversight of Suppliers of Items or Services of Nuclear Security Significance'
Operations/Maintenance	
Asset management	ONR-NS-TAST-GD-098 'Asset Management' in particular, paragraph 4.1
Ageing of plant structures	ONR-NS-TAST-GD-079 'Design Authority Capability' paragraphs 50, 66
Examination Inspection Maintenance and Testing (EIMT)	ONR-NS-TAST-GD-009 'Examination Inspection Maintenance and Testing of Items Important to Safety' in particular paragraph 4.1.6
	ONR-NS-INSP-GD-028 'LC28 – Examination Inspection Maintenance and Testing (EIMT)'
SSC operations in adverse conditions	ONR-NS-TAST-GD-019 'Essential Services', in particular paragraphs 2.3, 5.2

Structural welds	ONR-NS-TAST-GD-016 'Integrity of metal structures, systems and components' section: 5.66
Review of condition of buildings and structures	ONR-NS-TAST-GD-050 'Periodic Safety Review', in particular, annex 2 section 5.5, table 1
	ONR-NS-INSP-GD-015 'LC15 – Periodic Review'
Site security	ONR-CNS-TAST-GD-5.2 "Examination, Inspection, Maintenance and Testing of Physical Protection Systems
	ONR-CNS-TAST-GD-6.3 'Security Fencing Protection Requirement Timescales'
Decommissioning and Demolition	
General Guidance	ONR-NS-TAST-GD-026 'Decommissioning'
Waste Management Safety case	ONR-NS-TAST-GD-051 'The Purpose, Scope and Content of Safety Cases' in particular paragraph 101 – g)
	ONR-NS-TAST-GD-024 'Management of Radioactive Material and Radioactive Waste'
decommissioning and shielding properties of concrete	ONR-NS-TAST-GD-002 'Radiological Shielding', in particular, paragraph 5.8, 5.9, 5.37 – 5.38, 5.52, 5.67, 8, 11
Radiation exposure to workers: Fuel Storage Ponds	ONR-NS-TAST-GD-043 'Severe Accident Analysis', in particular, paragraph 5.20

7.7 APPENDIX G: EXTERNAL INTERFACES.**TOPICS COMMON TO CIVIL ENGINEERING AND OTHER EXTERNAL STAKEHOLDERS**

Scenario	Stakeholder(s)
Working under or over water or around the tide line, receipt of goods by boat or barge	Maritime Coastguard Agency, harbourmaster(s), Marine Management Organisation (Marine Licences), Department for Environment, Food and Rural Affairs (or successor organisations).
Generic Design Assessment, Site Licencing, New build issues relating to changes to site boundary plan, Development Consent Orders	Local authorities, site stakeholder groups, local engagement meetings with residents and local communities, Non-Governmental Organisations (NGOs)
	ONR are not the competent authority for planning decisions or authorising the construction of a nuclear facility in a particular location. These duties fall to the relevant national and local planning authorities.
Activities that may release discharges to the environment and activities that may result in the generation of solid radioactive materials and non-radioactive waste materials	The relevant environment regulator i.e. Environment Agency (England), Natural Resources Wales (Wales) and Scottish Environment Protection Agency (Scotland)
Temporary Works	HSE, Temporary Works Forum
Events, e.g. structural collapse	SCOSS, CROSS, Nationwide INF1 process and International Operational Experience
Decommissioning	The relevant environment regulator i.e. Environment Agency (England), Natural Resources Wales (Wales) and Scottish Environment Protection Agency (Scotland), Local Authority Waste, Environmental Health, Building Control and Planning Departments (including modification to or removal of emergency plans). Adjacent Licensees or duty holders at adjacent sites. HSE Local groups and the public near the site. Nuclear Decommissioning Authority
Civil engineering activities as part of the defence programme	Defence Nuclear Safety Regulator (DNSR)
Civil engineering activities that bridge the nuclear licenced site e.g. tunnels	Health and Safety Executive (HSE) Marine Management Organisation (MMO) or similar, other stakeholders e.g. harbourmaster
Environmental impact assessments, discharge permits, noise and other pollution, flood risk, rights of way, accessing land	Department for Environment, Food and Rural Affairs (or successor organisations).
Demolition or other activities using explosives	HSE Explosives Inspectorate