



ONR GUIDE			
MANAGEMENT OF RADIOACTIVE MATERIAL AND RADIOACTIVE WASTE ON NUCLEAR LICENSED SITES			
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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 dutyholders. The principles presented in the SAPs are supported by a suite of Technical Assessment Guide (TAG) [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 management of nuclear matter on nuclear licensed sites. This TAG has also been written with due cognisance of relevant International Atomic Energy Agency (IAEA) safety standards for the management of radioactive waste [4]. 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 [5] and for treatment and conditioning of radioactive waste [6].

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 relates to the management of radioactive material and radioactive waste, which is currently being, or may be accumulated or stored on nuclear licensed sites, which have met ONR's criteria relating to bulk quantities for licensing [7]. In this guidance, the meaning of these terms is as defined in ONR's Licence Condition Handbook [8]. Some radioactive material and radioactive waste is also nuclear matter, as defined in section 26(1) of the Nuclear Installations Act (NIA65) [9]:

“nuclear matter” means, subject to any exceptions which may be prescribed-

- a) *any fissile material in the form of uranium metal, alloy or chemical compound (including natural uranium), or of plutonium metal, alloy or chemical compound, and any other fissile material which may be prescribed; and*
- b) *any radioactive material produced in, or made radioactive by exposure to the radiation incidental to, the process of producing or utilising any such fissile material as aforesaid.*

2.4 Radioactive material and radioactive waste may be generated as a result of activities associated with the nuclear fuel cycle, nuclear medicine, licensed defence sites, research or as a result of decommissioning. Radioactive material includes materials in store prior to use (e.g. new reactor fuel and radioisotopes), and also certain fissile and other radioactive materials that may be declared as radioactive waste in the future. These materials will require safe long-term management in a similar manner as for radioactive waste.

2.5 This guidance is intended to be applicable to the predisposal management of radioactive material and radioactive waste, at all nuclear facilities on nuclear licensed sites, including nuclear power plant, nuclear chemical plant, storage facilities and disposal facilities. The management of radioactive material and radioactive waste is

closely linked with the management of the decommissioning of nuclear facilities, and these activities require an integrated approach.

- 2.6 It covers through-life management of all radioactive material and radioactive waste from creation through generation, processing, storage and up to but not including disposal or discharge. It includes all forms of radioactive material and radioactive waste: solid, liquid and gaseous.
- 2.7 Key terms pertinent to the management of radioactive material and radioactive waste are defined as follows:
- **Accumulation** – The gathering or amassing of radioactive material or radioactive waste in any form;
 - **Processing** – Any operation that changes the characteristics of the waste, including pre-treatment, treatment and conditioning;
 - **Keeping** – Possession of radioactive material with the intention of use for the purpose for which it was obtained;
 - **Storage** – Placement of radioactive material and radioactive waste in an appropriate engineered facility with the intention of retrieval;
 - **Disposal** – Placement of solid radioactive waste in an appropriate engineered facility without the intention of retrieval and release of liquid or gaseous radioactive waste to the environment, referred to as discharge.

3. RELATIONSHIP TO LICENCE AND OTHER RELEVANT LEGISLATION

Nuclear Site Licence Conditions

- 3.1 All of the licence conditions (LCs) apply and are relevant to activities involving the management of radioactive material and radioactive waste [8]. However, there are a number of LCs that are of particular relevance:
- LC4 Restrictions on nuclear matter on the site
 - LC5 Consignment of nuclear matter
 - LC6 Documents, records, authorities and certificates
 - LC15 Periodic review
 - LC17 Management systems
 - LC23 Operating rules
 - LC25 Operational records
 - LC28 Examination, inspection, maintenance and testing
 - LC32 Accumulation of radioactive waste
 - LC33 Disposal of radioactive waste
 - LC34 Leakage and escape of radioactive material and radioactive waste
 - LC35 Decommissioning.

Ionising Radiation Regulations 2017

- 3.2 The Ionising Radiations Regulations 2017 (IRR17) control the use of ionising radiation in the workplace with the intent of restricting exposure and limiting dose to the workforce and the public [10]. Some of the regulations are particularly relevant to the management of radioactive material and radioactive waste, examples include:
- Regulation 8 (radiation risk assessments)

- Regulation 9 (restriction of exposure)
- Regulation 12 (dose limitation)
- Regulation 29 (accounting for radioactive substances)
- Regulation 30 (keeping and moving of radioactive substances).

The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009

- 3.3 Legislation governing intra-national and international transport of radioactive materials is based on IAEA Regulations for the Safe Transport of Radioactive Materials, currently Specific Safety Requirements No. SSR-6 (SSR-6). These regulations are translated into European modal regulations (e.g. the Agreement concerning the International Carriage of Dangerous Goods by Road (ADR) and Rail (RID) transport, respectively), within which radioactive materials are referred to as Class 7 (out of 9 classes) Dangerous Goods. The modal regulations are given legal effect in Great Britain via the Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations (CDG) [11]. Specific paragraphs within the regulations prescribe the different safety requirements for radioactive material, packagings and packages (see NS-TAST-GD-99 for further details [2]).

Environmental Permitting Regulations 2016

- 3.4 The Environment Agency (EA) and Natural Resources Wales (NRW) regulate the disposal of radioactive waste from nuclear licensed sites under the Environmental Permitting Regulations 2016 (EPR16) in England and Wales, respectively [12].
- 3.5 Nuclear licensees in England and Wales are exempt from the EPR16 requirement to obtain a permit from the relevant environmental regulator to accumulate radioactive waste and/or keep and use radioactive material (EPR16 Schedule 23).
- 3.6 For further guidance on how ONR works with the environmental regulators on matters of mutual interest, see the Memoranda of Understanding for EA [13] and NRW [14] and supporting guidance [15] and [16], respectively.

