



<b>ONR GUIDE</b>			
<b>SAFETY ASPECTS SPECIFIC TO STORAGE OF SPENT NUCLEAR FUEL</b>			
<b>Document Type:</b>	Nuclear Safety Technical Assessment Guide		
<b>Unique Document ID and Revision No:</b>	NS-TAST-GD-081 Revision 4		
<b>Date Issued:</b>	June 2019	<b>Review Date:</b>	June 2024
<b>Approved by:</b>	L. Thomas	Professional Lead	
<b>Record Reference:</b>	CM9 Ref: 2020/311547		
<b>Revision commentary:</b>	Rev 3: Revision to existing document Rev 4: Updated Review Period		

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## 1. INTRODUCTION

1.1 The Office for Nuclear Regulation (ONR) has established its Safety Assessment Principles for Nuclear Facilities (SAPs) [1] which apply to the assessment by ONR specialist inspectors of safety cases for nuclear facilities that may be operated by potential licensees, existing licensees, or other duty-holders. The principles presented in the SAPs are supported by a suite of Technical Assessment Guides (TAGs) [2], to guide regulatory decision making. The outcome of an assessment by ONR is to reach an independent and informed judgement on the adequacy of a nuclear safety case [3]. This TAG contains guidance to advise and inform ONR inspectors and assessors in the exercise of their regulatory judgment.

## 2. PURPOSE AND SCOPE

2.1 This TAG contains general guidance, to advise and inform ONR inspectors in exercising their professional regulatory judgements on the safe storage of spent nuclear fuel. This TAG is also intended to demonstrate how ONR meets the Western European Nuclear Regulators' Association (WENRA) Safety Reference Levels (SRL) for waste and spent nuclear fuel storage [4]. This TAG has also been written with due cognisance of relevant International Atomic Energy Agency (IAEA) safety standards for spent nuclear fuel storage [5].

2.2 The TAG is written as guidance for ONR inspectors to carry out their regulatory duties, it is not written for duty holders and although it may be used by duty holders as a source of guidance or good practice, it should not be interpreted by duty holders as a set of prescriptive legal requirements.

2.3 This guidance solely covers storage of spent nuclear fuel and deals with both short-term storage of high decay heat fuel (recently removed from the reactor core) and long-term storage of spent nuclear fuel whose initial high decay heat has been allowed to reduce to a lower level. The long-term storage of this lower decay heat fuel is seen as an interim measure, prior to the fuel undergoing final disposal or reprocessing (should future economics make this an economically attractive proposition). This guidance is not intended to cover:

- operations prior to spent nuclear fuel storage;
- operations to prepare spent nuclear fuel for processing or disposal after the period of storage;
- movement of the spent nuclear fuel on-site, or transportation off-site; or
- construction, commissioning and decommissioning of storage and handling facilities.

2.4 The storage of the spent nuclear fuel may be in either a wet or dry storage environment and this TAG is intended to be generic to both options.

2.5 Storage is differentiated from disposal by virtue of the intention to retrieve the spent nuclear fuel for reprocessing or conditioning for disposal. In accordance with UK Government policy, spent nuclear fuel is not considered to be a waste unless declared to be a waste by the owner. However, for spent nuclear fuels where the baseline assumption is for direct disposal to a future geological disposal facility, radioactive waste management principles and practice are relevant to the safe and secure long-term management of spent nuclear fuel.

2.6 This TAG is principally concerned with the storage of spent civil nuclear reactor fuel. However, where the ONR inspector considers it justifiable to do so, the TAG can be applied to the storage of other spent nuclear fuels.

- 2.7 The ONR inspector should note that for operational reasons, a duty holder may remove fuel from a reactor before it is fully spent and may place that fuel in temporary storage (in a facility designed and engineered for that purpose) prior to re-introducing the fuel into the reactor core. The storage conditions required for fuel intended for re-introduction into the reactor are beyond the scope of this TAG.
- 2.8 This TAG does not cover fuel that is so badly damaged or degraded that it can no longer be retrieved using standard equipment; however, if the ONR inspector considers it justifiable to do so, the principles outlined within this TAG can be applied to the storage of such fuel.
- 2.9 This TAG does not provide recommendations on the physical protection of nuclear material and nuclear facilities. Such considerations are the responsibility of CNSS and are covered under the ONR's Security Assessment Principles (SyAPs) [6] and supporting TAGs [7]. The TAG considers physical protection and safeguards arrangements only to highlight their potential synergies with and impacts upon nuclear safety. Security requirements may change as the levels of radiation from the spent nuclear fuel decay.
- 2.10 Key terms pertinent to the storage of spent nuclear fuel are defined as follows:
- **Storage** - Emplacement of spent nuclear fuel in an appropriate engineered facility with the intention of retrieval.
  - **Disposal** – Emplacement of spent nuclear fuel in an appropriate engineered facility without the intention of retrieval.
  - **Reprocessing** – The chemical process which separates uranium and plutonium from the waste (fission products) in the spent nuclear fuel.
  - **Spent nuclear fuel** – Nuclear fuel that is permanently removed from a reactor following irradiation and is no longer usable to generate electricity in its present form.

### 3. RELATIONSHIP TO LICENCE AND OTHER RELEVANT LEGISLATION

#### Nuclear Site Licence Conditions

- 3.1 The management of spent nuclear fuel involves a broad range of activities, over a long time. Therefore, each of the standard Licence Conditions (LC) [8] is likely to be of relevance at some stage in the management lifecycle. However, the most relevant LCs that an Inspector may wish to consider are:
- 4 Restrictions on nuclear matter on the site
  - 5 Consignment of nuclear matter
  - 6 Documents, records, authorities and certificates
  - 15 Periodic review
  - 23 Operating rules
  - 25 Operational records
  - 28 Examination, inspection, maintenance and testing
  - 32 Accumulation of radioactive waste
  - 34 Leakage and escape of radioactive material and radioactive waste
  - 35 Decommissioning

#### Other Relevant Legislation

- 3.2 There are no specific regulations governing the safe storage of spent nuclear fuel, but the Inspector should remain mindful of the following legislation which will influence management of spent nuclear fuel, noting this list is neither exhaustive nor exclusive:

- Ionising Radiations Regulations 2017 (IRR17)
- Management of Health & Safety at Work Regulations 1999 (MHWSR)
- Nuclear Industries Security Regulations 2003 (NISR)
- The Nuclear Safeguards (EU Exit) Regulations 2018

### The Energy Act 2008

- 3.3 The Energy Act 2008 requires any operator of a new nuclear power station to have a Funded Decommissioning Programme (FDP), approved by the Secretary of State, in place before construction of a new nuclear power station begins and to comply with this programme thereafter. The FDP, prepared by the operator of a new nuclear power station, must include:
- Provision for the steps necessary to decommission the installation and manage and dispose of hazardous waste, including spent nuclear fuel;
  - An estimate of the costs of taking those steps; and
  - Details of any security to be provided in relation to those costs.
- 3.4 ONR does not enforce the requirement to have a FDP. However, ONR is a statutory consultee for the FDP, meaning it may provide advice to Government on the technical content of the operator's FDP .

