



ONR GUIDE			
LAND QUALITY MANAGEMENT			
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LAND QUALITY MANAGEMENT – SUMMARY

- Land quality management (LQM) refers to the prevention of contamination of both land and groundwater, and extends to remediation (including control and monitoring) of contamination on the surface of the ground, in the ground, and in groundwater.
- The ONR has vires for regulating radioactively contaminated land on GB nuclear sites under the Nuclear Installations Act 1965 and the Energy Act 2013.
- Vires for non-radioactively contaminated land and groundwater reside with the relevant environmental regulator (EA, NRW or SEPA).
- On nuclear licensed sites, radioactively contaminated land and groundwater are considered by ONR to be accumulations of nuclear matter.
- The principal Safety Assessment Principles (SAPs) are the Land Quality Management principles RL.1 to RL.9.
- The principal Licence Conditions applicable to the regulation of LQM are:
 - LC34 Leakage and escape of radioactive material and radioactive waste
Prevention of new land or groundwater contamination
Control and containment of land or groundwater contamination
 - LC35 Decommissioning
Strategy and plan for land quality management
 - LC14/23 Safety documentation
Production of a land quality safety case
 - LC25 Operational records
Characterisation and monitoring of land and groundwater quality
Records of optioneering and decision making

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 in 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 The purpose of this guidance is:

- to draw together those aspects of legislation, Government policy and international standards that are relevant to the work of the Office for Nuclear Regulation (ONR) in regulating the management of land quality, including radioactively contaminated land¹ and groundwater;
- to provide a framework for the assessment on a consistent basis of licensees' arrangements for land quality management; and
- to outline the mechanisms of working with the environmental regulators², with whom joint working on matters of land quality is essential.

2.2 Land quality management (LQM) is defined by ONR to include the prevention of new contamination and management of existing contamination of both land and groundwater, and extends to remediation (including control and monitoring) of radioactive and non-radioactive contamination on the surface of the ground, in the ground, and in groundwater. As LQM includes preventative measures, it is required irrespective of whether or not any contamination currently exists.

2.3 On GB nuclear sites, both ONR and the environmental regulators have roles for regulating land and groundwater contamination. When investigating and remediating such land, licensees must take account of all relevant UK legislation and policy when developing and executing plans for clean-up or on-site disposals. ONR will take the lead regulatory role for instances of radioactive contamination and this TAG deals solely with radioactively contaminated land and groundwater.

2.4 ONR has a Memorandum of Understanding (MoU) with each of the environmental regulators on matters of mutual interest on nuclear licensed sites [4], and supporting joint regulatory guidance to their inspectors concerning the working-level implementation of the MoUs [5].

2.5 ONR does not prescribe targets or methodologies for licensees to follow to achieve compliance with the Licence Conditions or the SAPs. It is the licensee's responsibility to set out how it will achieve compliance and for ONR to assess whether the arrangements are adequate.

¹ The term 'radioactively contaminated land' used in this TAG and within the SAPs is defined as "land containing radioactive contamination at levels that would preclude its delicensing" and is distinct from the statutory definition of 'radioactive contaminated land' as defined under the Part IIA regime.

² The environmental regulators are: in England, the Environment Agency (EA); in Scotland, the Scottish Environment Protection Agency (SEPA); and in Wales, Natural Resources Wales (NRW).

3. RELEVANT LEGISLATION

- 3.1 As stated in Licence Condition (LC) 1 in the Licence Condition Handbook [6], ONR has chosen to adopt similar definitions of radioactive material and radioactive waste to those contained within the Radioactive Substances Regulation (RSR) enforced by the environmental regulators, encompassing the Environmental Permitting (England and Wales) Regulations 2016 (EPR16) and the Environmental Authorisations (Scotland) Regulations 2018 (EASR). These regulations differ in some aspects of detail, but are sufficiently similar in aims and implementation that they can be regarded as providing a common framework.
- 3.2 It should be noted that LC1 is yet to be amended to reflect EASR which came into force on 1 September 2018, replacing the Radioactive Substances Act 1993 (RSA93), associated Exemption Order and the High-Activity Sealed Sources and Orphan Sources Regulations 2005. LC1 will be updated in due course.
- 3.3 In October 2014, LC 1 was amended to modify the definition of radioactive material to remove the exceptions for contaminated articles and substances (see Appendix 2). The effect of this amendment was to clarify that material such as radioactively contaminated land and groundwater can be regulated by ONR under relevant Licence Conditions as radioactive material.
- 3.4 In most cases it makes little difference for LC compliance purposes whether radioactively contaminated land and groundwater are considered by licensees as radioactive material or radioactive waste, as they are treated similarly in most of the relevant Licence Conditions.
- 3.5 To avoid complication, ONR considers radioactively contaminated land and groundwater to be accumulations of nuclear matter [1], irrespective of whether it is also radioactive material or radioactive waste (Figure 1).

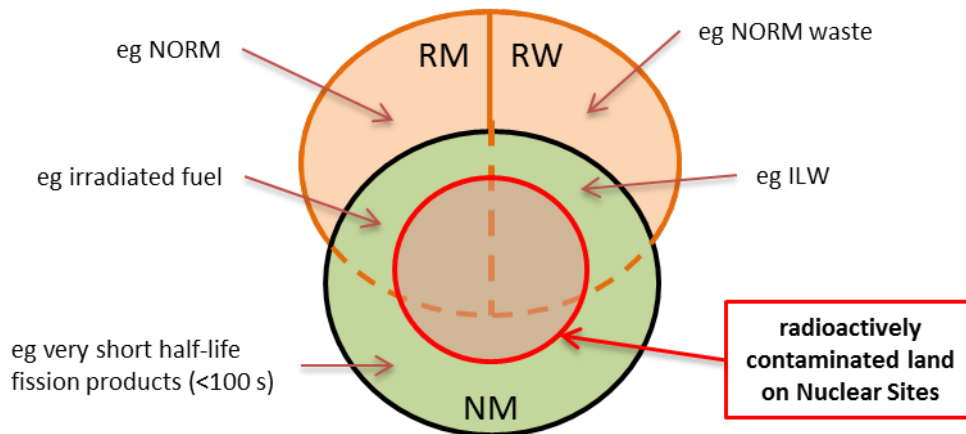


Figure 1. Relationship between nuclear matter (NM), radioactive material (RM) and radioactive waste (RW), demonstrating that some radioactive material and radioactive waste is nuclear matter, whilst some is not, and some nuclear matter is neither radioactive material nor radioactive waste. Radioactively contaminated land on nuclear licensed sites is considered to be nuclear matter; it may also be radioactive material, radioactive waste or neither of those.

ONR's nuclear safety purposes

- 3.6 Section 68 of the Energy Act 2013 (EA13) sets out ONR's nuclear safety purposes to mean the purposes of protecting persons against risks of harm from ionising radiations from GB nuclear sites, and these include through arrangements to minimise those risks in the event of an escape or release of such ionising radiations. An escape or release of ionising radiations from a GB nuclear site includes ionising radiations from nuclear matter that has escaped or been released on or from a GB nuclear site.

Nuclear site licensing

- 3.7 Under section 4 of NIA65, ONR has attached 36 standard conditions to each nuclear site licence, described in the LC Handbook [6]. All LCs apply to the extent that they are relevant. However, several LCs have general applicability for the regulation of LQM matters (Figure 2) and the following five are of particular relevance:

- **LC34: Leakage and escape of radioactive material and radioactive waste**
This condition requires the licensee, so far as is reasonably practicable, to ensure adequate control and containment of radioactive waste and radioactive material so as to prevent the creation of radioactively contaminated land and groundwater, and to ensure appropriate management of existing radioactively contaminated land and groundwater. However, this condition will also be used if a leak or escape of radioactive material or radioactive waste to land or groundwater on a nuclear licensed site (a) occurs; (b) has not been detected by the licensee; or (c) is not notified, recorded, investigated or reported by the licensee under its LC7 arrangements.
- **LC35: Decommissioning**
The licensee's decommissioning arrangements and programmes should consider (a) the risks to decommissioning workers from any existing radioactively contaminated land and groundwater; (b) measures to avoid or minimise the creation of new radioactively contaminated land or groundwater from decommissioning activities; and (c) the remediation of radioactively contaminated land and groundwater as an integral part of the decommissioning programme. It should be noted that although LQM is integral to decommissioning, it is not the intention that LQM should be confined to decommissioning.
- **LC14/23: Safety documentation**
The safety case should identify the relevant structures, systems and components (SSCs) that are important to prevention of leak and escape of radioactive material and radioactive waste and control of land quality, include the potential impact to the quality of land and groundwater from operations and be complemented by the licensee's plans for characterisation, monitoring, and remediation of any contamination arising. In general, licensees' safety cases should demonstrate how the risks of and from land and groundwater contamination are minimised. Where appropriate for any areas of contaminated land and groundwater that exist, licensees should produce a safety case demonstrating how the safety of employees and other persons has been achieved.
- **LC25: Operational records**
The licensee must undertake appropriate characterisation of any known or suspected contaminated land or groundwater to determine the extent of such contamination in respect of the quantity of radioactive material and its location

upon the site³, which should be kept up-to-date through adequate on-going monitoring. Additionally, the licensee should make and implement adequate arrangements for recording and preserving information needed for safe and effective control and remediation of radioactively contaminated land, now and in the future.