Environmental Authorisations (Scotland) Regulations 2018

- 3.7 The Scottish Environment Protection Agency (SEPA) regulates the management and disposal of radioactive waste on nuclear licensed sites under the Environmental Authorisations (Scotland) Regulations 2018 (EASR18) in Scotland [17]. SEPA has also published guidance on its standard conditions for authorisations for radioactive substances activities [18].
- 3.8 Nuclear licensees in Scotland now require a permit from SEPA for the management of radioactive waste on site, and for the long term storage of radioactive waste prior to disposal (EASR18 Schedule 8). Inspectors should be aware that SEPA's duties and powers now explicitly apply to any activities involved in the management of radioactive waste on nuclear licensed sites, in so far as such activities have the potential to give rise to exposures to the environment or the public, now or in the future. Nuclear licensees in Scotland remain exempt from the requirement for a permit from SEPA to keep and use radioactive material on nuclear licensed sites.
- 3.9 ONR and SEPA have agreed to work together to ensure that ONR's principal function and SEPA's general purpose can be achieved. This agreement is reflected in the updated MoU between ONR and SEPA [19] and the associated MoU Guidance [20].

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

Safety Assessment Principles

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). The SAPs are split into sections relating to different aspects of nuclear safety. One section of the SAPs is dedicated to radioactive waste and those principles are summarised here:

- **RW.1 – Strategies for radioactive waste**
A strategy should be produced and implemented for the management of radioactive waste on site
- **RW.2 – Generation of radioactive waste**
The generation of radioactive waste should be prevented or, where it is not reasonably practicable, minimised in terms of quantity and activity
- **RW.3 – Accumulation of radioactive waste**
The total quantity of waste accumulated on site at any time should be minimised so far as is reasonably practicable
- **RW.4 – Characterisation and segregation**
Radioactive waste should be characterised and segregated to facilitate its subsequent safe and effective management
- **RW.5 – 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 – Passive safety timescales**
Radiological hazards should be reduced systematically and progressively. The waste should be processed into a passive state as soon as is reasonably practicable
- **RW.7 – Making and keeping records**
Information that might be needed for the current and future safe management of radioactive waste should be recorded and preserved.

4.2 In addition to the RW SAPs, the following SAPs may also be of particular relevance to both radioactive material and radioactive waste:

- **FP.8** – one of the fundamental principles that underpin the SAPs and which outlines ONR's expectations regarding protection of present and future generations.
- **SC.1, SC.3 to SC.8** – these principles relate to the process for producing safety cases, including their characteristics, content, maintenance and ownership.
- **RP.1 to RP.7** – these principles relate to radiation protection and control of areas to limit spread of radioactive contamination.
- **ENM.1 to ENM.6** – these principles relate to the control of nuclear matter on the nuclear licensed site.
- **DC.1 to DC.9** – these principles relate to arrangements for decommissioning of a facility, which apply at all stages of the lifecycle of a facility.

- **RL.1 to RL.8** – these principles relate to land quality management.
- **ECS.1 to ECS.5** – these principles relate to classification and standards of structures, systems and components (SSC) employed to deliver safety functions.
- **EMT.2** – this principle relates to the regular and systematic examination, inspection, maintenance and testing of SSC.
- **EAD.1 to EAD.5** – these principles relate to the management of ageing and degradation of SSCs that may be required for the full lifetime of the facility.

Technical Assessment Guides

4.3 There are a number of other TAGs that may be of relevance to the management of radioactive material and radioactive waste [2]:

- NS-TAST-GD-005 ONR guidance on the demonstration of ALARP;
- NS-TAST-GD-023 Control of processes involving nuclear matter;
- NS-TAST-GD-026 Decommissioning on nuclear licensed sites;
- NS-TAST-GD-033 Duty holder management of records;
- NS-TAST-GD-081 Safety aspects specific to storage of spent nuclear fuel;
- NS-TAST-GD-083 Land quality management;
- NS-TAST-GD-101 Geological disposal.

IAEA Requirements and WENRA Safety Reference Levels

4.4 In addition to the SAPs, the International Atomic Energy Agency (IAEA) Safety Standards and the Safety Reference Levels (SRLs) developed by the Western European Nuclear Regulators Association (WENRA) are considered to be UK relevant good practice (RGP).

4.5 The most relevant IAEA documents are:

- General Safety Requirements: Predisposal Management of Radioactive Waste (GSR Part 5) [4];
- Safety Specific Guide: Predisposal Management of Radioactive Waste from Nuclear Power Plants and Research Reactors (SSG-40) [21];
- Safety Specific Guide: Predisposal Management of Radioactive Waste from Nuclear Fuel Cycle Facilities (SSG-41) [22].

4.6 The most relevant WENRA SRLs for the management of radioactive waste are:

- Waste and spent fuel storage [5];
- Treatment and conditioning of radioactive waste [6];

4.7 The IAEA requirements and WENRA SRLs have been explicitly considered during development of this TAG.

5. GOVERNMENT POLICY

5.1 The last full review of Government policy on radioactive waste was in 1994/95; the conclusions were set out in Cm2919 [23].

5.2 The following key principles arose from this policy:

- Radioactive wastes should not be unnecessarily created;

- Such wastes as are created should be safely and appropriately managed and treated; and
 - Wastes should be safely disposed of at appropriate times and in appropriate ways.
- 5.3 These are underpinned by general requirements that:
- Radioactive waste will be managed and disposed of in ways which protect the public, workforce and environment; and
 - Radioactive waste management should safeguard the interest of existing and future generations and the wider environment, and in a manner that commands public confidence and takes due account of costs.
- 5.4 Radioactive waste disposal is a devolved matter in the UK, and the relevant Governmental bodies have since elaborated on various aspects of policy as described in the following sections.
- 5.5 The following sections on radioactive waste management policies in the UK refer to specific classifications of waste: higher activity radioactive waste (HAW) and low level waste (LLW). Further information on these and other waste classifications is provided in Reference [23] and Appendix A.