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

- 4.1 The SAPs provide nuclear inspectors with a framework for making consistent regulatory judgements on the safety of activities on nuclear installations, and also recognises the legal duty on licensees to reduce risk so far as is reasonably practicable (SFAIRP).
- 4.2 There is a range of prescribed activities for which a nuclear site licence is required. Not all of the SAPs are applicable to all facilities; and not all of the applicable SAPs will be relevant to all assessments for that facility. However, many of the SAPs are relevant to the safety of spent nuclear fuel storage and the Inspector should constantly bear this in mind. Furthermore, to carry out a comprehensive assessment, it may be necessary to refer to several other TAGs in addition to this TAG.
- 4.3 Appendices 1 and 2 to this TAG list the specific SAPs and TAGs that the Inspector may wish to consider in the conduct of their assessment work on duty holder's safety submissions related to the storage of spent nuclear fuel.
- 4.4 Section 4 of NS-TAST-GD-005 identifies that the WENRA Safety Reference Levels (SRL) are considered by ONR to be sources of relevant good practice (RGP) for operating reactors, facilities in decommissioning and facilities for the storage of radioactive waste and spent nuclear fuel. The applicable SRLs for spent nuclear fuel are clearly identified in the relevant sections of this TAG.
- 4.5 The WENRA SRLs are split into four safety areas, and the guidance to Inspectors provided in Section 5 of this TAG mirrors these, as follows:
- **Safety management** – including responsibility, organisational structure, management systems and record keeping.
  - **Design** – including storage facility design requirements, handling and retrieval requirements and storage capacity.
  - **Operation** – including conduct of operation, emergency preparedness, operational experience feedback, operational facility modification, maintenance, periodic testing and inspection, specific contingency plans and requirements for

acceptance of waste and spent nuclear fuel packages and unpackaged fuel elements.

- **Safety verification** – including contents and updating of the safety case and periodic safety review.

4.6 The relevant IAEA safety standard, related to the storage of spent nuclear fuel is SSG-15 [5] is being updated by the IAEA. The version of SSG-15 under revision has been taken into account during the revision of this TAG.

## 5. ADVICE TO INSPECTORS

### Background

- 5.1 Spent nuclear fuel is generated from the operation of nuclear reactors of all types and needs to be safely managed following removal from the reactor core. The safety of a spent nuclear fuel storage facility (and the spent nuclear fuel stored within it) is ensured by:
- Appropriate containment of the radionuclides involved.
  - The maintenance of criticality safety.
  - The removal of fission product decay heat.
  - The provision of radiation shielding.
  - Ensuring the retrievability of the fuel.
  - Safe handling of spent nuclear fuel
- 5.2 ONR Safety Inspectors need to be aware of security and safeguards requirements when considering proposals for spent nuclear fuel storage and the development of spent nuclear fuel storage facilities.
- 5.3 Spent nuclear fuel, generated by operating reactors, is usually stored in an engineered facility for a period immediately following discharge from the reactor to allow the fission product decay heat to reduce and the radiation levels emitted by the fuel to decay. For the spent nuclear fuel from light water reactors (e.g. Pressurised Water Reactors, PWR and Boiling Water Reactors, BWR) this initial storage is conducted in the reactor storage pool, (the water in the pool provides radiation shielding and cooling of the fuel. Criticality safety is generally maintained by design features of the spent nuclear fuel storage racks). For the UK's Advanced Gas Cooled Reactors (AGR), initial spent nuclear fuel storage requirements can be met by emplacement within a fuel pond, or in Decay (Buffer) Storage Tubes (BST), adjacent to the reactor core and located in a heavily shielded cell. Decay (buffer) Storage Tubes enable fuel to be stored dry (one fuel assembly per Tube) in a pressurised carbon dioxide environment (a cooling water jacket on the outside of the tubes takes away the decay heat transferred to the tube walls by the natural convection of the pressurised carbon dioxide gas in the tube).
- 5.4 In the case of light water reactors, the inspector should note that sufficient capacity should be retained at all times in the at-reactor cooling pond, to not only safely accommodate the spent nuclear fuel awaiting transfer to the interim storage facility, but also to accommodate an emergency off-load of the entire reactor core of fuel should this be necessary. The infrastructure supporting the at-reactor pond should be able to cope with the cooling, containment, radiation shielding and criticality requirements of any such emergency core off-load. In the UK AGR context sufficient cooling should be provided to ensure core integrity is maintained post shutdown.
- 5.5 It is important that the licensee be able to provide a robust justification for the minimum period it is required to store the spent nuclear fuel in such facilities and how it ensures the spent nuclear fuel cannot be discharged in advance of this minimum stipulated

cooling period (early discharge can pose multiple nuclear safety challenges to the downstream storage facility).

- 5.6 Following this initial fuel cooling period, the spent nuclear fuel may be transferred to a designated wet or dry storage facility, where it will await reprocessing or disposal.
- 5.7 For fuel placed into long-term storage, this is likely (as described above) to have been through an initial cooling period. For the long-term storage period, therefore, the safety considerations only differ to storage during the initial cooling period because of the extended storage duration and the fact that the fuel will be both thermally and radioactively cooler.
- 5.8 The control of the spent nuclear fuel in the long-term storage phase is outlined below, but there are a number of other factors that could be relevant to the facility which follows on from the discussions on the control of spent nuclear fuel.
- 5.9 The following sections have purposely been laid out to mimic the layout of the WENRA Safety Reference Levels (SRL) [4], so that the reader can easily confirm that ONR is following the WENRA guidance (specific SRL are referred to against the various subsections), however, additional text has been added as required to reflect the UK context.

#### **Joint Guidance on the Management of Higher Activity Radioactive Waste on Nuclear Licensed Sites**

- 5.10 The Environment Agency (EA), Scottish Environment Protection Agency (SEPA), Natural Resources Wales (NRW) and ONR have published joint guidance on the management of higher activity radioactive waste (HAW) on nuclear licensed sites (the Joint Guidance) [9]. The Joint Guidance covers all aspects to the safe and secure management of HAW (intermediate and high level wastes) produced on nuclear licensed sites.
- 5.11 Spent nuclear fuel management has similarities with radioactive waste management i.e. long-term storage pending processing or disposal. Additionally, fuel failures in long-term storage can result in the production of radioactive waste and there is also a risk of leakage and escape of radioactivity/radioactive material. Therefore, ONR consider it appropriate that the principles in the Joint Guidance are applied to management of spent nuclear fuel. However, intact spent nuclear fuel is not considered to be radioactive waste, a view supported by ONR.
- 5.12 It is for the owner of the spent nuclear fuel to determine when it becomes a waste. Presently the UK Nuclear Decommissioning Authority (NDA) has title to most of the spent nuclear fuel from the civil nuclear reactors on behalf of the UK Government. Operators pay for the management of the spent nuclear fuel including its storage via the Nuclear Liabilities Fund. With respect to spent nuclear fuel ownership within the defence and propulsion programmes, the ownership and associated liability resides with the Ministry of Defence (MoD).
- 5.13 The assumed position for new build programmes is to retain the spent nuclear fuel on-site until such a time that direct disposal within a geological disposal facility (GDF) can be completed. This assumes the title of the liability will be transferred to the NDA; however, policy states that the management of spent nuclear fuels is a matter for the commercial judgement of its owners therefore this position is subject to the licensees' discretion. Irrespective of the decision taken by the licensee, and prior to implementation, the ALARP principle will need to be applied. The option to retrieve and reprocess, should the liability title be transferred to the NDA, should not be foreclosed.