3.8 Other LCs relevant to LQM are considered in Appendix 1.

3.9 ONR expects that new licensees will implement Land Quality Management arrangements that are proportionate to the hazard and risk on the site and reflect the scope of operations being undertaken, through construction and operation of a new nuclear facility.

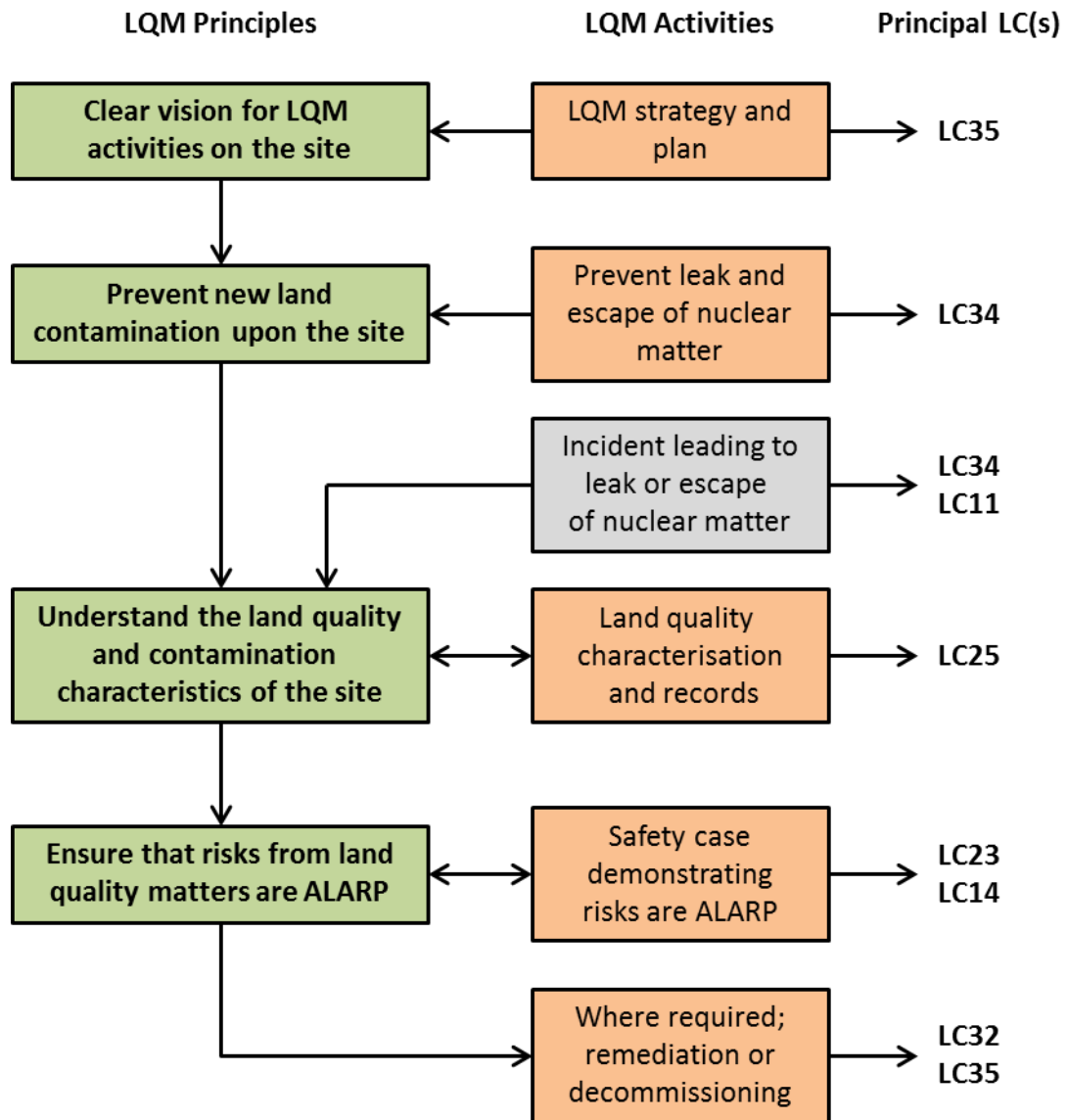


Figure 2. General activities to achieve the main principles of LQM and the principal LCs underpinning enforcement. This diagram is intended as a guide and is not exhaustive or exclusive with respect to LC applicability.

³ “upon the site” has the meaning of a modified version of the principle of *cuius est solum*, whereby the licensed site boundary is considered to extend below ground to the Earth’s core and above ground to an altitude of 100 km.

Health and safety legislation

- 3.10 Activities for safe and effective LQM must be undertaken by licensees to ensure that, so far as is reasonably practicable, the health, safety and welfare of their employees and the health and safety of other persons are protected, as required by sections 2(1) and 3(1) of HSWA74. Licensees and operators must reduce the risks associated with radioactively contaminated land or groundwater, so far as is reasonably practicable, through the production of a justification for the work to be done that demonstrates that the risk to employees or other persons is as low as reasonably practicable (ALARP). More guidance on the demonstration of ALARP is available in the relevant TAG (NS-TAST-GD-005) [2].
- 3.11 In addition to HSWA74 the following regulations also have relevance to LQM:
- 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. Regulations 7 (radiation risk assessments), 9 (restriction of exposure), 12 (dose limitation) and 29 (accounting for radioactive substances) are particularly relevant to LQM activities.
 - The Management of Health and Safety at Work Regulations 1999 (MHSWR99) require employers to carry out an assessment of the risks resulting from work activity to the health and safety of employees, and others, such as the public, volunteers and external contractors visiting the premises, and then implement measures to control the risks identified. The more specific requirement for a prior risk assessment under regulation 7 of IRR17 is complementary to the more general risk assessments required by regulation 3 of MHSWR99.

Environmental legislation

- 3.12 The Radioactive Contaminated Land Regulations⁴, under the Environmental Protection Act 1990 (EPA90) Part IIA regime, do not apply in relation to land within a nuclear licensed site or an MoD nuclear site [7, 8, 9]. Radioactively contaminated land on nuclear sites is regulated by ONR under NIA65.
- 3.13 Radioactive substances are considered to be hazardous substances [10] and so their discharge to groundwater must be prevented or limited. For planned disposals of radioactive waste this is achieved through conditions in environmental permits and authorisations and enforced by the environmental regulators. Accidental releases to groundwater are regulated by ONR under NIA65 [10]⁵, in close liaison with the relevant environmental regulator to ensure a coordinated regulatory response.
- 3.14 For further information on the interface between NIA65 and the environmental regulations see Appendix 2.

⁴ Radioactive Contaminated Land (Modification of Enactments) (England) Regulations 2006
Radioactive Contaminated Land (Scotland) Regulations 2007
Radioactive Contaminated Land (Modification of Enactments) (Wales) Regulations 2006.

⁵ The guidance applies to England and Wales only. In Scotland, SEPA also has vires for regulating inputs of hazardous substances to groundwater under the Water Environment (Controlled Activities) (Scotland) Regulations 2011.

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

Safety Assessment Principles

4.1 The Safety Assessment Principles (SAPs) [1] provide nuclear inspectors with a framework for making consistent regulatory judgements on the safety of activities, and include the legal duty 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 LQM and those principles are summarised here:

- **RL.1** – this principle relates to the production of a strategy for the control and remediation of any known or suspected radioactively contaminated land on the site, which should be integrated with other related strategies (eg for radioactive waste or decommissioning).
- **RL.2** – this principle relates to licensees understanding the extent and nature of radioactively contaminated land on and adjacent to the site.
- **RL.3** – this principle relates to licensees having suitable arrangements for detection of leaks and escapes giving rise to radioactive land contamination, such that they can be controlled.
- **RL.4** – this principle relates to characterisation of radioactively contaminated land to facilitate its safe and effective control and remediation.
- **RL.5** – this principle relates to characterisation of any radioactively contaminated land such that it is kept up to date.
- **RL.6** – this principle relates to preparation and implementation of a plan for safe control and remediation of radioactively contaminated land, and which is subject to appropriate stakeholder engagement.
- **RL.7** – this principle relates to the records for safe and effective control and remediation of radioactively contaminated land, now and in the future.
- **RL.9** – this principle relates to the production of a safety case to demonstrate safety of LQM activities, which is kept up to date as work progresses.
- **RL.8** – this principle relates to appropriate remediation and control of any radioactively contaminated land prior to construction of new facilities upon that land.

4.2 In addition to the LQM SAPs, the following SAPs may also be of relevance to LQM:

- **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.
- **RW.1 to RW.7** – these principles relate to the management of radioactive waste at all stages of the lifecycle of a facility.
- **DC.1 to DC.6, DC.9** – these principles relate to arrangements for decommissioning of a facility, which apply at all stages of the lifecycle of a facility.
- **ECS.1 to ECS.5** – these principles relate to classification and standards of structures, systems and components (SSC) employed to deliver safety functions, which may include, for instance, leak detection systems and groundwater monitoring networks.
- **EMT.2** – this principle relates to the regular and systematic examination, inspection, maintenance and testing of SSC employed in, for instance,

preventing land contamination and delivering LQM plans, as defined in the safety case.