Policy for HAW (England and Wales)

- 5.6 In 2006 the Committee for Radioactive Waste Management (CoRWM) published its recommendations for the long term management of higher activity wastes (HAW) [24]. In response, the UK Government established that deep geological disposal is the preferred route for HAW in England and Wales. Since then, the Government has set out (in 2008) and updated (in 2014 and 2018) the framework for managing HAW in the long term through geological disposal, coupled with safe and secure interim storage and on-going research and development to support its optimised implementation:
- *Managing Radioactive Waste Safely (MRWS), 2008 [25]*
 - *Implementing Geological Disposal, 2014 [26]*
 - *Implementing Geological Disposal – Working With Communities, 2018 [27].*
- 5.7 The Welsh Government has adopted the policy of geological disposal for the long term management of HAW; their current policy is set out in the following documents:
- *Welsh Government Policy on the Management and Disposal of Higher Activity Radioactive Waste, 2015 [28]*
 - *Geological Disposal of Higher Activity Waste: Community Engagement and Siting Process, 2015 [29]*
 - *Geological Disposal of Higher Activity Waste: Working with Communities, 2019 [30].*

Policy for HAW (Scotland)

- 5.8 Scotland's policy for HAW is that long-term management of HAW should be in near-surface facilities which should be located as near to the site where the waste is produced as possible so that the need to transport the waste over long distances is minimal. The policy also states the need to demonstrate how facilities will be monitored and how waste packages, or waste could be retrieved. The current policy is set out in the following documents:
- *Scotland's Higher Activity Radioactive Waste Policy, 2011 [31]*

- *Implementation Strategy for Scotland's Policy on Higher Activity Radioactive Waste, 2016 [32].*

Policy for LLW (UK)

- 5.9 The UK policy for the management of solid low level waste (LLW) is set out in the following document:
- *Policy for the Long Term Management of Solid Low Level Radioactive Waste in the United Kingdom, 2007 [33].*
- 5.10 A complementary UK Strategy on solid LLW was published in 2016 [34]. The key aim of the LLW policy is to provide a high-level framework within which individual LLW management decisions can be taken flexibly, to ensure safe, environmentally-acceptable and cost-effective management solutions that appropriately reflect the nature of the LLW concerned.
- 5.11 A key component of the policy is definitions for Low Level Waste as in Appendix A.
- 5.12 In its policy, Government looks to the various regulators to maximise the consistency of their approaches in regulating radioactive waste management, including disposal of LLW, and on matters relating to delicensing and clean-up of nuclear sites and other land contaminated by radioactivity. Government also looks to the regulatory bodies to make clear, through published material, the steps that have been taken to address this requirement.
- 5.13 In its policy, Government states that plans for the management of all radioactive waste, including LLW, must be developed by waste managers. These plans must be prepared in a form, and to a level of detail, suitable for consideration by the relevant regulatory bodies.
- 5.14 All nuclear licensed sites should have a plan for the management of their LLW holdings and predicted future arisings that is part of a wider integrated waste management strategy, and is compatible with proposed end states.
- 5.15 The environment agencies' guidance on the decommissioning and clean-up of nuclear licensed sites sets out their expectations for waste management plans [35].

6. ADVICE TO INSPECTORS

Fundamental expectations

- 6.1 ONR has four fundamental expectations, which it expects licensees to meet so far as is reasonably practicable. These expectations are as follows:
- Generation of radioactive waste should be avoided, where radioactive waste is unavoidable, generation should be minimised according to the waste hierarchy
 - Radioactive material and radioactive waste should be managed safely throughout its lifecycle in a manner that is consistent with modern standards
 - Predisposal management of radioactive waste should take account of the anticipated disposal route, and full use should be made of existing routes
 - Where the disposal route is not yet available, radioactive material and radioactive waste should be put into a passively safe state as soon as reasonably practicable for interim storage pending future disposal, or other long-term solution.
- 6.2 These fundamental expectations should form a common thread through any assessment relating to the management of radioactive waste or radioactive material.

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

- 6.3 Whilst ONR regulates the management of radioactive waste on nuclear licensed sites and the environment agencies regulate disposals, the regulators work together on decisions concerning permissioning of activities relating to HAW [36]. This is necessary to ensure both safety and environmental protection can be achieved over the long timescales associated with the management of HAW.
- 6.4 To this end, the environment agencies and ONR have published joint guidance on the management of HAW on nuclear licensed sites [37] (the Joint Guidance). The Joint Guidance covers all aspects relating to the safe and secure management of HAW produced on nuclear licensed sites.
- 6.5 In assessments relating to HAW, inspectors should look to the Joint Guidance for further details on joint regulatory expectations. However, the principles therein may also be relevant to the management of other radioactive waste, and also to radioactive material, for example spent fuel.
- 6.6 In addition to providing guidance on regulatory expectations for the management of HAW, the Joint Guidance also describes the regulatory process by which licensees may obtain regulatory acceptance of their proposals.

Strategies for the management of radioactive waste

- 6.7 In line with Government Policy [23], ONR expects licensees to produce and maintain a strategy that describes their approach to the current and future management of radioactive material and radioactive waste. If a licensee is responsible for a number of sites, then it may be appropriate for the licensee to produce a corporate strategy supported by a series of site-specific strategies.
- 6.8 In selecting a preferred strategy, licensees should demonstrate that a full range of management options have been examined, taking account of all technical factors, social factors, Government Policies and international agreements. The reasons for reaching the preferred strategy should be recorded and major assumptions and uncertainties should be identified, together with the approach for their resolution.
- 6.9 The scope of the strategy should include all materials and wastes arising on a site, including secondary wastes and those expected to arise from final decommissioning. The strategy should take account of interdependencies between waste streams and processes among all steps to demonstrate that an optimum management process is delivered.
- 6.10 The licensee's strategy should identify the inventory of its nuclear liabilities and describe the means of managing each waste stream from generation to disposal by practical and cost-effective methods. The strategy should cover the complete lifecycle of the material and associated facilities, and should include routine discharges of liquid and gaseous radioactive wastes. The strategy should not be restricted to the consideration of nuclear matter that licensees currently regard as radioactive waste: it should also cover all radioactive material, including materials held up in store prior to operational use, spent nuclear fuel, other stocks of fissile and recyclable material and radioactively contaminated land (referred to as an 'accumulation of nuclear matter'; see NS-TAST-GD-83 [2]).
- 6.11 The strategy should describe how the licensee will provide and maintain the arrangements to ensure that the radioactive material and radioactive waste is managed safely until its ultimate disposal, including the provision of an appropriate organisation and supporting infrastructure.