- 5.14 The Joint Guidance considers production of a radioactive waste management case (RWMC) to be good practice (not a legal requirement) in addition to the requirement under Licence Condition (LC) 23(1) to produce adequate safety cases in respect of any operation that may affect safety. An RWMC is intended to provide a summary of how the key elements of long-term safety and environmental performance will be delivered for the management of radioactive waste streams, which may not be addressed in the individual plant safety cases and environmental documentation. Where a waste stream is transferred between multiple plant or sites, good practice would suggest generation of the RWMC early in the waste stream lifecycle, enabling its maintenance and update upon subsequent transfer(s). The RWMC for a particular waste stream should cover the period from generation, through the conditioning, storage and up to the removal of the waste stream from site for eventual disposal.
- 5.15 Whilst spent nuclear fuel is not considered to be a waste, there are similarities between long-term management of spent nuclear fuel and radioactive waste. Application of principles for long-term management of radioactive waste to long-term management of spent nuclear fuel will ensure that should spent nuclear fuel be categorised as waste in future, the spent nuclear fuel will have been managed to facilitate its eventual disposal as a waste.
- 5.16 Where spent nuclear fuel is to be stored for long periods, prior to onward processing or conditioning for disposal, there are benefits from considering production of an RWMC, noting this is not a regulatory requirement. However, there is a need for regular review to confirm that risks associated with current storage arrangements remain ALARP.

## **SAFETY MANAGEMENT**

### **Responsibility (SRL-01 – SRL-10)**

- 5.17 The duty holder of the spent nuclear fuel storage facility is responsible for the safety of all activities in the facility during the lifetime of the facility and must establish and implement safety policies, programs and procedures, to ensure safety issues are given the highest priority, commensurate with the scale of the facility and its inventory.
- 5.18 Delivery of the safety policy will require the development by the duty holder of an organisational structure, with responsibilities, accountabilities, lines of authority and communication - all clearly defined.
- 5.19 There must be clear and unequivocal ownership of the spent nuclear fuel stored in the facility and the owner shall be responsible for the overall strategy for the management of the spent nuclear fuel, taking into account interdependencies between all stages of spent nuclear fuel management and options available, from generation to disposal. However, the strategy must be consistent with the UK Government strategy for spent nuclear fuel management.
- 5.20 Where the spent nuclear fuel owner and the duty holder of the spent nuclear fuel storage facility are not the same, then the interface between the responsibilities between the entities must be clearly defined, agreed and documented. Any changes to the relationship between the duty holder and the spent nuclear fuel owner, or changes in ownership of the spent nuclear fuel, should be communicated to ONR. In the UK context this is relevant with respect to AGR fuel, where some fuel is Nuclear Decommissioning Authority (NDA) title and some is EdF Energy Nuclear Generation Ltd (EdF NGL) title.
- 5.21 The duty holder must commit to maintaining the safety of the spent nuclear fuel storage facility and, so far as is reasonably practicable, to improve safety on the basis of operating experience. Operating experience in this context refers to global

operating experience OpEx and the inspector should seek evidence that the duty holder of the spent nuclear fuel storage facility is actively seeking information from the operation of other similar spent nuclear fuel stores elsewhere in the world and/or from relevant research projects e.g. the Electric Power Research Institute's (EPRI) Extended Storage Collaboration Project (ESCP), looking at high burn-up spent nuclear fuel performance during long-term storage.

- 5.22 As per the requirements of Licence Condition (LC) 10 ("Training") the duty holder shall specify the necessary qualifications and experiences, and make and implement adequate arrangements for suitable training, for those who have a responsibility for any spent nuclear fuel storage operations which can affect safety.
- 5.23 Over the lifetime of the spent nuclear fuel storage facility, the duty holder must maintain its capability in terms of staffing, skills, experience and knowledge in order to undertake the required activities from initial siting to eventual decommissioning. Where the resources and skills, necessary to undertake these activities, are delivered by an external organisation, then (consistent with the requirements of LC 26 – "Control and Supervision of Operations"), the duty holder must retain within its organisation an ability to assess the adequacy of the external organisation's capabilities through the role of an intelligent customer, to ensure safety, (see NS-TAST-GD-049 for further guidance on 'Licensee Core and Intelligent Customer Capabilities').
- 5.24 Given the potential timescales involved, there should be adequate processes in place to sustain an adequate organisational capability to manage nuclear safety throughout the lifecycle of the facility. Specifically, this should take account of:
- The need to ensure a continued understanding of design intent and to maintain documentation relating to the design and modification of the facility throughout its life.
  - The need to identify and support the delivery of sufficient competent resource to understand the design and to carry out actions to keep the facility in a safe state.
  - The need for robust knowledge management arrangements, which secure effective transfer of information and learning.
  - The need to sustain a positive safety culture, which recognises the hazards and risks associated with maintaining a nuclear licensed nuclear facility through all phases of the lifecycle.

### **Management Systems (SRL-11 – SRL-14)**

- 5.25 As per the requirements of LC 17 ("Management Systems") the duty holder must establish and implement a management system, giving due priority to safety but also ensuring that health, environmental, security, quality and economic requirements are not considered separately from the safety requirements. The management system, which should bring together, in a coherent manner, all the requirements for managing the organisation, should be assessed and continually improved. The management system must also be aligned to the goals of the organisation and contribute to their achievement.
- 5.26 The management system must cover the full facility lifetime and the entire duration of activities in normal, transient and emergency situations. For the spent nuclear fuel storage facility, this must include planning, siting, design, construction, commissioning, operation and decommissioning.
- 5.27 The duty holder shall identify the management system processes needed to achieve the goals and meet the requirements of the organisation and ensure that their development is planned, implemented, assessed and continually improved. Any work



carried out on the management system processes should be carried out under controlled procedures and periodically reviewed to ensure its adequacy and effectiveness.