- **ESR.8** – this principle relates to the provision of leak detection systems, which includes instrumentation to enable monitoring of the location and quantity of escaped radioactive material.
- **FP.1 to FP.5, FP.8** – these are the fundamental principles which underpin the SAPs and outline ONR’s expectations regarding responsibility, leadership and management for safety, optimisation of protection measures, safety assessment, limitation of risks to individuals and protection of present and future generations.

Technical Assessment Guides

4.3 There are many other TAGs which may be of relevance to LQM, due to the large number of SAPs which are of potential relevance. The full list of TAGs can be accessed from HOW2 or the ONR website, and the most relevant are listed below:

- NS-TAST-GD-004 Fundamental principles
- NS-TAST-GD-005 ONR guidance on the demonstration of ALARP (As Low As Reasonably Practicable)
- T/AST/009 Examination, inspection, maintenance and testing of items important to safety
- NS-TAST-GD-023 Control of processes involving nuclear matter
- NS-TAST-GD-024 Management of radioactive materials and radioactive waste on nuclear licensed sites
- NS-TAST-GD-026 Decommissioning on nuclear licensed sites
- NS-TAST-GD-027 Training and assuring personnel competence
- NS-TAST-GD-033 Licensee management of records
- NS-TAST-GD-035 Limits and conditions for nuclear safety (operating rules)
- NS-TAST-GD-038 Radiological protection
- NS-TAST-GD-049 Licensee use of contactors and intelligent customer capability
- NS-TAST-GD-051 The purpose, scope and content of nuclear safety cases

WENRA Safety Reference Levels and IAEA Requirements

- 4.4 LQM is outside of the scope of the WENRA Safety Reference Levels (SRLs) for decommissioning and those relevant to delicensing. There are no SRLs of relevance to LQM.
- 4.5 LQM activities covered by this TAG will contribute to satisfying aspects of the IAEA General Safety Requirements [11] Part 3 (Radiation Protection and Safety of Radiation Sources), Part 4 (Safety Assessment for Facilities and Activities), Part 5 (Predisposal Management of Radioactive Waste), and Part 6 (Decommissioning of Facilities). Further information on how this TAG covers specific requirements is provided in Appendix 3.

5. ADVICE TO INSPECTORS

- 5.1 Where the inspector is not a specialist on the topic of land quality management, guidance should be sought from specialist inspectors from within the Nuclear Liabilities Regulation specialism.

Joint Regulatory Expectations

- 5.2 In June 2014, a paper titled Regulatory Expectations for Successful Land Quality Management at Nuclear Licensed Sites was published [12] by ONR and the environmental regulators, outlining the overall objective for LQM on nuclear licensed sites in Great Britain. The joint expectations laid out in that document apply to radioactive and non-radioactive contamination of land and groundwater. It is expected that a joint regulatory approach will be adopted, especially in instances where radiological and non-radiological contamination is co-located.

Overall objective of LQM

- 5.3 Our high-level expectations are set out in the joint regulatory expectations paper [12] published by ONR and the environment agencies in June 2014. These expectations are intended to promote relevant good practice; they do not specify regulatory requirements and in their own right are not legally binding on licensees. However, in most areas the expectations are underpinned by the LCs described in Section 3, which are legally binding requirements. It should also be noted that licensees will need to take account of other relevant legislation and guidance, in particular regarding possible on-site disposals of radioactive waste. This guidance builds on the joint regulatory expectations document, providing more detail regarding how those expectations fit into our system of regulation.
- 5.4 The overall objective of LQM is to take all reasonably practicable measures to prevent contamination and to ensure existing contamination is managed to mitigate safety and environmental risks. ONR and the environmental regulators expect that licensees and operators manage land quality in ways that:
- prevent unacceptable activities in terms of land and groundwater protection taking place; and
 - ensure that any risks to people and the environment associated with land quality are promptly and properly managed.
- 5.5 This includes ensuring that where contamination exists, proportionate remediation is undertaken to avoid, so far as is reasonably practicable, risks to human health, safety and the environment for present and future generations. Licensees and operators should have a robust strategy for managing land quality which is implemented through a single LQM plan. The development of both strategy and plan should be systematic, integrated and iterative, addressing the following expectations:
- prevent new land contamination, so far as is reasonably practicable;
 - understand the land quality and contamination characteristics of the site, so as to inform decisions on LQM;
 - assess the options for LQM taking due account of sustainable development;
 - identify and prioritise LQM activities;
 - apply the waste management hierarchy;
 - avoid the creation of radioactive wastes in forms which may foreclose options for safe and effective long-term management;
 - ensure sufficient and competent resources are allocated to implement LQM activities;

- engage with stakeholders (including the regulators) from an early stage;
- develop the safety case / radioactive (and non-radioactive) waste management arrangements for LQM;
- ensure that risks are as low as reasonably practicable/achievable; and
- maintain fit-for-purpose land management records and manage relevant knowledge appropriately.

LQM strategy and plan

- 5.6 The arrangements for decommissioning required under LC35(1) extend to include the regulatory expectation for the licensee to produce and maintain an appropriate LQM strategy. The LQM strategy may be a stand-alone document or integrated to other relevant strategies (eg radioactive waste).
- 5.7 As a minimum, the strategy should recognise relevant stakeholder expectations or requirements (including those of the local community) for site management and subsequent re-use of the land, including any agreed interim or final site end states and dates. The strategy should set out what is to be achieved through LQM, and be supported by a single coherent plan that sets out 'how' LQM is delivered. The plan should set out key objectives, milestones, timescales and responsibilities, and make clear reference to LQM enabling procedures and arrangements such as record keeping, quality assurance, decision-making and stakeholder engagement.
- 5.8 Production of a site wide LQM strategy will satisfy Principle RL.1, whilst activities to determine the current baseline and inform the plan will satisfy Principles RL.2 and RL.6. The LQM strategy should be consistent and integrate with other relevant site strategies, such as those for radioactive waste (Principle RW.1) and decommissioning (Principle DC.2) as per paragraph 880 in the SAPs.
- 5.9 Production of a specific LQM strategy is a regulatory expectation in order to promote relevant good practice. Production of an LQM strategy will enable the licensee to clearly demonstrate its compliance with the LCs and SAPs which underpin ONR's expectations with respect to LQM.
- 5.10 The inspector may consider whether the following factors have been adequately addressed by the licensee's LQM strategy and plan:
- Has the licensee identified all potential sources of leaks, both historic and future?
 - To facilitate appropriate and proportionate remediation to be undertaken, have a range of remediation options been identified for a range of contamination scenarios?
 - Has the licensee defined a plan of activities to achieve the objective of LQM which clearly states how the plan will be delivered?
 - Is the identified end point satisfactory and does it remediate the radioactively contaminated land so far as is reasonably practicable?
 - Has the licensee undertaken suitable stakeholder engagement and incorporated such feedback into development of the LQM strategy and plan?

Prevention and limitation of new contamination

- 5.11 In the first instance, arrangements should be in place to prevent the leak and escape of radioactive material and radioactive waste that could lead to the contamination of land and groundwater. Further information is contained within the LC34 Technical Inspection Guide [13]. Where contamination has already occurred, arrangements

should be in place to control or remediate the contamination, whether on or arising from the nuclear licensed site, to reduce the risk so far as is reasonably practicable.

- 5.12 All structures, systems and components that are identified as potential sources of contamination should be designed and maintained to prevent leaks. This means considering both fixed and mobile sources of radioactive material and radioactive waste, including those above and below the ground. Priority should be given to those sources that present the highest hazard and risk to people from radioactively contaminated land and groundwater.
- 5.13 Options for leak prevention could include adoption of non-liquid processes, conversion of waste to a passive solid form, multi-barrier containment, external bunding, pressure detection, and leak detection (at source and receptor). All potential sources of leaks should, so far as is reasonably practicable, have effective monitoring systems, including leak detection, which are proportionate to the risks and hazards. Contingency plans should exist, ready for implementation in the event of any leak occurring. Arrangements should exist to ensure that leakage control and detection systems (including those that form part of any contingency plans) are appropriately tested and maintained.
- 5.14 Assessing the potential sources of leaks and ensuring appropriate systems for leak detection are in place and maintained will satisfy Principle RL.3 and is enforceable under LC34.
- 5.15 In line with Principle RL.3, if new contamination occurs, its effects should be assessed quickly, and appropriate and proportionate remediation undertaken to minimise the impacts on groundwater and land quality. Any leak that is detected should be stopped or otherwise controlled to prevent continuation or recurrence of contamination. Such incidents should be reported to ONR promptly as per arrangements made under LC34 / LC7, recorded, characterised and the risks assessed. ONR expects that licensees should implement good practice with respect to learning from experience to reduce the likelihood of similar events occurring in the future.
- 5.16 All reasonably practicable measures should be used to minimise the spread of contamination (whether new or existing) and to monitor the extent and consequences of its impacts. Site-wide arrangements should recognise the possibility of accidents occurring, and should include activities to mitigate and manage leaks and escapes of any contaminants.
- 5.17 The inspector may consider whether the following factors have been adequately addressed by the licensee's arrangements:
- Is there adequate provision of monitoring systems at potential sources of leaks and of receptors to those potential leaks?
 - Are there adequate inspection and testing arrangements for the monitoring systems, with complete records of inspections to date?
 - Has the licensee made appropriate contingency plans in case of a leak, including waste management arrangements?