- 6.12 The strategy should be linked to, or integrated with the strategy for decommissioning of nuclear facilities including the management of radioactively contaminated land and the ability to dispose of the resulting wastes.
- 6.13 The strategy should demonstrate how the objectives of the OSPAR Convention have been taken into account, in particular, the impact on the volume and total activity of on-site waste arisings of solid and liquid wastes, options for storage and ultimate disposal, and implications for compliance with the ALARP principle. The UK strategy for radioactive discharges, which was reviewed in 2018 [38], aims to prevent pollution of the OSPAR maritime area (the North East Atlantic) from radiation through progressive and substantial reductions of discharges, emissions and losses of radioactive substances.
- 6.14 The manner and form in which they choose to prepare, maintain and document the information relating to their strategies is a matter for the licensees. It is not the aim of this guidance to be prescriptive; however, strategies are expected to contain the following elements:
- Descriptions of:
 - the licensee’s radioactive waste management objectives and policy;
 - the current and future waste inventory, including decommissioning wastes and radioactive materials that may be declared as waste in the future;
 - the preferred option for managing each waste stream throughout its lifecycle to disposal, including programmes showing timescales, methods and proposed disposal route. For wastes where disposition is not defined fully or optimised, a description of the management arrangements for these, including strategies to minimise generation of these in future;
 - the justification of the preferred option based on ALARP and Best Available Techniques (BAT), including the alternative options examined, the selection factors taken into account, major assumptions and the availability of disposal routes;
 - how the balance between foreclosure of disposal options and passive safety has been addressed, and resolved in cases where there may be conflict.
 - Demonstration of consistency with Government Policy and ONR’s fundamental expectations for radioactive waste management;
 - Significant uncertainties should be identified, the impact assessed and the approach for resolution described;
 - Results of analyses to assess the sensitivity of the selection of the preferred option to assumptions, uncertainties and factors;
 - Approach to ensuring safety including, where appropriate, demonstration that hazards posed by legacy wastes are being adequately controlled and progressively reduced;
 - Corporate arrangements and infrastructure for continuing capability to meet licensee responsibilities.
- 6.15 The strategy should contain sufficient detail to be standalone, but may be supported by a number of other documents, including individual documents describing waste stream lifecycle management, site lifetime plan, site decommissioning strategy and site strategy for end states. In some cases, the strategy may be encompassed by existing documents, such as Waste Management Plans for LLW.

- 6.16 Further guidance on the production of radioactive waste strategies can be found in the Joint Guidance [37]. Licensees may choose to present their strategy in the form of an Integrated Waste Strategy (IWS) document, for which NDA has produced guidance on the form and content of such documents [39].

Application of ALARP across the lifecycle

- 6.17 ONR expects licensees to manage radioactive waste in a manner that is compatible with ultimate disposal, or other long-term solution, and, unless justified on safety grounds, does not unnecessarily foreclose any foreseeable management options. The risks should be assessed in a holistic manner and not restricted to part of the overall time period.
- 6.18 However, the nature of radioactive waste management means that multiple facilities are likely to be involved in the different aspects relating to generation, processing, storage, transport and disposal, and for HAW, these activities are expected to take place over a significant period of time. Safety cases specific to individual facilities in radioactive waste management are unlikely to provide sufficient information on the case for the management that covers the whole waste lifecycle.
- 6.19 Additionally, there may be situations, particularly during post operation clean-out and decommissioning, where the risks may increase temporarily so that the long-term risks can then be reduced or eliminated. Such increased risks need to be balanced against the continuing risks from doing nothing and with due consideration of the alternatives available to address the hazard.
- 6.20 Therefore, the case for safe management of some waste streams across their whole lifecycle needs to be considered on a case-by-case basis, taking account of all factors, to ensure that an appropriate balance is achieved. These factors include requirements imposed by the environmental permit (including optimisation, BAT and disposability) and any waste acceptance criteria for the final disposal facility. The licensee also needs to address the risk that future disposal options may require the wastes to be reworked into an alternative form and also that reworking may be necessary as a result of deterioration of the waste packages or accidental damage. For HAW, Radioactive Waste Management Ltd. (RWM) has an advisory role, and it is for the licensee to seek appropriate advice from RWM. The advice may be used by the licensee as part of the case for safe management of the waste across the lifecycle.
- 6.21 In addition to the requirement to produce adequate facility safety cases, licensees should also demonstrate how the key elements of long-term safety and environmental performance will be delivered for the management of radioactive waste across the lifecycle, which may not be addressed in the individual plant safety cases and environmental documentation. Where waste is transferred between multiple plants or sites, good practice would suggest production of the case for its overall management early in the waste stream lifecycle, enabling its maintenance and update upon subsequent transfer(s). The case for a particular waste stream should cover the period from generation, through processing, storage, transport and up to the removal of the waste stream from site for eventual disposal, or other long-term solution.
- 6.22 The manner and form in which they choose to prepare, maintain and document the information relating to the case for management of radioactive waste is a matter for the licensees, and should be proportionate to the hazard presented by the waste. Licensees may choose to present their case in the form of a Radioactive Waste Management Case (RWMC). Further guidance on the form and content of RWMCs for HAW can be found in the Joint Guidance [37].

Predisposal management of radioactive waste

- 6.23 Radioactive waste should be managed in a manner that minimises the need for processing, and that it is compatible with anticipated facilities for ultimate disposal or long-term solution.
- 6.24 The following steps, as identified in GSR Part 5 and discussed in more detail below, are key to the safe management of radioactive waste:
- Generation
 - Processing
 - Storage
 - Waste acceptance criteria.
- 6.25 Whilst the next sections are focussed on the predisposal management of radioactive wastes, many of the principles may be applicable to the management of radioactive materials. Further guidance on the predisposal management of HAW can be found in the Joint Guidance [37].