5.28 The documentation of the management system shall include the following:

- The policy statements of the licensee.
- A description of the management system.
- A description of the functional responsibilities, accountabilities, levels of authority and interactions of those managing, performing and assessing work.
- A description of the interactions with relevant external organizations.
- A description of the processes and supporting information that explain how work is to be prepared, reviewed, carried out, recorded, assessed and improved.

### **Information Recording and Reporting (SRL -15 - SRL-18)**

5.29 Licence Condition 25 (“Operational Records”) requires records to be generated at all stages of the facility lifetime, taking into account the condition of the spent nuclear fuel package or unpackaged spent nuclear fuel element upon receipt into the storage facility, and for any subsequent transfers between storage facilities. Upon receipt into a store, the duty holder should document the baseline condition for comparison with future inspection and examination data to verify integrity of the spent nuclear fuel packages, or unpackaged spent nuclear fuel elements.

5.30 Provision should also be made by the duty holder, in accordance with Licence Condition 6 (“Documents, Records, Authorities and Certificates”), for the retention and updating (throughout the whole storage period) of those records required to demonstrate operational history, safe storage, transport and onward processing or disposal of spent nuclear fuel and that provide a safety input into planning and implementation of facility modifications and eventual decommissioning. For further guidance on expectations regarding duty holder management of records, see NS-TAST-GD-033.

5.31 The duty holder, with the agreement of the spent nuclear fuel owner (the role of the owner is of importance since the licensee / duty holder may change) must develop and maintain a record system on the location and characteristics of all spent nuclear fuel in storage, including information on its ownership, origin and up-to-date information on the radioactive inventory. Key information needs to be managed in a manner that protects against the likelihood and consequences of their loss, damage or deterioration and retains its evidential value.

5.32 A marking system that will last for the storage period should be developed by the duty holder, so that all spent nuclear fuel can be uniquely identified.

## **DESIGN**

### **Storage Facility Design Requirements (SRL-19 – SRL-30 and SRL-44 – SRL-47)**

5.33 The design of the spent nuclear fuel storage facility must ensure delivery of the fundamental safety functions (defined in paragraph 5.1 above) during normal operations, anticipated operational occurrences and design basis accident conditions. In addition, the design must take into account the expected operational lifetime of the facility in ensuring the safety conditions, operational limits and the conditions identified in the safety case can be met. In the UK context it is important to recognise that delays in the realisation of the UK GDF may impact i.e. extend the operational lifetime of spent nuclear fuel storage facilities. Given the potentially extended lifetime of spent

- nuclear fuel storage facilities, effective management of ageing and degradation is needed so that the safety function of structures, systems and components are delivered throughout the require period (for further guidance see SAPS EAD.1-6 and NS-TAST-GD-098 on “Asset Management”).
- 5.34 The duty holder must demonstrate that the design and construction of the spent nuclear fuel storage facility are based upon applicable standards and appropriate materials, especially considering the lifetime of the facility. The design should also incorporate passive safety features so far as is reasonably practicable – see SAP ENM 6, i.e. in the context of spent nuclear fuel storage, providing and maintaining a safety function by minimising the need for active safety systems, monitoring, or prompt human intervention. The selection of suitable structural materials should be based on the potential cumulative effects of radiation, chemical and thermal environment (noting in the UK context that spent nuclear fuel stores are likely to be constructed in coastal locations with associated saline atmospheres and that store lifetime extensions i.e. beyond the projected design lifetime, may be required).
- 5.35 In assessing whether passive safety has been achieved, consideration should be given to:
- Confidence in the continuing cladding and structural integrity of the spent nuclear fuel.
  - The application of good engineering practices.
  - Any short or long-term effect on the spent nuclear fuel of required monitoring and inspection to demonstrate its integrity.
  - The demonstration that passive safety can be maintained across the storage lifetime and under credible accident conditions.
  - The potential impact of radiation, heat generation, corrosion or other chemical reactions on spent nuclear fuel and facility equipment.
  - The potential generation of hazardous gases by chemical and/or radiolytic effect (e.g. the generation of hydrogen by radiolysis).
  - The build-up of pressure in sealed systems.
  - The ageing of the facility.
- 5.36 In the case of new UK reactor designs, the ONR inspector should seek assurances from an ONR fuel performance inspector that post operation storage has been adequately considered in the design of the fuel for the new reactor [It is necessary to maintain both the spent nuclear fuel assemblies and the storage facility itself in a demonstrably safe condition over the proposed lifetime of the facility (including checking there are no ‘cliff edges’ in beyond design basis events and where extended storage periods are envisaged)].
- 5.37 The fuel storage layout and fuel handling arrangements should be optimised to minimise the risk of accidents (including potential physical hazards).
- 5.38 Where spent nuclear fuel storage is to be in a wet environment (i.e. a pond or equivalent) the duty holder must demonstrate that the water chemistry can be adequately controlled and that the resultant chemical environment will be appropriate to protect the stored fuel against degradation of the fuel cladding. The means of controlling the pond chemistry should be passive, robust and reliable. Robust and diverse instrumentation should be provided to ensure any deviation in the required chemical environment is identified promptly to allow remedial action to be taken.
- 5.39 The design basis of the spent nuclear fuel store must be clearly and systematically defined and documented and be based upon the assumed conditions for normal operations and assumed incidents or accidents. All structures, systems and

- components (SSC) important to safety must be identified and classified, using a graded approach.
- 5.40 The duty holder shall make design arrangements for fire safety on the basis of a fire safety analysis and implementation of defence in depth (prevention, detection, control and mitigation of fire).
- 5.41 The ageing of SSCs and safety features of spent nuclear fuel storage facilities must be addressed e.g. (as required by LC 28 – “Examination, Inspection, Maintenance and Testing”) by the establishment of provisions for maintenance, testing and inspection (according to written procedures) to ensure that the SSCs are able to function in accordance with design intents and safety requirements. The extent of the programme of maintenance, periodic testing, or inspection of SSCs must be in accordance with the facility safety case. The results of the maintenance, periodic testing and inspection must be recorded and assessed and the maintenance programme itself must be reviewed at regular intervals, to incorporate the lessons learnt from experience. Results from the conduct of these maintenance, inspection and testing activities should be used as an input into the periodic reviews of the design’s ongoing safety by the duty holder.
- 5.42 As per the requirements of LC 23, operating limits and conditions must be established and must consider (as appropriate):
- Environmental conditions<sup>1</sup> within the store (e.g. temperature, humidity, contaminants etc.).
  - The effects of heat generation from the spent nuclear fuel (both from the individual spent nuclear fuel packages – storage casks and from each individual spent nuclear fuel assembly in pond storage) and from the whole store.
  - Potential gas (e.g. hydrogen) generation from the stored spent nuclear fuel (in the context of potential fire, explosion spent nuclear fuel package/unpackaged spent nuclear fuel element deformations and radiation protection).
  - Maintaining the spent nuclear fuel in a sub-critical array under all foreseeable realistic conditions to prevent criticality (which should be achieved by design as far as is practicable).  
The suitability of the spent nuclear fuel for handling and retrieval.
- 5.43 The duty holder should develop procedures for the receipt of spent nuclear fuel packages or unpackaged failed fuel and spent nuclear fuel elements, Should the duty holder’s criticality safety submission make a claim for the burn-up of the fuel (termed burn-up credit), then such claims should only be accepted if they are based upon demonstrably robust engineered safety features and operational controls. The minimum required burn-up value should be verified by independent assessment.
- 5.44 With respect to criticality safety, ONR TAG (NS-TAST-GD-041) notes that the principal means of passive engineering controls for criticality should include a geometrical constraint (e.g. in the design of the fuel storage basket within a spent nuclear fuel cask, or the pond storage racks in a wet, pond type, spent nuclear fuel storage facility). Where sub-criticality cannot be maintained through geometrical constraint alone, additional engineered safety measures should be specified (e.g. fixed neutron absorbers). However, reliance of a design upon fixed neutron absorbers requires the duty holder to demonstrate their continued presence and effectiveness over the lifetime of the storage facility. For pond storage of spent nuclear fuel, where criticality control is achieved or claimed through the specification of a chemical parameter