Understanding of the land quality characteristics of the site

- 5.18 The LQM plan should be based on sound knowledge and understanding of the characteristics of the site and surrounding area, now and in the past, and any contamination that may exist.
- 5.19 The extent of site characterisation (including characterisation of any contaminants) should be sufficient to understand the potential and existing sources of contamination,

- pathways and receptors, as per Principle RL.4. Site characterisation activities should also allow any changes to be managed (including any changes in the influence of external factors on the site eg landscape change as a result of coastal erosion or increases in risk of flooding owing to climate change). In the event of any contamination occurring or being suspected, site characterisation activities should allow the behaviour and migration of contamination to be predicted, and an appropriate level of control to be exerted.
- 5.20 Licensees are not expected to investigate radioactive contamination on an adjoining site that is operated by a separate licensee. However, ONR would expect both licensees to cooperate with control and remediation activities in relation to radioactive contamination which may be, or has the potential to migrate from one site to another.
- 5.21 Site characterisation and monitoring should be used to establish and inform the development of a conceptual site model which describes the pathways by which contamination from a source could reach receptors, and the risks posed to those receptors. This conceptual site model should also set out baseline conditions against which any subsequent changes can be reviewed and their potential impacts assessed. Where land quality issues are potentially significant, more detailed characterisation of the source term, pathways and receptors may be necessary. Where appropriate and proportionate, this may also include the use of models to aid understanding of the geology, hydrogeology, geochemistry and contaminant transport mechanism(s).
- 5.22 It is essential that immediate investigation and risk assessment takes place on finding any new contamination, whether due to previously undetected sources or worsening impacts from known sources. Where appropriate, proportionate characterisation and on-going monitoring of contamination should be carried out (Principle RL.5). The radionuclide half-lives of some radioactive contaminants may appear to negate on-going monitoring, either because they are very short (contaminant will decay rapidly) or very long (radioactive characteristics will not change rapidly). However, there is a need to perform on-going monitoring to provide confidence that the total quantity and location of known sources of radioactively contaminated land/groundwater are not changing through time due to additional leaks or escapes, or through migration of the contaminant(s).
- 5.23 LC11(1) states that licensees “shall make and implement adequate arrangement for dealing with any accident or emergency arising on the site and their effects”, and ONR expects licensees to make arrangements to mitigate the effects of accidents and emergencies leading to LQM issues, so far as is reasonably practicable.
- 5.24 Inspectors may be aware that Public Health England (PHE, previously Health Protection Agency, HPA) has set guideline dose criteria [14] for land to be designated as radioactively contaminated land for the Part IIA regime, based on recommendations from the International Commission on Radiological Protection (ICRP) [15]. However, as the Part IIA regime does not apply to nuclear licensed sites, neither do the criteria (see Appendix 2).
- 5.25 The inspector may consider whether the following factors have been adequately addressed by the licensee’s arrangements:
- Has the licensee undertaken characterisation of the site to develop understanding of the current state of land and groundwater quality?
 - Has the licensee identified potential areas of concern through either characterisation or identification of potential leaks?

- Has the licensee established a conceptual site model to aid understanding of potential contaminant migration which identifies the pathways through which contamination may reach receptors from the identified potential sources?
- Are the risks to the receptors identified and quantified?
- Are suitable arrangements in place for continued monitoring to ensure that characterisation is kept up to date and the conceptual model updated accordingly?

Assessment of options for LQM

- 5.26 LQM decisions should be informed by an assessment of options for remediation that exist for each land and groundwater contamination source term taking account of the overall remediation strategy for the site. An appropriate level of stakeholder dialogue should occur early in the process of identifying, screening and selecting remediation options.
- 5.27 The inspector may consider whether the following factors, which are not intended to be an exclusive list, have been adequately considered by the licensee during assessment of LQM options:
- Is the physio-chemical nature and current state of contaminants sufficiently known?
 - Are the actual or potential risks to people and the environment under current conditions adequately quantified?
 - Have the benefits and detriments that implementation of each option would bring been clearly identified?
 - Has the impact that any delay in implementing the option might have upon the spread of contamination been adequately quantified?
 - Have the actual or potential risks, and the costs of each option been quantified?
 - Have the radiological protection risks to people for each option been quantified?
 - Have the nature and volume of wastes that would be generated been quantified, and availability of disposal routes identified?
 - Have the lifecycle impacts on people and the environment been identified and suitably quantified?
 - Have the practical issues of implementation associated with each option been adequately identified?
 - Has the intended site end states (interim and/or final) been proposed, and do the options identified enable achievement of the proposed state?
 - Has the licensee identified the extent to which each option addresses any concerns raised by stakeholders?
 - Has the selected option been chosen on a suitable basis, with due consideration of relevant good practice and safety benefits, such that risks will demonstrably be reduced so far as is reasonably practicable?

Prioritisation of LQM activities

- 5.28 The outcome of the assessment of remediation options should be a strategy which should form the basis of a prioritised programme of work to implement the selected option.
- 5.29 LQM activities should integrate fully with other site restoration and waste management activities, both current and future. Unless otherwise justified, contaminated areas of land should be remediated to appropriate standards before any new construction is started (Principle RL.8). Where appropriate, opportunities should be taken for remediation when civil works are being undertaken. Plans for other site activities

should take account of the potential impact that any new development might have upon any land and groundwater contamination (for example, impacting on local groundwater flows and so changing contaminant migration rates or pathways).

- 5.30 ONR expects that the licensee's LQM plan is appropriately prioritised to address those areas posing the greatest hazard and risk. The order in which remediation work is undertaken will generally reflect the risk posed to people and the environment from the area of concern. In general, the highest priority for action should be given to those areas posing the greatest hazard and risk, however, it should be recognised that this may not always be possible. Any change to planned management activities should be justified and the reasons for the changes clearly recorded. LQM activities should continue throughout the period that the site remains under regulatory control, including any periods of monitoring.
- 5.31 Principle DC.3 states that "where adequate levels of safety cannot be demonstrated, prompt decommissioning should be carried out and, where necessary, prompt remedial and operational measures should be implemented to reduce the risk". In such instances, ONR would expect, so far as is reasonably practicable, that appropriate and prompt remedial measures be taken to reduce risks posed by radioactively contaminated land or groundwater. Where prompt action cannot be undertaken, the licensee must justify the safety of the radioactively contaminated land.
- 5.32 The inspector may consider whether the following factors have been adequately addressed by the licensee's arrangements:
- Have LQM activities been prioritised so as to reduce the greatest hazard and risk?
 - Are any risks from identified potential future hazards adequately integrated into the prioritised plan?

Application of the waste management hierarchy

- 5.33 It is a requirement of LC32 that licensees minimise "so far as is reasonably practicable the rate of production and total quantity of radioactive waste accumulated on the site at any time". In order to achieve this, the LQM plan should implement the waste management hierarchy:
- production of radioactive waste should be avoided;
 - where radioactive waste is unavoidable, in order of priority:
 - its production should be minimised;
 - it should be reused;
 - it should be recycled;
 - only as a last resort should it be disposed of.
- 5.34 LQM activities should avoid the unnecessary generation of waste (Principle RW.2) and measures to minimise the volume of waste arising from LQM should be implemented (Principle RW.3). It is important that licensees consider the potential types and quantities of wastes which may arise from a particular remediation option, and implement measures so as to minimise secondary waste. Any wastes generated should be managed, stored and disposed of in a safe and environmentally responsible manner (Principles RW.4 and RW.5).
- 5.35 However, licensees should balance the need for implementation of the waste management hierarchy with any aims to delicense the site, and the criteria which would be applied in order to achieve this. Further information on delicensing is

provided in HSE's Criterion for Delicensing Nuclear Sites [16], and associated guidance [17].

5.36 The inspector may consider whether the following factors have been adequately addressed by the licensee's arrangements:

- Has the licensee identified the potential waste production routes for each remediation technique considered during optioneering?
- Has the licensee undertaken early containment or removal of the source term to minimise spread of contamination and protect groundwater?
- Has the licensee given due consideration to alternative management options? Examples could include but are not limited to the following:
 - In situ alternatives to excavating material for management as waste (eg monitored natural attenuation);
 - Re-use of excavated material, for example via in-fill or landscaping on site or elsewhere, ensuring that any necessary permit or authorisation is obtained;
 - Sorting, segregation and treatment of excavated material, where practicable; and
 - Implementation of sentencing arrangements and protocols to exclude or exempt material or waste from regulatory control.

Working with stakeholders

5.37 To ensure achievable, cost effective and acceptable solutions for remediation it is important to identify at an early stage stakeholders with an interest in LQM; including, but not restricted to, the regulators (ONR and relevant environmental regulators), other sites, the supply chain, and the public. Once identified, stakeholders should be engaged in a proportionate way during the development and implementation of LQM plans.