Generation

- 6.26 Licensees should demonstrate that radioactive waste is not unnecessarily created, and that the generation and accumulation of radioactive waste is minimised.
- 6.27 Licence Condition 32 requires licensees to make and implement adequate arrangements for minimising, so far as is reasonably practicable, the rate of production and total quantity of radioactive waste accumulated on site. Licence Condition 4(1) requires licensees to ensure that no nuclear matter is brought onto site, except in accordance with adequate arrangements for this purpose.
- 6.28 The licensee should demonstrate that adequate steps have been taken first to avoid the creation of radioactive waste, and then to minimise the amount generated, both in terms of volume and activity, initially in the design phase and then throughout the lifetime of facilities that generate or manage radioactive waste. Generation also includes the transfer of radioactive material or radioactive waste from other national and international sites; where this occurs, ownership shall be clear and unequivocal.
- 6.29 The licensee should demonstrate suitable and sufficient design features and operational procedures to support the management of radioactive waste, which should be subject to systematic review and review as necessary.
- 6.30 The licensee's approach to the minimisation of radioactive waste shall include application of the waste management hierarchy, the key principles of which should be reflected within the operational procedures. Inspectors should be cognisant that licensees are also required by the environment agencies to demonstrate that waste management options have been optimised using BAT; this should be balanced with ONR's requirement for risks to be ALARP (see NS-TAST-GD-005 on the demonstration of ALARP [2]). ONR's expectations for the application of waste minimisation, which encompass the waste hierarchy, include the following:
- Minimisation of the production of secondary wastes;
 - Segregation of waste streams;
 - Preventing spread of contamination;
 - Recycling and reusing material;
 - Clearance and exemption;

- Activity reduction;
 - Volume reduction;
 - Disposal.
- 6.31 The generation of wastes that may be difficult to convert into a passive form for storage, or for which there is no obvious disposal route should be avoided; these wastes may be classed by licensees as 'problematic' or 'orphan' wastes. Where these wastes exist, licensees should demonstrate adequate arrangements for their management, and further arisings of problematic wastes are minimised.
- 6.32 The licensee should, so far as is reasonably practicable, characterise and segregate radioactive waste in order to facilitate safe and effective management and disposal.
- 6.33 The radioactive waste should be characterised in terms of its physical, mechanical, chemical, radiological and biological properties, along with its source or origin. Licensees should develop a systematic approach to characterisation that takes account of regulatory expectations for control and management over the entire lifetime of the radioactive waste, including disposal, or other long-term solution. Characterisation should be done as soon as practicable to inform onward management, but further characterisation may be required at any of the subsequent steps in predisposal management. Licensees should also take into account the requirements for Nuclear Material Accountancy and Control (NMAC) for Safeguards purposes.
- 6.34 Segregation involves accumulating those materials with similar characteristics, and separating or avoiding mixing those with different characteristics. Where practicable, radioactive waste should be segregated as close to the point of generation as possible. Segregation is most effective if it is taken into account at the process design stage and can contribute significantly to the effective and safe management of radioactive waste. Some legacy wastes have arisen because incompatible wastes have been mixed inappropriately, without due consideration of ALARP across the lifecycle.
- 6.35 Pre-treatment operations may also be employed to minimise the amount of radioactive waste to be further processed, stored and disposed of. These operations, for example decontamination and incineration, may be employed in order to allow reclassification of the waste at a lower level or to allow the waste to be cleared from regulatory control (see Appendix A). Additionally, licensees may opt for decay storage in cases where wastes are borderline in terms of classification; ONR expects this alternative approach to be justified in terms of ALARP and underpinned as part of the overall waste strategy.

Processing

- 6.36 Licensees should process radioactive waste into a passively safe state as soon as is reasonably practicable. Appendix B provides general principles for radioactive waste management.
- 6.37 Radioactive waste should be processed as close to the point of generation as practicable and in a form suitable for subsequent waste management steps. Passive safety is most appropriately achieved by providing multiple physical barriers to the release of radioactivity to the environment, which should be designed to provide effective containment and prevent leakage. These barriers include the form of the raw or processed waste, and the packaging, where appropriate.
- 6.38 To achieve passive safety, the radioactivity should be immobilised, and packaged in a form that is physically and chemically stable. For some wastes, the radioactivity may be immobilised by virtue of the nature of the material, for example, activated uncontaminated metals. The term 'passive safety' is more usually associated with

- wastes that have already been processed for long-term storage, pending disposal. However, passive safe storage should be provided at all stages in predisposal management of all radioactive waste, to ensure isolation and for environmental protection.
- 6.39 Passive safety is most relevant in cases where radioactive wastes need to be managed in the long-term, for example HAW, where the disposal route is not yet available. However, ONR expects licensees to consider proportionate application of the principles of passive safety in the management of all radioactive wastes (see Appendix B).
- 6.40 ONR expects licensees to demonstrate that their processing of radioactive waste will not unnecessarily foreclose future management options, unless there are worthwhile safety benefits. There may be potential for a conflict between the expectations not to foreclose options with expectations for achieving passive safety. In such cases, all relevant factors will need to be taken into account and a judgement made that an appropriate balance has been achieved, and which considers radioactive waste management across the lifecycle.
- 6.41 There are a number of factors that could influence the timing of the implementation of passive safety, such as:
- The magnitude of the radioactive hazard;
 - The current form of the radioactive waste;
 - The safety of the current facilities in which accumulation of raw waste is taking, or has taken place;
 - The rate of deterioration of the facilities;
 - The rate of deterioration in the condition of the radioactive waste;
 - Uncertainty in the knowledge of the waste;
 - Integration with decommissioning plans;
 - Radioactive decay or ingrowth;
 - The availability of a disposal route;
 - The need for active safety systems.
- 6.42 Radioactive waste processing may comprise treatment and/or conditioning, with the ultimate goal of producing a waste product that is suitable for disposal. Examples of treatment options include filtration, ion exchange, incineration and size reduction; these should be employed with the aim of rendering the waste into a state that facilitates conditioning of solid and some liquid wastes, or discharge of liquid and gaseous wastes. Conditioning consists of operations that produce a waste product suitable for safe handling, storage and disposal, taking account of the timescales expected for these onward activities. Examples of conditioning operations include encapsulation of the wastes in a suitable matrix, for example cementitious grout, vitrification or drying of the wastes.
- 6.43 The processing techniques should be selected on the basis of the characteristics (including non-radiological) of the waste concerned, as these may affect safety during processing and the suitability of the product for onward management to disposal. The licensee should describe the expected properties of the intended waste product and ensure that adequate controls are applied to processes and activities to achieve consistent, safe outcomes.
- 6.44 For conditioned wastes, the waste packaging should be selected such that it contributes to passive safety over the expected timescales. Dependent on the nature

of the waste and the hazard it presents, the packaging may need to provide shielding in addition to containment, and may also need to take account of criticality safety and heat-bearing wastes.