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<sup>1</sup> consideration of the likely location of the spent nuclear fuel store being in a coastal environment will be of importance

(typically a concentration of a soluble neutron absorber such as Boron in the pond water), a robust means must be demonstrated by the duty holder for maintenance and assurance of the presence of the chemical, at the required concentration, throughout the facility lifetime.

- 5.45 The design of the spent nuclear fuel storage facility must take into account all relevant postulated initiating events (including both internally and externally initiated events); dependent upon the storage characteristics. The SRLs provide a list of potential initiating events for guidance.
- 5.46 In recognition that the spent nuclear fuel facility may be constructed on a nuclear licensed site where it utilises the infrastructure of other pre-existing facilities on that site and that the remnant lifetime of these existing facilities may be shorter than that required for the spent nuclear fuel storage facility, then necessary infrastructure must be provided if and when the other facilities are decommissioned. This required infrastructure is required to ensure the continued safe management of the spent nuclear fuel until it is transferred from the site. This is likely to be applicable in most UK context cases.
- 5.47 The duty holder's safety case should provide a clear demonstration that the heat removal and ventilation systems for the spent nuclear fuel storage facility are capable of providing the necessary functions to cover all design and beyond design basis scenarios.
- 5.48 The generation of secondary radioactive waste from the management of spent nuclear fuel should be prevented or, where this is not reasonably practicable, minimised in terms of quantity and activity. For example, systems for radioactivity control of a wet storage pond should consider the rate of production of secondary waste when defining the functional requirements of the system and its operation.

#### **Handling and Retrieval Requirements (SRL-31- SRL-33 and SRL-48)**

- 5.49 The handling equipment at the spent nuclear fuel storage facility must be designed to take account of radiation protection aspects, ease of maintenance and minimisation of the probability and consequences of associated accidents.
- 5.50 The spent nuclear fuel storage facility must be designed so that any spent nuclear fuel package (or unpackaged spent nuclear fuel in a pond storage facility) can be retrieved within an appropriate time at the end of the facility operation (or to permit intervention in the event of unexpected faults).
- 5.51 The spent nuclear fuel storage facility must also be designed so that spent nuclear fuel packages, or unpackaged spent nuclear fuel elements can be inspected to verify their continuing integrity throughout the spent nuclear fuel life cycle. It is noted that where spent nuclear fuel will be retained on site beyond the operational life of the reactor, provisions for inspection must be maintained.
- 5.52 In addition to ensuring the integrity of spent nuclear fuel packages, or unpackaged spent nuclear fuel elements, the inspection programme should enable verification of compliance with the limits and conditions specified in the safety case to ensure continued functionality of the safety features on which safety case is based.

#### **Storage Capacity (SRL-34 and SRL-36)**

- 5.53 The duty holder must demonstrate that reserve storage capacity has been included in the design, or is otherwise available to allow for inspection, retrieval, maintenance or remedial work.

- 5.54 Given a global focus on lifetime extensions for operating reactors, with the UK being no exception, the duty holder should also be able to satisfactorily demonstrate that its spent nuclear fuel store can accommodate all spent nuclear fuel arisings from any credible reactor lifetime extensions, or is capable of being extended to meet this requirement. More generally the duty holder should identify what contingencies will be required if the assumed facility lifetime is extended and how such changes will be managed, including consideration of any refurbishment of the storage facility which may be required.

## **OPERATION**

### **Conduct of Operation (SRL-35)**

- 5.55 The storage facility shall be operated so that, in accordance with a defined inspection programme, the spent nuclear fuel packages or unpackaged spent nuclear fuel can be inspected.
- 5.56 The stored spent nuclear fuel must be maintained in a condition that minimises contamination spread (this is more applicable to wet storage schemes where the fuel cladding may be the only barrier between the fission products contained in the fuel and the pond water, in dry storage there will be multiple barriers to fission product release). In addition, there should be remedial measures in place to deal with any contamination spread. More generally, radiological conditions in the facility should be maintained to allow continuing personnel access. Should this not be practicable, then suitable alternatives should be incorporated into the design. Where resins are used for contamination clean-up (i.e. in a pond storage environment), the regeneration or replacement of the resins, or their associated system, should not preclude such operations in the event of fuel degradation or other contaminating incident.

### **Emergency Preparedness (SRL-37 – SRL-39)**

- 5.57 As per the requirements of LC 11 (“Emergency Arrangements”) and based upon an assessment of reasonably foreseeable events and situations that may require protective measures, the duty holder must have arrangements in place for responding effectively to events requiring protective measures at the scene to:-
- Regain control of any emergency arising at the site (including events related to combinations of non-nuclear and nuclear hazards).
  - Preventing or mitigating the consequences at the scene of any such emergency.
  - Cooperate with external emergency response organisations in preventing adverse health effects to workers and the public.

Accordingly, the duty holder must:

- Prepare an on-site emergency plan.
- Document emergency response procedures, keep these up to date and make them available to the personnel concerned.
- Establish an organisational structure for clear allocation of responsibilities, authorities and arrangements for coordinating facility activities and cooperating with external response agencies.
- Ensure that, based on the on-site emergency plan, trained and qualified personnel, facilities and equipment needed to control an emergency are appropriate, reliable and available at the time.

- The emergency plan must be routinely exercised<sup>2</sup> at a frequency agreed by ONR.

5.58 In a UK context the emergency plan for the spent nuclear fuel storage facilities may be encompassed by the existing emergency arrangements for the nuclear site the spent nuclear fuel storage facility is constructed on. However, if the lifetime of the spent nuclear fuel storage facility exceeds that of other operational facilities on that site, then in due course stand-alone emergency arrangements for the spent nuclear fuel storage facility will be required.