5.38 To achieve this, the process of developing LQM plans should be supported by an engagement plan that reflects the range of needs of stakeholders. Early, open, continued and transparent involvement of, and communication with those with an interest in LQM plans should help develop trust. Engagement should occur from the outset, focused on an agreed set of objectives and any hold points that may be appropriate. Invitation to the regulators to observe the process and have input if necessary is encouraged, but the licensee should be aware that the regulators will not be directly involved in any decision making processes.

5.39 Paragraph 882(e) under Principle RL.1 in the SAPs, states that ONR expects the LQM strategy to be subject to appropriate stakeholder engagement, promoting relevant good practice through closer working relationships between all parties who have an interest in LQM. It is in the licensee's interest to involve the regulators from the outset to ensure expectations for compliance are understood and achieved.

5.40 Appropriate stakeholders could include, but are not limited to:

- Regulators and other enforcing authorities (eg ONR, EA, SEPA, NRW, Local Authority);
- Other facilities on the site;
- Other sites;
- The public.

Development of LQM arrangements (safety and waste management)

- 5.41 All land and groundwater contamination should be managed in accordance with an appropriate safety case and waste management arrangements, to demonstrate that risks to operating staff, to other persons and to the environment are avoided, so far as is reasonably practicable. Although radioactively contaminated land is not deemed to be radioactive waste whilst *in situ*, waste may be generated during characterisation or remediation and so the licensee must have suitable arrangements to plan for management of such waste arising in the future.
- 5.42 The environment agencies have published guidance on surrender of radioactive substances permits [18] which requires duty holders to produce a site wide environmental safety case (SWESC). ONR would not expect a licensee to produce a separate safety case where the SWESC addresses all of ONR's requirements.
- 5.43 Principle RL.9 states ONR's expectation that licensees provide a safety case to demonstrate the safety of the plan for managing the control and remediation activities associated with radioactively contaminated land and groundwater. The safety case should be kept up to date as the work progresses to implement the plan, as per Principle SC.7. Further guidance on safety case assessment is provided in the relevant TAG (NS-TAST-GD-051) [2]. It is up to the licensee to decide how the LQM safety case is presented and documented, eg as a stand-alone document or forming part of an operational facility's safety documentation.
- 5.44 The expectation that licensees develop suitable arrangements in relation to their LQM activities forms part of the requirements upon licensees under LC23 (operating rules), LC17 (management arrangements), and LC35 (decommissioning) and further guidance on compliance with these conditions is provided in the relevant TAGs [2].
- 5.45 The safety arrangements for LQM should take account of the radiation protection SAPs RP.1 to RP.7 and the requirements for compliance with IRR17. Licensees' arrangements should provide adequate protection for members of the public and workers against exposure to ionising radiation, including radioactive contamination. Further guidance on this topic is provided in the relevant TAG (NS-TAST-GD-038) [2].
- 5.46 In addition, paragraph 817 in the SAPs states that "appropriate and sufficient capacity should be provided for temporary storage of radioactive waste", which includes "allowance for waste resulting from incidents". Potential waste arising from land and groundwater remediation required as a result of an incident or emergency should be considered in the licensee's arrangements.

Maintenance of records

- 5.47 Arrangements should be in place to ensure records are made of any leaks and incidents resulting in land and/or groundwater contamination. All records should be kept and updated as necessary. Care should be taken to ensure that transfer of LQM information between operators, including any contractors, is carried out in a responsible manner, following any transfer in responsibilities at a site.
- 5.48 Principle RL.7 sets out ONR's expectation that arrangements are made such that information needed for the safe and effective control and remediation of radioactively contaminated land and groundwater, now and in the future, is recorded and preserved. Information relating to radioactively contaminated land and groundwater may also be recorded along with information held regarding safe management of radioactive waste or decommissioning, as per Principles RW.7 and DC.6, respectively. Further detailed guidance on the the keeping and preservation of records is provided in the relevant TAG (NS-TAST-GD-033) [2].

- 5.49 The requirement for licensees to make such records of radioactively contaminated land and groundwater upon the site is stipulated in LC25(2), which states that the licensee's records "shall include records of the amount and location of all radioactive material, including nuclear fuel and radioactive waste, used, processed, stored or accumulated upon the site at any time". Note, however, that licensees may instigate monitoring regimes under their LC28 arrangements, for regular and systematic testing of the ground conditions to ensure that safety of persons is maintained.
- 5.50 The inspector may consider whether the following have been adequately addressed by the licensee's recording arrangements:
- the nature and extent of radioactive contamination, including records from surveys, investigation, monitoring and surveillance work and the analysis of their results;
 - the processes used for deciding management options and the setting of strategies;
 - records of any incidents, leakages or accidents resulting in radioactively contaminated land, and of the management actions taken in response;
 - remediation activities that have been or are planned to be carried out;
 - the methodology for, and results of, validation of the remediation work;
 - relevant information related to the history and use of the site; and
 - aspects concerning records for radioactive waste relevant to LQM.

On-site disposal of radioactive waste on nuclear sites by deposit or burial

- 5.51 In November 2016, ONR and the environmental regulators jointly published a statement of common understanding which sets out the harmonised regulatory approach taken for the regulation of the disposal of radioactive waste on nuclear sites by deposit or burial [19], to ensure the safety of the public, workers and the environment.
- 5.52 The approach ensures that any proposals for such disposals will need to demonstrate that human health and the environment will be protected. The statement explains the interface between the permitting of radioactive waste disposals by the environment agencies, and the regulation of the safety of disposal activities by ONR. The document also clarifies the terminology used in this context for "radioactive waste", "disposal" and "storage" and sets out regulatory expectations for the timing of applications to the agencies for disposal activities.

6. RELEVANT GOOD PRACTICE

- 6.1 In instances where a shortfall exists between ONR's expectations and the performance of a licensee, the inspector will need to determine the extent of the risk gap by reference to relevant good practice (RGP), as per the Enforcement Management Model (EMM). Where examples of RGP are less well defined, inspectors should influence licensees through engagement and provision of advice, to achieve ONR's regulatory expectations.
- 6.2 The following sections provide potential examples of relevant good practice (RGP), when implemented for particular circumstances in an appropriate context and in the appropriate way. For further guidance on determining what may constitute RGP, see the TAG on demonstration of ALARP (NS-TAST-GD-005).

Nuclear Industry Codes of Practice (NICoP) and Good Practice Guides (NIGPG)

- 6.3 Nuclear Industry Codes of Practice (NICoP) and Good Practice Guides (NIGPG) [20] may be considered to be 'established standards' when considering the application of

the EMM, and as such ONR would normally expect licensees to have regard to the guidance given in the relevant NICO P or NIGPG. However, ONR has not formally endorsed any of the guidance contained within the NICO Ps or NIGPGs and does not prescribe that they should be implemented. It is the responsibility of the licensee to justify use of such standards; ONR will judge the applicability and adequacy of use in each case.

- NICO P for Routine Water Quality Monitoring
- NICO P for Qualitative Risk Assessment for Land Contamination, Including Radioactive Contamination
- Nuclear Industry Good Practice Guide (NIGPG) on the Application of ALARP to Radiological Risk⁶
- NICO P on Best Available Techniques (BAT) for the Management of the Generation and Disposal of Radioactive Wastes⁷
- NICO P on Clearance and Radiological Sentencing: Principles, Processes and Practices for use by the Nuclear Industry⁸

SAFEGROUNDS+ - A CIRIA learning Network

- 6.4 SAFEGROUNDS+ [21] is a forum and learning network focussing on contaminated land on nuclear and defence sites and on non-active/low activity waste from nuclear and defence site decommissioning. The network covers technical, regulatory, public-opinion and commercial issues, recognising the inter-relationships between these and the solutions adopted for contaminated land and decommissioning waste issues.
- 6.5 Guidance produced by SAFEGROUNDS has undergone a peer review process following CIRIA's approach. On completion, the guidance documents have been assigned a SAFEGROUNDS logo to denote consensus-based endorsement by the Steering Group, although it should be noted that it is now a number of years since the SAFEGROUNDS guidance was last updated. The following guidance documents have achieved endorsed status:
- Approach to managing contaminated land on nuclear licensed and defence sites – an introduction
 - Good practice guidance for the management of contaminated land on nuclear licensed and defence sites
 - Good practice guidance for site characterisation
 - Guide to the comparison of contaminated land management options
 - Community stakeholder involvement
 - Good practice guidance for land quality records management for nuclear licensed and defence sites
- 6.6 SAFEGROUNDS guidance documents may also be considered to be 'established standards' when considering the application of the EMM, and as such ONR would normally expect licensees to have regard to the guidance given in the relevant document. However, ONR has not formally endorsed any of the SAFEGROUNDS guidance and does not prescribe that they should be implemented. It is the responsibility of the licensee to justify use of such standards; ONR will judge the applicability and adequacy of use in each case.

⁶ The NIGPG should be read in conjunction with ONR guidance on ALARP (NS-TAST-GD-005) and radiological protection (NS-TAST-GD-038).

⁷ Although ONR does not recognise BAT in its judgements, radioactive and non-radioactive contamination is often co-located on nuclear licensed sites and licensees may utilise arrangements for environmental permit compliance to achieve compliance with LCs.