- 6.45 Waste products should be uniquely identifiable via appropriate labelling, which should be designed to ensure identification over the expected period and conditions of passive safe storage. Licensees should ensure that labelling of waste packages for disposal is compliant with the requirements set out by the disposal facility.
- 6.46 Licence Condition 17 requires licensees to make and implement adequate quality management arrangements in respect of all matters which may affect safety. With respect to the predisposal management of radioactive waste, licensees are expected to make and implement adequate arrangements for quality control and quality assurance procedures for the processing and packaging of radioactive waste. These arrangements should ensure that the waste products comply with the relevant specifications, including those of the final disposal facility, or discharge routes for liquid and gaseous wastes. These arrangements should cover the procurement of the packaging and any raw materials used in processing, the quality of the final product and all necessary records.

Storage

- 6.47 Licensees should, so far as is reasonably practicable, store radioactive waste in a passively safe state, such that it can be inspected, monitored, retrieved and preserved in a condition suitable for its subsequent management.
- 6.48 Licence Condition 4(2) requires licensees to ensure that nuclear matter is stored in accordance with adequate arrangements made for this purpose. Licence Condition 34 requires the licensee to ensure, so far as is reasonably practicable, that radioactive material and radioactive waste is adequately controlled or contained so that it cannot leak or otherwise escape.
- 6.49 Storage of radioactive waste is by definition an interim measure and can occur at, or between, any steps in predisposal management from generation to disposal, including decay storage as a step on the way to disposal. The storage vessel, for example tanks containing raw liquid wastes or conditioned waste packages, and the storage building or structure form part of the multi-barrier system and should be designed to provide effective containment and prevent leakage. In some cases, the role of the storage building or structure may be limited to providing environmental protection, radiation shielding and presenting a secure boundary against unauthorised intrusion or interference and entry of wildlife.
- 6.50 The licensee should demonstrate that the design of the storage building or structure is fit for purpose, taking account of the hazards posed by the stored radioactive waste and the expected timescales for passive safe storage, which could extend beyond 100 years in some cases. There should be sufficient storage capacity for waste generated during normal operations, and consideration given to reserve capacity in case of incidents or abnormal events. For storage of liquid wastes, this should include an adequate provision of secondary containment.
- 6.51 Licensees may wish to use temporary facilities for radioactive waste storage in the short-term to support other processes, for example decommissioning, retrieval of radioactive waste for disposal or passive safe storage, or pending construction of other facilities. In these cases, licensees should demonstrate that the temporary facilities are fit for purpose and that any risks from their use are reduced ALARP through provision of an adequate safety case. ONR expects that such arrangements to be truly temporary and required for relatively short periods of time. If such arrangements are required for longer time periods, then they cannot be regarded as temporary.

- 6.52 Licence Condition 23 requires the licensee to identify the conditions and limits necessary in the interests of safety (referred to as operating rules). Licence Condition 28 requires the licensee to make and implement adequate arrangements for the regular and systematic examination, inspection, maintenance and testing of all plant which may affect safety.
- 6.53 The fundamental objective of inspection of stored radioactive waste, including unconditioned waste and waste packages is to confirm that they, and the facilities that contain them, are in an acceptable condition for continuing safe storage, retrieval, processing and final disposal, and will remain so for the relevant timescales.
- 6.54 Licensees should develop a strategy, including criteria (operating rules) against which the condition of the stored radioactive waste and stored waste packages are to be assessed. The strategy should also provide justification as to the method and frequency of inspections. Where strategies are based on predicted rates of degradation, inspections should also be undertaken at appropriate time intervals to confirm that the waste is not evolving to an unexpected degree. The licensee should also include consideration of the environmental conditions within the storage facility.
- 6.55 Given that an increasing number of waste treatment and storage facilities are being constructed and operated, there is a need to ensure that the operating rules for such facilities are appropriately defined within the safety case and are set in suitably measurable terms. It should be noted that in such cases, surveillance inspections will be infrequent, with long gaps, potentially years, between inspections. Thus, any such operating rules should have robust margins of safety associated with them and be demonstrable within the safety case.
- 6.56 The inspection strategy should be reviewed for adequacy at appropriate intervals, taking account of results derived from previous inspections.
- 6.57 Further guidance on ONR's expectations for dedicated storage facilities that is also applicable to waste packages is given in the TAG for Spent Fuel Management (NS-TAST-GD-081). In addition, NDA has produced industry guidance on the interim storage of HAW [40].

Waste Acceptance Criteria

- 6.58 Licensees should establish acceptance criteria (operating rules) for radioactive waste and waste packages that are accepted for processing, storage, transport and disposal, and make arrangements for assessment against them. The criteria should specify the radiological, physical, chemical and biological characteristics of the waste or waste packages that are to be processed or stored, taking account of the operating limits and conditions to ensure consistency with the safety case.
- 6.59 Licensees should also make adequate provisions for the safe management of radioactive waste or waste packages that do not meet the criteria.