#### **Operational Experience Feedback (SRL-40 – SRL-41)**

5.59 The duty holder should establish an Operational Experience Feedback (OEF) programme to systematically collect, screen, analyse and document safety relevant operating experience and events at the spent nuclear fuel storage facility. (Relevant OpEx should also be collated from other operational facilities globally). Results from the OEF programme should lead to conclusions being drawn and to timely and appropriate corrective actions being taken to prevent reoccurrence and to counteract developments adverse to safety. The good practices of others should be considered for their applicability to the spent nuclear fuel storage facility under consideration.

#### **Design and Operational Facility Modification (SRL-42 – SRL-43)**

5.60 The design and optimisation process for the spent nuclear fuel storage facility should include a “gap analysis” of the proposed design against reasonably foreseeable future operational requirements and facility modifications e.g.

- Increases in the required spent nuclear fuel storage capacity.
- Increases in the lifetime of the spent nuclear fuel store.
- Fuel design evolution over the operational lifetime of the facility.
- Fuel burn up evolution over the operational lifetime of the facility.
- The requirement to store other items (in a UK context this might include other core components and/or failed fuel).

5.61 The results of the “gap analysis” should be used to inform the design process. This may place constraints on the conditions for acceptance (CfA) of material into the store, or on the regime for operation and maintenance of the store.

5.62 Where there are plans for a change that affects the store in the future, it should be shown that the changes are safe to implement and that the resulting facility can meet an equivalent standard of safety to the spent nuclear fuel store.

5.63 As per the requirements of LC 22 (“Modification or Experiment on Existing Plant”), modifications to the design, equipment, storage conditions, spent nuclear fuel characteristics, control/management (especially changes to SSCs operating limits and conditions, or operational procedures) in a spent nuclear fuel store must be subject to planning, assessment, review and authorisation processes (commensurate with the safety significance of the proposed modification). These processes must ensure that the proposed modifications will not adversely affect the safety of the facility, or associated facilities, or the future management of the spent nuclear fuel.

5.64 Prior to the introduction of any modification, personnel must, as appropriate, have been trained according to the new operating procedures and all relevant documents, necessary for the facility operation, must have been updated.

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<sup>2</sup> For situations where a spent nuclear fuel storage facility is constructed on an existing license nuclear site, then emergency exercises should also consider scenarios that include or are specific to the spent nuclear fuel storage facility

### **Contingency Plans (SRL-49 – SRL-50)**

- 5.65 The duty holder's procedures for the receipt of spent nuclear fuel packages or unpackaged failed fuel and spent nuclear fuel elements shall contain provisions to deal safely with those that fail to meet the acceptance criteria (e.g. return to the owner or the execution of remedial actions).
- 5.66 Consideration must be given to the possible need to relocate the spent nuclear fuel or spent nuclear fuel storage packages because of threats to their integrity. The duty holder must have appropriate plans and contingency arrangements for spent nuclear fuel packages, or unpackaged spent nuclear fuel that are not retrievable by normal means, or which show signs of degradation. Consideration should include the requirements for any specialised equipment and the continuing existence of a credible export route. Additionally, to inform contingency plans, the duty holder should have measures in place for the forewarning and estimation of the rate of degradation of the spent nuclear fuel.
- 5.67 The duty holder is expected to intervene before fuel has failed and can no longer be safely handled and transported using installed fuel handling equipment. This intervention strategy should be supported by knowledge of the potential failure mechanisms and the likelihood of occurrence of fuel failure.

### **Requirements for Acceptance of Spent nuclear fuel Packages and Unpackaged Spent nuclear fuel Elements (SRL-51 – SRL-54)**

- 5.68 The duty holder must establish Conditions for Acceptance (CfA) for its spent nuclear fuel storage facility, which are clearly derived from the operational limits and conditions for the facility, as derived from the safety case. The duty holder is responsible for ensuring that the spent nuclear fuel packages and unpackaged spent nuclear fuel elements fulfil all relevant requirements e.g.
- Compatibility with handling, transport and storage requirements, including suitability for retrieval and transport after the anticipated storage period.
  - Known or likely requirements for subsequent disposal or other management aspects included in the owner's waste and spent nuclear fuel management strategy (e.g. the need for further treatment or conditioning of the spent nuclear fuel).
- 5.69 The CfA must take into account the storage conditions and must ensure compatibility with the safety case of the storage facility and must also ensure suitability for handling and retrieval.
- 5.70 Appropriate processes must be set up and implemented by the duty holder, which involve auditing, inspection and testing, to ensure that the spent nuclear fuel packages or unpackaged spent nuclear fuel elements meet the CfA for storage.

## **SAFETY VERIFICATION**

### **Contents and Updating of the Safety Case (SRL-55 – SRL-58)**

- 5.71 Safety cases and safety assessments must be in place throughout the lifetime of the spent nuclear fuel storage facility (see NS-TAST-GD-051 for guidance on ONR expectations with respect to safety cases). The safety case must be used by the duty holder as a basis for assessing the safety implications of changes to the spent nuclear fuel facility or to its operating practices.
- 5.72 The safety case must cover the spent nuclear fuel facility itself and the spent nuclear fuel packages or unpackaged spent nuclear fuel elements and their respective, safety

- relevant, features. The safety case must include a description of how all the safety aspects of the site, the design, construction and operation, as well as the provisions for decommissioning of the spent nuclear fuel facility and the managerial controls satisfy the regulatory requirements.
- 5.73 The safety case must be consistent with the storage strategy for the spent nuclear fuel in question and when developing the storage strategy, the potential lifetime of the spent nuclear fuel storage facility must be considered. The timing of removal of spent nuclear fuel from storage (in a UK context) is likely to be many decades and the implications of the length of the storage period on the structures and availability of local and national infrastructure needs to be considered.
- 5.74 Specific issues that should be considered in the safety case include those influenced by the assumed facility lifetime e.g.
- The importance of continued maintenance of passive safety features and the impact of their potential degradation over time.
  - The continued capability to retrieve the spent nuclear fuel for off-site transport.
  - The provision of supporting services for the spent nuclear fuel storage facility (i.e. beyond that for reactor operations on the site).
  - The evidence available to demonstrate that the fuel can survive in storage for the required lifetime of the spent nuclear fuel storage facility, including demonstration of no 'cliff-edge' effects for periods beyond the design lifetime of the spent nuclear fuel store.
- 5.75 The safety case should define the monitoring, inspection and maintenance regimes for the stored spent nuclear fuel and for the storage facility itself. The safety case should be updated to reflect:
- Modifications and new regulatory requirements and relevant standards. (The safety case updates should be as soon as practicable and in accordance with the safety relevance of any modification or after new information is available and applicable).
  - The results of periodic safety reviews (conducted as per the requirements of LC 15 – "Periodic Review").
  - The results from the analysis of incidents.
- 5.76 Updates to the safety case should analyse the data to give confidence in the integrity of the spent nuclear fuel and the storage facility over the storage lifetime and up until eventual off-site transfer.
- 5.77 The safety case should adequately consider the risks of/mitigations against the ingress of foreign objects and substances (e.g. corrosive chemicals from a saline atmosphere) into the storage environment. Consideration should also be given to the measures to detect such occurrences in a timely manner and the provisions for subsequent recovery of the storage environment.
- 5.78 The safety case should consider the handling of the spent nuclear fuel after the period of storage and assess the potential effects of degradation of the spent nuclear fuel and the ability to handle and retrieve the spent nuclear fuel.
- 5.79 Where it is judged that fuel failure is a possibility, e.g. because of the length of the storage period, or the condition of the spent nuclear fuel, then a specific safety case for its safe recovery will be required. Whilst different fuel types will have different failure mechanisms and hence will require different processes for their recovery, the specific safety case should:



- Consider any changes or actions that will improve the situation for the failed fuel and any other affected sound fuel.
- Look at all potential recovery options and the associated processes, recognising that a fault may limit access to the spent nuclear fuel.
- Consider whether any onward processing plans need to be expedited.
- Consider the implications of the failure mechanisms for other sites and for other types of spent nuclear fuel.
- If the failure mechanism is likely to affect the remaining stored spent nuclear fuel, ensure that the duty holder is developing contingency plans.

#### **Periodic Safety Review (SRL-59 – SRL-61)**

- 5.80 The duty holder must carry out, at regular intervals, a review of the safety of the spent nuclear fuel storage facility (Periodic Safety Review – PSR) and of the spent nuclear fuel packages, or the unpackaged spent nuclear fuel. The review would normally be expected to be conducted circa once per 10 years (however the duty holder can submit a justification for a different periodicity e.g. to coincide with key outputs from international research programmes). The review of the safety case should take account of OEF from the site, national and international activities (e.g. research) and should also include lessons learnt from incidents and events. The outputs from the PSR should be incorporated in future spent nuclear fuel storage facility designs and their operational management.
- 5.81 The scope and methodology of the PSR must be clearly defined and justified and the PSR shall confirm compliance with the licensing requirements. The PSR shall also identify and evaluate the safety significance of differences from the applicable current safety standards and good practices and will take into account the cumulative effects of changes to procedures, modifications to the facility and the operating organisation, technical developments, operational experience accumulated and ageing of SSCs. The PSR must consider the acceptance criteria for spent nuclear fuel packages and unpackaged spent nuclear fuel elements and any deviation from these criteria during the preceding storage period.
- 5.82 The PSR must be documented and an Action Plan must be constructed to deliver all reasonably practicable improvement measures.

## 6. REFERENCES

- 1 Safety Assessment Principles for Nuclear Facilities. 2014 Edition Revision 0. November 2014. [www.onr.org.uk/saps](http://www.onr.org.uk/saps)
- 2 Nuclear Safety Technical Assessment Guides, Office for Nuclear Regulation. [www.onr.org.uk/operational/tech\\_asst\\_guides](http://www.onr.org.uk/operational/tech_asst_guides)
- 3 ONR Guide, Purpose and Scope of Permissioning. NS-PER-GD-014 Revision 4. ONR. July 2014. [www.onr.org.uk/operational/assessment/ns-per-gd-014.pdf](http://www.onr.org.uk/operational/assessment/ns-per-gd-014.pdf)
- 4 Western European Nuclear Regulators' Association. [www.wenra.org](http://www.wenra.org) Waste and Spent nuclear fuel Storage Safety Reference Levels, Working Group on Waste and Decommissioning (WGWD), Version 2.2, April 2014.
- 5 IAEA Safety Standards. Specific Safety Guide No. SSG-15 – Storage of Spent Nuclear Fuel, 2012. [www.iaea.org](http://www.iaea.org)
- 6 Security Assessment Principles for the Civil Nuclear Industry. 2017 Edition Version 0. [www.onr.org.uk/syaps](http://www.onr.org.uk/syaps)
- 7 Nuclear Security Technical Assessment Guides, Office for Nuclear Regulation. [www.onr.org.uk/operational/tech\\_asst\\_guides](http://www.onr.org.uk/operational/tech_asst_guides)
- 8 Licence Condition Handbook. Office for Nuclear Regulation. February 2017. [www.onr.org.uk/silicon.pdf](http://www.onr.org.uk/silicon.pdf)
- 9 The management of higher activity radioactive waste on nuclear licensed sites. Joint guidance from ONR, EA, SEPA and NRW to nuclear licensees. Revision 2, 2015.

## 7. GLOSSARY AND ABBREVIATIONS

AGR	Advanced Gas Cooled Reactor
ALARP	As Low As Reasonably Practicable
BST	Buffer Storage Tubes
BWR	Boiling Water Reactor
CfA	Conditions for Acceptance
CNSS	Civil Nuclear Security and Safeguards (Office for Nuclear Regulation)
EA	Environment Agency
EdF NGL	EdF Energy Nuclear Generation Ltd
EPRI	Electric Power Research Institute
ESCP	Extended Storage Collaboration Project
FDP	Funded Decommissioning Programme
GDF	Geological Disposal Facility
IAEA	International Atomic Energy Agency
NDA	Nuclear Decommissioning Authority
NRW	Natural Resources Wales
OEF	Operational Experience Feedback
OpEx	Operating Experience
PSR	Periodic Safety Review
PWR	Pressurised Water Reactor
RGP	Relevant Good Practice
RHWG	Reactor Harmonisation Working Group (WENRA)
RWMC	Radioactive Waste Management Case
SAP	Safety Assessment Principle(s)
SFAIRP	So Far As Is Reasonably Practicable
SEPA	Scottish Environment Protection Agency
SRL	(WENRA) Safety Reference Level
SSC	Structures, Systems and Components
TAG	Technical Assessment Guide(s)
TIG	Technical Inspection Guide
WENRA	Western European Nuclear Regulators' Association
WGWD	Working Group on Waste and Decommissioning (WENRA)

## 8. APPENDICES

### APPENDIX 1. LIST OF ONR SAPs POTENTIALLY RELEVANT TO THIS GUIDANCE

SAP No.	SAP Title	Description
EKP.1	Engineering principles: key principles - Inherent safety	The underpinning safety aim for any nuclear facility should be an inherently safe design, consistent with the operational purposes of the facility.
EKP.2	Engineering principles: key principles - Fault tolerance	The sensitivity of the facility to potential faults should be minimised.
EKP.3	Engineering principles: key principles - Defence in depth	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.
EKP.4	Engineering principles: key principles - Safety function	The safety function(s) to be delivered within the facility should be identified by a structured analysis.
EKP.5	Engineering principles: key principles - Safety measures	Safety measures should be identified to deliver the required safety function(s).
EMT.1	Engineering principles: maintenance, inspection and testing - Identification of requirements	Safety requirements for in-service testing, inspection and other maintenance procedures and frequencies should be identified in the safety case.
EMT.2	Engineering principles: maintenance, inspection and testing - Frequency	Structures, systems and components should receive regular and systematic examination, inspection, maintenance and testing as defined in the safety case.
EMT.6	Engineering principles: maintenance, inspection and testing -Reliability claims	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.
EAD.1	Engineering principles: ageing and degradation - Safe working life	The safe working life of structures, systems and components that are important to safety should be evaluated and defined at the design stage.
EAD.2	Engineering principles : ageing and degradation - Lifetime margins	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.
EAD.3	Engineering principles: ageing and degradation - Periodic measurement of material properties	Where material properties could change with time and affect safety, provision should be made for periodic measurement of the properties.
ENM.1	Engineering principles: control of nuclear matter – Strategies for managing nuclear matter	A strategy (or strategies) should be made and implemented for the management of nuclear matter.