⁸ This guidance should be read in conjunction with ONR's guidance on delicensing criterion [16, 17].

IAEA Safety Guides

6.7 The following safety guides form part of the IAEA Safety Standards Series [11] and provide supporting recommendations and guidance in order to achieve compliance with the requirements set out in the BSS:

- RS-G-1.7 Application of the Concepts of Exclusion, Exemption and Clearance – includes derivation of activity concentration levels used for exclusion, exemption and clearance of bulk amounts of material which provide useful bounding limits for LQM activities.⁹
- RS-G-1.8 Environmental and Source Monitoring for Purposes of Radiation Protection – provides guidance on programmes for monitoring radionuclides in the environment, including aspects of generic and detailed programme design, interpretation of the data they generate, quality assurance and recording.
- WS-G-3.1 Remediation Process for Areas Affected by Past Activities and Accidents – provides guidance on the process to be undertaken during remediation planning and implementation.
- WS-G-5.1 Release of Sites from Regulatory Control on Termination of Practices – this guide is more applicable to delicensing of nuclear sites but is a useful guide to the end-state requirements which should be the ultimate aim of LQM.

6.8 Further information on relevant IAEA guidance is contained in Appendix 3.

Drinking Water Indicator Parameters and Screening Values

6.9 Many licensees use drinking water indicator parameters and screening values as a benchmark for groundwater quality. Information is provided here for context to inform inspectors of the significance of such values.

6.10 In the UK, the Water Supply (Water Quality) Regulations 2000 specify screening values for total indicative dose and an indicator value for tritium. The DWI guidance on implementation of the regulations in England [22] states:

“the level of gross alpha activity should be assessed against a screening level of 0.1 Bq/l and the level of gross beta activity assessed against a screening level of 1 Bq/l. If either screening value is exceeded additional analysis should be undertaken to establish which radionuclides are present. The range of radionuclides analysed should take into account relevant information on potential sources. The total indicative dose (TID) is then calculated from the individual isotope concentrations excluding any activity from tritium, potassium-40, radon and radon decay products. If the TID exceeds the indicator value of 0.10 mSv/year appropriate medical advice should be sought.”

6.11 Tritium is listed as an ‘indicator parameter’ with a specification of 100 Bq/l. Tritium was included on the basis that it provides an indication of other artificial sources of radioactivity in drinking water. Therefore, if the indicator parameter value is exceeded, further analysis is recommended to identify other radioactive isotopes present to enable calculation of the total indicative dose which would be received, with comparison to the screening values discussed in paragraph 6.10 [22].

⁹ Table 2 in Part 2 of Schedule 23 to EPR16 lists concentrations of radionuclides (in Bq/g) below which a substance is considered to be ‘out of scope’, which is similar to the values contained within RS-G-1.7, with some differences. Where Table 2 and RS-G-1.7 differ, it is the value in Table 2 that should be used.

- 6.12 The World Health Organisation (WHO) prescribe 'screening levels' and 'guidance levels' for radioactivity in drinking water which represent the concentration that, if present in drinking water throughout the year, would result in an individual dose of 0.1 mSv [23]. These guidelines are based on the approach proposed by the ICRP in situations of prolonged radiation exposure of the public.

Dose criteria for designation of radioactively contaminated land

- 6.13 In 2006, the Health Protection Agency (HPA, now Public Health England (PHE)) produced a paper providing advice on the dose criteria for the designation of Radioactive Contaminated Land [14]. The HPA advice drew upon, but is more conservative than, the ICRP recommendation, and considers that an annual effective dose of 3 mSv is appropriate for designation of land as radioactively contaminated.
- 6.14 This threshold is used within the Part IIA Radioactive Contaminated Land regime, and is not applicable on nuclear licensed sites.

7. REFERENCES

- 1 *Safety Assessment Principles for Nuclear Facilities. 2014 Edition Revision 0, Office for Nuclear Regulation. November 2014. www.onr.org.uk/saps/saps2014.pdf*
- 2 *Nuclear Safety Technical Assessment Guides, Office for Nuclear Regulation. www.onr.org.uk/operational/tech_asst_guides/index.htm*
- 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*
- 4 *Office for Nuclear Regulation Memoranda of Understanding, HOW2 Diagram.*
Memorandum of Understanding between the Office for Nuclear Regulation and the Environment Agency, August 2015.
Memorandum of Understanding between the Office for Nuclear Regulation and the Scottish Environment Protection Agency on matters of mutual interest in Scotland, June 2016.
Memorandum of Understanding between the Office for Nuclear Regulation and Natural Resources Wales, February 2015.
- 5 *Guidance to Support the Memoranda of Understanding between the Office for Nuclear Regulation and the Environment Agencies. Technical Inspection Guides, HOW2 Diagram.*
ONR-INSP-GD-061 Guidance to Support the Joint Regulatory Memorandum of Understanding between ONR and EA on Matters of Mutual Interest in England
ONR-INSP-GD-062 Guidance to Support the Joint Regulatory Memorandum of Understanding between ONR and SEPA on Matters of Mutual Interest in Scotland
ONR-INSP-GD-063 Guidance to Support the Joint Regulatory Memorandum of Understanding between ONR and NRW on Matters of Mutual Interest in Wales
- 6 *Licence Condition Handbook, Office for Nuclear Regulation. October 2014. www.onr.org.uk/silicon.pdf*
- 7 *Environmental Protection Act 1990: Part IIA Contaminated Land - Radioactive Contaminated Land Statutory Guidance. DECC, April 2012. www.gov.uk/government/publications/statutory-guidance-covering-radioactive-contaminated-land*
- 8 *Environmental Protection Act 1990: Part IIA Contaminated Land - Radioactive Contaminated Land (Scotland) Regulations 2007 Statutory Guidance. Scottish Government, November 2007. www.scotland.gov.uk/Resource/Doc/217739/0058314.pdf*
- 9 *Radioactive Contaminated Land Statutory Guidance for Wales – 2012. Welsh Government. wales.gov.uk/docs/legislation/inforcenonsi/environmental/rclguidance0613.pdf*
- 10 *Environmental Permitting Guidance – Groundwater Activities; guidance for the Environmental Permitting (England and Wales) Regulations 2010. Defra, December 2010. www.gov.uk/government/publications/environmental-permitting-guidance-groundwater-activities*
- 11 *IAEA Safety Standards. www.iaea.org*

- 12 *Regulatory Expectations for Successful Land Quality Management at Nuclear Licensed Sites, ONR/EA/NRW/SEPA. June 2014. www.onr.org.uk/documents/2014/land-quality-management.pdf*
- 13 *Nuclear Safety Technical Inspection Guides, Office for Nuclear Regulation. www.onr.org.uk/operational/tech_insp_guides/index.htm*
- 14 *Dose Criteria for the Designation of Radioactively Contaminated Land (RCE-2). Health Protection Agency, March 2006.*
- 15 *2007 Recommendations of the International Commission on Radiological Protection ICRP Publication 103. Ann. ICRP 37 (2-4).*
- 16 *HSE criterion for delicensing nuclear sites. Health and Safety Executive, May 2005, www.onr.org.uk/delicensing.pdf*
- 17 *Interpretation and implementation of criterion of no danger. Health and Safety Executive, August 2008. www.onr.org.uk/delicenceguide.pdf*
- 18 *Management of radioactive waste from decommissioning of nuclear sites: Guidance on Requirements for Release from Radioactive Substances Regulation. SEPA/EA/NRW. Version 1.0: July 2018. www.sepa.org.uk/regulations/radioactive-substances/nuclear-industry*
- 19 *Disposal of radioactive waste on nuclear sites by deposit or burial: Joint Regulators' Statement of Common Understanding. ONR/EA/NRW/SEPA. November 2016. www.onr.org.uk/documents/2016/joint-regulators-statement.pdf*
- 20 *Nuclear Industry Codes of Practice and Nuclear Industry Good Practice Guides:*
- Routine Water Quality Monitoring: A Nuclear Industry Code of Practice. Nuclear Industry Group for Land Quality. Version 1, February 2015.*
- Qualitative Risk Assessment for Land Contamination, including Radioactive Contamination: Industry Guidance. Nuclear Industry Group for Land Quality. Version 1.1, June 2012.*
- The Application of ALARP to Radiological Risk: A Nuclear Industry Good Practice Guidance. Industry Radiological Protection Co-ordination Group, Issue 1, December 2012.*
- Best Available Techniques (BAT) for the Management of the Generation and Disposal of Radioactive Wastes: A Nuclear Industry Code of Practice. Best Available Techniques Working Group. Issue 1, December 2010.*
- Clearance and Radiological Sentencing: Principles, Processes and Practices for Use by the Nuclear Industry: A Nuclear Industry Code of Practice. Clearance and Exemption Working Group. Issue 2, December 2012.*
- 21 *SAFEGROUNDS+, Incorporating SD:SPUR, A CIRIA Learning Network. www.safegrounds.com*
- SAFEGROUNDS: Good practice guidance for land quality records management for nuclear licensed and defence sites, CIRIA, W21, 2007.*
- SAFEGROUNDS: Approach to managing contaminated land on nuclear licensed and defence sites – an introduction, CIRIA, W27, 2009.*
- SAFEGROUNDS: Guide to the comparison of contaminated land management*

options, CIRIA, W28, 2009.