Data and information recording

- 6.60 Licensees should make adequate provision for recording and preserving all the data and information that may be required in the future to ensure the safe management of radioactive material and radioactive waste, for as long as such information may be required.
- 6.61 Licence Condition 6 requires licensees to make adequate records to demonstrate compliance with each condition of the site licence, and to ensure that such records are preserved for 30 years. Licence Condition 25 requires licensees to ensure that adequate records are made and kept of the operation, inspection and maintenance of nuclear facilities; these shall include records relating to the amount and location of all

- nuclear matter. Licence Condition 32 requires licensees to make adequate arrangements for the recording the amount of radioactive waste accumulated on site.
- 6.62 The record preservation period of 30 years reflects the requirements of NIA65 with respect to third party liability. This period starts from the time when decommissioning or decontamination of the plant is complete and all radioactive waste has been transferred to another location or disposed of. However, records required to support the safe management of radioactive waste during long-term storage and final disposal will need to be managed by the licensee over a significant period of time prior to disposal, and subsequently by the operator of the disposal facility. As a result, the records may be required for periods in excess of 100 years and consideration needs to be given to the content of such records, and the form in which they are kept. Records should be held by the licensee until the responsibility for the waste has been passed to another body such as the operator of a disposal facility; however, some information will need to be retained to comply with NIA65 requirements. For on-site disposals, records would need to be maintained until the site is released from regulation.
- 6.63 ONR expects licensees to develop and maintain a records system that takes into account the purpose, content and storage of records, where the records should
- Contain all the information that may be required in the future,
 - Be accessible and legible to those who will consult them, and
 - Be assembled and maintained in a secure form.
- 6.64 The information contained in records is required for two principal reasons: firstly in connection with nuclear liabilities under NIA65, and secondly, to support the safe management of the waste of the whole lifecycle. This guidance is relevant to the latter, in particular the roles that operational records play in supporting future radioactive waste management and decommissioning, including:
- Review of waste management (and decommissioning) strategies;
 - Review of facility safety cases (periodic review of safety);
 - Ensuring continued safe storage;
 - Retrieval of waste and waste packages;
 - Packaging or repackaging of waste;
 - Disposal of waste;
 - Dismantling of structures and plant;
 - Management following incidents;
 - Making modifications.
- 6.65 In addition to the regulators and the licensee, records will be of value to other organisations or persons in the future, for example:
- Any successor licensee;
 - The operator of a disposal facility;
 - Local planning authority;
 - Members of the public;
 - International organisations (e.g. IAEA).

- 6.66 It is beyond the scope of this guidance to define the extent of the records that licensees are expected to assemble with respect to their nuclear facilities, but the following provides some guidance specifically for radioactive waste:
- Relevant characteristics, including radionuclide inventory, the amount, radiological classification, its physical, chemical and biological form, any associated uncertainties in the estimates of the characteristics and any criticality-relevant information;
 - Details of the ownership;
 - Origin of the waste and its location on site or within a storage facility;
 - Development and specification of waste packages, including treatment and conditioning;
 - Details of packaging;
 - Design and construction materials;
 - Inspection, maintenance and testing;
 - Records of all waste disposals;
 - Quality records;
 - Safety case records;
 - Records of incidents;
 - Research and development;
 - Regulatory interactions;
 - Interactions with operators of disposal facilities.
- 6.67 The fundamental requirement for records storage is that they should be in a secure and accessible form for as long as the information could be of value. Due to the long timescales associated with the interim storage of HAW and some licensee's decision to defer decommissioning, the projected storage period for many records will be significant, in excess of 100 years in some cases, and should be taken into account in developing the records system. Further guidance on the management of records is provided in Reference [2] (NS-TAST-GD-033).

Safety management

- 6.68 ONR expects licensees to provide safety cases demonstrating the safe operation of all their facilities, including those for the management of radioactive material and radioactive waste.
- 6.69 Licence Condition (LC) 23(1) requires licensees to provide safety cases that demonstrate the safe operation of all facilities on site, including those specifically for the management of radioactive waste. General guidance on the purpose, scope and content of safety cases for all types of nuclear facilities is available in Reference [2] (NS-TAST-GD-051). However, there are a number of important issues that are particularly relevant to radioactive waste management facilities, which need to be addressed in the safety cases.
- 6.70 The lack of a disposal facility for HAW means that radioactive waste management facilities will be required to operate safely for very long periods of time. In some cases, these facilities may be new, but in many other cases the plants were built a long time ago and to different standards. Some historical plants remain in good condition, but others may be physically deteriorating. Additionally, some historical plants may be repurposed for the management of radioactive waste. All these issues need to be considered in developing an acceptable safety case.

6.71 The safety case should demonstrate that the design and operation of the facility and its associated arrangements meet modern standards and also justify safe operation throughout the projected life of the facility. For older facilities built to earlier standards, the age of the facility, as well as the anticipated remaining lifetime, must be taken into account and the issue of whether suitable and sufficient measures are available to satisfy ALARP will need to be judged on a case by case basis. A safety case comprises a suite of safety documentation which, when taken together, provide this justification. The specification and format of a safety case is the responsibility of the licensee; however, the following elements that are particularly relevant to radioactive waste management facilities should be considered:

- Descriptions of facilities, environment and processes, including
 - buildings and plant;
 - site conditions;
 - waste streams (characterisation and quantities);
 - waste management processes;
- Consistency with waste management and decommissioning strategies;
- Identification of modern standards and good practice;
- Demonstration that radioactive material and radioactive waste are adequately controlled and contained;
- Operations procedures, including
 - Operating instructions;
 - Relevant limits, rules and conditions for operations;
 - Inspection, maintenance and monitoring schedules.
- Demonstration that the plant:
 - is fit for purpose;
 - is consistent with good engineering and good practice;
 - provides adequate safety throughout its proposed life;
 - that risks are reduced ALARP.
- That the ageing of structures, systems and components, plant and waste packages is adequately managed.

6.72 Licence Condition 15 requires licensees to make and implement adequate arrangements for the periodic and systematic review and assessment of safety cases. Further guidance on periodic safety reviews can be found in Reference [2] (NS-TAST-GD-050).

6.73 The review would normally be expected to be conducted at least every 10 years and ONR expects licensees to give adequate consideration to the following, as they relate to the management of radioactive materials and radioactive wastes:

- the accumulation and monitoring of radioactive waste
- operating experience since the last review
- maintenance, inspection and testing experience since the last review
- the history of incidents and abnormal events since the last review.