SAP No.	SAP Title	Description
ENM.4	Engineering principles: control of nuclear matter – Control and accountancy of nuclear matter	Nuclear matter should be appropriately controlled and accounted for at all times.
ENM.5	Engineering principles: control of nuclear matter – Characterisation and segregation	Nuclear matter should be characterised and segregated whenever practicable to facilitate its safe management.
ENM.6	Engineering principles: control of nuclear matter - Storage in a condition of passive safety	When nuclear matter is stored on site for a significant period of time it should be stored in a condition of passive safety whenever practicable and in accordance with good engineering practice.
ENM.7	Engineering principles: control of nuclear matter - Retrieval and inspection of stored nuclear matter	Storage of nuclear matter should be in a form and manner that allows it to be retrieved and, where appropriate, inspected.
ECV.1	Engineering principles: containment and ventilation: containment design - Prevention of leakage	Radioactive material should be contained and the generation of radioactive waste through the spread of contamination by leakage should be prevented.
ECV.2	Engineering principles : containment and ventilation: containment design - Minimisation of releases	Containment and associated systems should be designed to minimise radioactive releases to the environment in normal operation, fault and accident conditions.
ECV.3	Engineering principles : containment and ventilation: containment design - Means of confinement	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.
ECV.7	Engineering principles : containment and ventilation: containment monitoring - Leakage monitoring	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.
ECR.1	Engineering principles : criticality safety - Safety measures	Wherever a significant amount of fissile material may be present, there should be safety measures to protect against unplanned criticality.
ECR.2	Engineering principles : criticality safety - Double contingency approach	Criticality safety should employ the double contingency approach.
RP.1	Radiation protection - Normal operation (planned exposure situations)	Adequate protection against exposure to radiation and radioactive substances should be provided in those parts of the facility to which access is permitted during normal operation.

SAP No.	SAP Title	Description
RP.2	Radiation protection – Fault and accident conditions (emergency exposure situations)	Adequate protection against exposure to radiation and radioactive contamination should be provided in those parts of the facility that will need to be accessed during faults or as part of accident management. This should include prevention or mitigation of accident consequences.
RP.3	Radiation protection - Designated areas	Where appropriate, designated areas should be further divided, with associated controls, to restrict exposure and prevent the spread of radioactive material.
RP.4	Radiation protection - Contaminated areas.	Effective means for protecting persons entering and working in contaminated areas should be provided.
RP.5	Radiation protection - Decontamination	Suitable and sufficient arrangements for decontaminating people, the facility, its plant and equipment should be provided.
RP.6	Radiation protection - Shielding	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.
FA.1	Design basis analysis, PSA and severe accident analysis	Fault analysis should be carried out comprising suitable and sufficient design basis analysis, PSA and severe accident analysis to demonstrate that risks are ALARP.
FA.2	Identification of initiating faults	Fault analysis should identify all initiating faults having the potential to lead to any person receiving a significant dose of radiation, or to a significant quantity of radioactive material escaping from its designated place of residence or confinement.
FA.3	Fault sequences	Fault sequences should be developed from the initiating faults and their potential consequences analysed.
RW.1	Radioactive waste management - Strategies for radioactive waste	A strategy should be produced and implemented for the management of radioactive waste on a site.
RW.2	Radioactive waste management - Generation of radioactive waste	The generation of radioactive waste should be prevented or, where this is not reasonably practicable, minimised in terms of quantity and activity.
RW.3	Radioactive waste management - Accumulation of radioactive waste	The total quantity of radioactive waste accumulated on site at any time should be minimised so far as is reasonably practicable.
RW.4	Radioactive waste management - Characterisation and segregation	Radioactive waste should be characterised and segregated to facilitate its subsequent safe and effective management.

<b>SAP No.</b>	<b>SAP Title</b>	<b>Description</b>
RW.5	Radioactive waste management - Storage of radioactive waste and passive safety	Radioactive waste should be stored in accordance with good engineering practice and in a passively safe condition.
RW.6	Radioactive waste management - Passive safety timescales	Radiological hazards should be reduced systematically and progressively. The waste should be processed into a passive safe state as soon as is reasonably practicable.
RW.7	Radioactive waste management – Making and keeping records	Information that might be needed for the current and future safe management of radioactive waste should be recorded and preserved.
DC.1	Decommissioning - Design and operation	Facilities should be designed and operated so that they can be safely decommissioned.
DC.2	Decommissioning - Decommissioning strategies	A decommissioning strategy should be prepared and maintained for each site and should be integrated with other relevant strategies.
DC.6	Decommissioning - Records for decommissioning	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.

**APPENDIX 2. LIST OF ONR TAGs POTENTIALLY RELEVANT TO THIS GUIDANCE**

<b>TAG No.</b>	<b>TAG Title</b>
NS-TAST-GD-002	Radiation Shielding
NS-TAST-GD-005	Guidance on the Demonstration of ALARP (As Low As Reasonably Practicable)
NS-TAST-GD-009	Examination, Inspection, Maintenance and Testing of Items Important to Safety
NS-TAST-GD-016	Integrity of Metal Structures, Systems and Components
NS-TAST-GD-017	Civil Engineering
NS-TAST-GD-023	Control of Processes Involving Nuclear Matter (SAP ENM.1 to 8)
NS-TAST-GD-024	Management of Radioactive Materials and Radioactive Waste on Nuclear Licensed Sites
NS-TAST-GD-026	Decommissioning
NS-TAST-GD-033	Duty Holder Management of Records
NS-TAST-GD-035	Limits and Conditions for Nuclear Safety (Operating Rules)
NS-TAST-GD-038	Radiological Protection
NS-TAST-GD-041	Criticality Safety
NS-TAST-GD-050	Periodic Safety Reviews (PSR)
NS-TAST-GD-051	The Purpose, Scope and Content of Safety Cases
NS-TAST-GD-098	Asset Management