SAFEGROUNDS: Good practice guidance for the management of contaminated land on nuclear licensed and defence sites, CIRIA, W29 version 2, 2009.

SAFEGROUNDS: Good practice guidance for site characterisation, CIRIA, W30 version 2, 2009.

SAFEGROUNDS: Community stakeholder involvement, CIRIA, W38 version 3, 2011.

- 22 *Guidance on the implementation of the Water Supply (Water Quality) Regulations 2000 (as amended) in England, Drinking Water Inspectorate, Version 1.1. March 2012.*
- 23 *Guidelines for drinking-water quality, fourth edition. World Health Organization 2011.*
- 24 *Guidance on the scope of and exemptions from the radioactive substances legislation in the UK, Welsh Government, Department of the Environment, The Scottish Government, Department of Energy & Climate Change, Department for Environment, Food & Rural Affairs, Version 1.0, September 2011.*

Note: ONR staff should access the above internal ONR references via the HOW2 Business Management System.

8. GLOSSARY AND ABBREVIATIONS

ALARP	As low as reasonably practicable
BAT	Best Available Technique(s)
BSS	Basic Safety Standard
BSSD	Basic Safety Standards Directive
CEWG	Clearance and Exemption Working Group
DWI	Drinking Water Inspectorate (England and Wales)
EA	Environment Agency
EMM	Enforcement Management Model
GSR	General Safety Requirement
GWD	Groundwater Daughter Directive
HOW2	ONR Business Management System
HSE	Health and Safety Executive
IAEA	International Atomic Energy Agency
IRPCG	Industry Radiological Protection Co-ordination Group
LQM	Land Quality Management
MNA	Monitored Natural Attenuation
NDA	Nuclear Decommissioning Authority
NEPLG	Nuclear Emergency Planning Liaison Group
NICoP	Nuclear Industry Code of Practice
NIGLQ	Nuclear Industry Group for Land Quality
NIGPG	Nuclear Industry Good Practice Guide
NM	Nuclear matter
NRW	Natural Resources Wales
RGP	Relevant Good Practice
RM	Radioactive material
RSR	Radioactive Substances Regulation
RW	Radioactive waste
SAP	Safety Assessment Principle(s)
SDF	Nuclear Industry Safety Directors Forum
SFAIRP	So far as is reasonably practicable
SEPA	Scottish Environment Protection Agency
SRL	Safety Reference Level(s)
SSC	Structures, Systems and Components
SWESC	Site Wide Environmental Safety Case
TAG	Technical Assessment Guide(s)
TIG	Technical Inspection Guide(s)
WENRA	Western European Nuclear Regulators' Association

WFD Water Framework Directive

WHO World Health Organisation

9. APPENDICES

APPENDIX 1: ADDITIONAL RELEVANT LICENCE CONDITIONS

9.1 The following LCs may have relevance when undertaking assessment of the adequacy of LQM arrangements and activities, depending upon the scope of the assessment:

- **LC11: Emergency arrangements** – *“the licensee shall make and implement adequate arrangements for dealing with any accident or emergency arising on the site and their effects”*.
Licensees’ accident and emergency arrangements should include adequate provision for dealing with aspects of accidents and emergencies capable of resulting in radioactively contaminated land or groundwater on the site.
- **LC17: Management systems** – *“the licensee shall establish and implement management systems which give due priority to safety”* and *“within its management systems, make and implement adequate quality management arrangements in respect of all matters which may affect safety”*.
Adequate LQM arrangements should be incorporated within the licensee’s management systems.
- **LC18: Radiological protection** – *“the licensee shall make and implement adequate arrangements for the assessment of the average effective dose ... to such class or classes of persons as may be specified in the aforesaid arrangements”*.
Dose assessments should include adequate consideration of effective dose arising from any radioactively contaminated ground and groundwater.
- **LC19: Construction or installation of new plant** – *“the licensee shall make and implement adequate arrangements to control the construction or installation”*.
Arrangements should include reasonably practicable provision for the control of the potential impact to the quality of land and groundwater from construction and installation operations.
- **LC22: Modification or experiment on existing plant** – *“the licensee shall make and implement adequate arrangements to control any modification...carried out on any part of the existing plant or processes which may affect safety.”*
Modifications to the safety case to demonstrate safety of persons from radioactively contaminated land and groundwater should be managed under the licensee’s LC22 arrangements.
- **LC32: Accumulation of radioactive waste** – *“the licensee shall 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 the site at any time and for recording waste so accumulated”*.
Licensees should therefore have adequate arrangements for LQM to minimise the generation of radioactive waste from LQM activities, including the control, monitoring and remediation of radioactively contaminated land or groundwater.

- 9.2 The following LCs may also have relevance, depending upon the particular scope of the assessment:
- **LC6** Documents, records, authorities and certificates
 - **LC7** Incidents on the site
 - **LC12** Duly authorised and other suitably qualified and experienced persons
 - **LC24** Operating instructions
 - **LC26** Control and supervision of operations
 - **LC27** Safety mechanisms, devices and circuits
 - **LC28** Examination, inspection, maintenance and testing
- 9.3 Inspectors should ensure that the LQM arrangements take appropriate account of the licensee's arrangements for compliance with the LCs discussed in paragraphs 9.1 and 9.2, however, it is not expected that LQM would necessarily be included during operational inspection of compliance with those LCs.
- 9.4 The presence of radioactively contaminated land or groundwater on a nuclear licensed site is not normally considered by ONR to be "*storage*" of nuclear matter. Storage would imply that the contamination is subject to some form of engineered containment, and in a form and manner that allows it to be retrieved or inspected within a reasonable timescale. Whereas, in reality the nature of the contamination is generally uncontrolled and without any means of confining the contamination to that location. Hence, ONR considers such contamination to be an accumulation of nuclear matter [1]. Consequently, radioactively contaminated land would not be considered a breach of LC 4(2), which requires licensees to "*ensure that no nuclear matter is stored on the site except in accordance with adequate arrangements made by the licensee for this purpose.*"
- 9.5 Any migration of radioactively contaminated groundwater across a nuclear licensed site boundary in either direction is not considered by ONR as nuclear matter being brought onto the site, as per LC4(1), nor nuclear matter being consigned from the site, as per LC5(1). This does not preclude ONR from taking enforcement action under LC34 in respect of a leak or escape leading to radioactively contaminated land or groundwater.
- 9.6 LC 33 (directed disposal of radioactive waste) is not relevant to the regulation of radioactively contaminated land or groundwater *in situ*, as ONR does not consider it to be radioactive waste *in situ*. Radioactively contaminated land and groundwater may become radioactive waste after it has been removed during characterisation or remediation activities, at which point ONR has the power to direct its disposal under LC33 in accordance with an EPR16 environmental permit or EASR authorisation, if that is appropriate and after discussion with the relevant environmental regulator.

APPENDIX 2: ADDITIONAL INFORMATION ON RELEVANT LEGISLATION

Definitions

- 9.7 It should be noted that on 1 September 2018, the Environmental Authorisations (Scotland) Regulations 2018 (EASR) came into force for radioactive substances activities in Scotland. This replaces the Radioactive Substances Act 1993 (RSA93), associated Exemption Order and the High-Activity Sealed Sources and Orphan Sources Regulations 2005. LC1 will be updated in due course to reflect this change.

Radioactive material

- 9.8 In ONR's LCs "radioactive material" has the meaning:
- *"in England and Wales, disregarding the exception in paragraph 9 (contaminated articles or substances) of Part 2 of Schedule 23 to the Environmental Permitting (England and Wales) Regulations 2016, given in paragraph 3 of that Part of that Schedule to those Regulations;*
 - *in Scotland, disregarding section 1G of the Radioactive Substances Act 1993, given in section 1A of that Act".*
- 9.9 Previously, ONR's definition of radioactive material in its LCs had been identical to that in EPR16 and RSA93. However, in October 2014, LC 1 was amended to modify the definition of "radioactive material". The modified definition removed the exception provided in paragraph 9 of Schedule 23 to EPR16 and section 1G of RSA93 for contaminated articles and substances. The effect of the modification is to clarify that material such as radioactively contaminated land and groundwater arising on a nuclear licensed site is defined in ONR's LCs as radioactive material and can be regulated by ONR as such.

Radioactive waste

- 9.10 In ONR's LCs, "radioactive waste" has the meaning:
- *"in England and Wales, assigned thereto in paragraph 3 of Part 2 of Schedule 23 to the Environmental Permitting (England and Wales) Regulations 2016*
 - *in Scotland, assigned thereto in section 1A of the Radioactive Substances Act 1993".*
- 9.11 Government guidance [24] on radioactive substances legislation states that in the case of land where radioactive contamination is present, the radioactivity is not being kept or used, and neither is it radioactive waste *in situ*. Waste may be generated, if and when the contamination is characterised or remediated, which may become radioactive waste under EPR16 or EASR. Hence, Government guidance considers that radioactively contaminated land becomes radioactive waste only after it has been removed during activities to characterise or remediate the land, and not whilst *in situ*.
- 9.12 The Government guidance is for radioactive substances legislation that does not apply to regulation of radioactively contaminated land on nuclear licensed sites, but ONR follows the Government guidance approach: radioactively contaminated land and groundwater *in situ* are not considered to be radioactive waste; rather, they are considered to be radioactive material until they have been excavated or abstracted, in which case they are liable to become radioactive waste.