6.74 The review should ensure that in cases where the facility provides a safety function that cannot be provided by an alternative means, the forward look includes consideration of the time which may be needed to design, construct and commission, or to procure a replacement facility or equipment, should the original be found to be unserviceable at some point in the future, i.e. there must be no interruption in safety

function. This applies particularly to radioactive waste stores, and to other facilities in which the hazard cannot be simply removed by shutting them down. For stores containing significant quantities of radioactive material and radioactive waste, the review needs to consider the entire period until retrieval. This is particularly important if the material or waste is chemically reactive, degrading or could leak to the environment.

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8. ACRONYMS

ALARP	As low as reasonably practicable
BAT	Best Available Techniques
CDG	Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009
CoRWM	Committee on Radioactive Waste Management
EA	Environment Agency
GDF	Geological Disposal Facility
GSR	General Safety Requirement
HAW	Higher Activity Radioactive Waste
HLW	High Level Waste
IAEA	International Atomic Energy Agency
ILW	Intermediate Level Waste
(NS)LC	(Nuclear Site) Licence Condition
LLW	Low Level Waste
NIA65	Nuclear Installations Act 1965
NMAC	Nuclear Material Accountancy and Control
NRW	Natural Resources Wales
PSR/PRS	Periodic Safety Review / Periodic Review of Safety
RGP	Relevant Good Practice
SAP	Safety Assessment Principle(s) (ONR)
SEPA	Scottish Environment Protection Agency
SFAIRP	So far as is reasonably practicable
SRL	Safety Reference Level (WENRA)
SSC	Structure, System and Component
SSG	Specific Safety Guide
TAG	Technical Assessment Guide(s) (ONR)
TIG	Technical Inspection Guide(s) (ONR)
WENRA	Western European Nuclear Regulators' Association

9. APPENDICES

APPENDIX A – RADIOACTIVE WASTE DEFINITIONS

Higher Activity Radioactive Waste (HAW)

- 9.1 Higher Activity Waste comprises High Level Waste (HLW) (or heat generating waste), Intermediate Level Waste (ILW) and such Low Level Waste (LLW) as cannot be disposed of at present.

High Level Waste (HLW)

- 9.2 HLW – radioactive waste that is sufficiently radioactive that the decay heat significantly increases its temperature and the temperature of its surroundings [23].
- 9.3 Typical characteristics of HLW are thermal power above ~ 2 kW/m³. The heat generated from such waste has to be taken into account when designing storage or disposal facilities.

Intermediate Level Waste (ILW)

- 9.4 ILW - radioactive waste with radioactivity levels exceeding the upper boundaries for LLW, but which does not require heating to be taken into account for the design of storage or disposal facilities [23]. IAEA guidance is that ILW thermal power is below ~ 2 kW/m³.

Low Level Waste (LLW)

- 9.5 LLW is defined [33] as:
- “radioactive waste having a radioactive content not exceeding four giga-becquerels per tonne (GBq/te) of alpha or 12 GBq/te of beta/gamma activity.”
- 9.6 The lower activity limit for LLW, below which waste is not required to be subject to specific regulatory control is defined as ‘out of scope’ in the environmental permitting regulations:
- For England and Wales: EPR16, Schedule 23, Part 2 and Part 3 [12]
 - For Scotland: EASR18, Schedule 8, Part 1 and Part 6 [17].

Very Low Level Waste (VLLW; a sub-category of LLW)

- 9.7 VLLW is a sub-category of LLW; however amendments to legislation in 2011 means that this sub-category is now obsolete. Notwithstanding this, the term continues to be used in nuclear policy and guidance documents, as well as some environmental permits for England and Wales. The following definitions are taken from the *UK Strategy for the Management of Solid LLW from the Nuclear Industry* [34].

VLLW (Low Volume)

- 9.8 Low volumes (‘dustbin loads’) of “radioactive waste which can be safely disposed of to an unspecified destination with municipal, commercial or industrial waste (“dustbin” disposal) if:
- each 0.1 m³ of waste contains less than 400 kBq of total activity or single items contain less than 40 kBq of total activity
 - For wastes containing carbon-14 or hydrogen-3 (tritium):
 - in each 0.1 m³, the activity limit is 4,000 kBq for carbon-14 and hydrogen-3 (tritium) taken together; and
 - for any single item, the activity limit is 400 kBq for carbon-14 and hydrogen-3 (tritium) taken together.

- 9.9 *Controls on disposal of this material, after removal from the premises where the wastes arose, are not necessary.”*

VLLW (High Volume)

- 9.10 For bulk disposals – High Volume VLLW – where:

- *“Radioactive waste with maximum concentrations of four megabecquerels per tonne (MBq/te); or*
- *for waste containing hydrogen-3 (tritium), with maximum concentrations of 40 MBq/te;*

can be disposed of to specified landfill sites.

- 9.11 *Controls on disposal of this material, after removal from the premises where the wastes arose, will be necessary in a manner specified by the environment regulators.”*

APPENDIX B – GENERAL PRINCIPLES FOR PASSIVE SAFETY

9.12 The following is a list of general principles taken from the SAPs [1] that should be considered in proposals developed by licensees.

- The radioactivity should be immobilised;
- The wasteform and its container should be physically and chemically stable;
- Energy should be removed from the wasteform;
- A multibarrier approach should be adopted in ensuring containment;
- The wasteform and its container should be resistant to degradation;
- The storage environment should avoid degradation that may render the waste unsuitable for long-term management or disposal;
- The need for active safety systems to ensure safety should be minimised;
- The need for monitoring and maintenance to ensure safety should be minimised;
- There should be no need for prompt intervention to maintain the facility in a safe condition;
- The storage building should be resistant to foreseeable hazards;
- Access should be provided for response to incidents;
- The storage facility should be designed and operated so that individual packages can be inspected and retrieved within an appropriate period of time. This may include the need for reserve storage space;
- The lifetime of the storage building should be appropriate for the storage period prior to disposal;
- Appropriate provisions should be made for dealing with any radioactive waste or its packaging that shows signs of unacceptable behaviour;
- The package should be compatible with the long-term management strategy for the waste, which may include the need for a further period of storage, or disposal.