Radioactive material and radioactive waste are treated similarly in most of the relevant ONR LCs; in most cases it makes little difference for LC compliance purposes whether radioactively contaminated land and groundwater are considered by licensees as radioactive material or radioactive waste.

Nuclear matter

- 9.13 The SAPs state that “*ONR treats radioactively contaminated land and emplaced radioactive material as accumulations of nuclear matter unless they are, or arise from, authorised disposals*” [1]. In this instance, ‘*authorised disposals*’ refers to disposal of radioactive waste in accordance with a permit (England and Wales) or authorisation (Scotland) granted by the relevant environmental regulator.
- 9.14 In ONR’s LCs, the term “nuclear matter” has the same meaning as that provided in section 26 of NIA65. The definition of “nuclear matter” has some overlap with the definitions of radioactive material and radioactive waste (see Figure 1). That is to say, regardless of whether a substance is radioactive material or radioactive waste, it can also be nuclear matter.
- 9.15 However, the relevant LCs for the regulation of radioactively contaminated land and groundwater do not use the term “nuclear matter”. Therefore, for LC compliance purposes it may be helpful to consider radioactively contaminated land and groundwater as “radioactive material”.

Nuclear site licensing interface with EPR16 and EASR

- 9.16 A permit or authorisation to dispose of radioactive waste on or from a nuclear licensed site is granted by the relevant environmental regulator under EPR16 in England and Wales or, the Environmental Authorisation (Scotland) Regulations 2018 (EASR) in Scotland.
- 9.17 A leak or escape of either radioactive material or radioactive waste is liable to be a breach of LC34 if the licensee is unable to demonstrate adequate control or containment, so far as is reasonably practicable. Such a leak or escape may also be a breach of environmental permit or authorisation.
- 9.18 If a leak or escape of radioactive material or radioactive waste to land or groundwater occurs on a nuclear licensed site ONR shall liaise closely with the relevant environmental regulator to ensure a coordinated regulatory response. Inspectors are referred to the relevant MoU for further guidance [4].

Interface with EU groundwater legislation

- 9.19 The Water Framework Directive 2000 (WFD)¹⁰ and the Groundwater Daughter Directive 2006 (GWDD)¹¹ collectively require EU member states including the UK to ensure that inputs (discharges) of pollutants to groundwater are either prevented or limited, to avoid or control groundwater pollution [10]. Radioactive substances are considered hazardous substances [10] and so their input to groundwater must be prevented or limited. For disposals of radioactive waste this is achieved through conditions in environmental permits and authorisations.

¹⁰ Directive 2000/60/EC establishing a framework for Community action in the field of water policy (the Water Framework Directive – WFD)

¹¹ Directive 2006/118/EC on the protection of groundwater against pollution and deterioration (the Groundwater Daughter Directive – GWDD)

- 9.20 Government guidance states that ONR “*holds the statutory power to regulate the use and storage of radioactive substances by the nuclear site licensee on the site, and thereby to ensure that there is no unintended release of radioactive substances to groundwater*”. Accidental releases to groundwater are regulated by ONR under NIA65 [10]¹² in close liaison with the relevant environmental regulator to ensure a coordinated regulatory response. Inspectors are referred to the relevant MoU for further guidance [5].
- 9.21 The environment agencies are the competent authorities for the purposes of the Groundwater Directive 2006 and as such are responsible for the permitting of any inputs of hazardous substances into groundwater. In England and Wales this is transposed by the Environmental Permitting (England and Wales) Regulations 2016 and in Scotland by the Water Environment (Controlled Activities) (Scotland) Regulations 2011. These regulations are to ensure that the input into groundwater of any hazardous substance or other pollutant (including any radioactive substance) other than in accordance with a permit or an authorisation, is prohibited.

Interface with the contaminated land regimes established under Part IIA of the Environmental Protection Act 1990 (EPA90)

- 9.22 In 1996 Part IIA of EPA90 established a legal framework for dealing with non-radioactively contaminated land with responsibilities allocated to local authorities and the environmental regulators. The Part IIA regime for non-radioactively contaminated land applies on nuclear licensed sites where regulatory responsibilities are held by the relevant environmental regulator.
- 9.23 In 2007 the regime was modified to include radioactively contaminated land. However the Radioactive Contaminated Land regime does not apply in relation to land within a nuclear licensed site or an MoD nuclear site [7, 8, 9] and so regulatory responsibility for radioactively contaminated land and groundwater on or arising from a nuclear licensed site remains with ONR under NIA65.
- 9.24 ONR does not have vires for regulating the environmental impacts of non-radioactively contaminated land on nuclear licensed sites. Therefore, inspectors need to liaise closely with colleagues in the relevant environmental regulator to ensure that licensees with non-radioactively contaminated land experience a coherent approach across the radioactively/non-radioactively contaminated land regulatory interface.

Interface with the statutory nuisance regime under Part III of EPA90

- 9.25 Contaminated land does not constitute a statutory nuisance, and the statutory nuisance regime in Part III of EPA90 is not applicable.

Interfaces with end states

- 9.26 ONR regulates radioactively contaminated land and groundwater under NIA65 and conditions attached to nuclear site licences for the nuclear safety purposes of protecting persons against risks of harm from ionising radiations, as described in paragraph 3.6. Inspectors and assessors need to be aware that licensees may also be working to define or achieve site end states for other related but different purposes:
- A licensee wishing to end its “*period of responsibility*” under NIA65 for all or part of its nuclear licensed site is required to demonstrate to ONR that the site (or

¹² The guidance applies to England and Wales only. In Scotland, SEPA also has vires for regulating inputs of hazardous substances to groundwater under the Water Environment (Controlled Activities) (Scotland) Regulations 2011.

part of the site) meets the 'delicensing criterion' [16]. Separate guidance is available on this topic [17].

- A licensee may be working with the relevant environmental regulator to meet its requirements for the revocation of an EA(S)R authorisation or the surrender of an EPR16 environmental permit.
- A licensee that is also one of the Nuclear Decommissioning Authority (NDA) site licence companies (SLCs) may be working towards achieving an end state for the purposes of revocation of a designating direction given by the Secretary of State to the NDA under the Energy Act 2004, and if the site is in Scotland, the Scottish Ministers also.

UK Statutory Guidance

- 9.27 Statutory guidance has been published for England and Wales in relation to groundwater activities [10], however these are not applicable to Nuclear Licensed Sites in England and Wales. It should be noted that this does not apply to Scotland and SEPA has duties for the protection of groundwater on nuclear licensed sites in Scotland.
- 9.28 The Radioactive Contaminated Land regulations under the Part IIA regime do not apply on nuclear licensed sites, and therefore the guidance associated with these regimes does not apply [7, 8, 9].

APPENDIX 3: IAEA SAFETY STANDARDS

IAEA Safety Standards

- 9.29 The fundamental safety objective set down in the IAEA Fundamental Safety Principles [11] is “**to protect people and the environment from the harmful effects of ionising radiation**” through control of exposure of people and release of radioactive material to the environment, restriction of likelihood of events that could lead to such instances and to mitigate the consequences of such instances if they were to occur.
- 9.30 The fundamental safety principles [11] flow from the fundamental safety objective, and from those principles, the general safety requirements are derived [11]. Both the requirements and the guides which support them are considered as relevant good practice by ONR and they should therefore be consulted, where relevant.
- 9.31 Principle 7 states that “**people and the environment, present and future, must be protected against radiation risks**” whilst Principle 10 states that “**protective actions to reduce existing or unregulated radiation risks must be justified and optimised.**” Together these principles frame the requirement to protect people and the environment through effective LQM, by reducing the risk posed by radioactively contaminated land using a planned approach, which is optimised to the particular situation.

IAEA General Safety Requirements (GSR)

- 9.32 Radioactively contaminated land and groundwater constitute an ‘existing exposure situation’, defined in GSR Part 3 – Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards (BSS) [11]; as areas contaminated “by residual radioactive material deriving from...past activities that were never subject to regulatory control or that were subject to regulatory control but not in accordance with the requirements of these standards.” In respect of public exposure, Requirement 48 stipulates that remedial and protective actions are justified and optimised, whilst Requirement 49 lays out the responsibilities for remediation of areas with residual radioactive material and the actions to be taken by those with whom the responsibility rests. With regards to occupational exposure, Requirement 52 refers to protection for the workforce.
- 9.33 The requirement for a safety assessment to be conducted, and the components to be included in such an assessment, is laid down in GSR Part 4 – Safety Assessment for Facilities and Activities [11], for which more guidance is given in the relevant TAG [2]. ONR expects that duty holders and licensees produce a land quality strategy, which is supported by safety assessments and is integrated with other relevant strategies, such as those for radioactive waste management and decommissioning.
- 9.34 GSR Part 5 – Predisposal Management of Radioactive Waste [11] covers all the steps in the management of radioactive waste from its generation up to disposal, including processing (pre-treatment, treatment and conditioning), storage and transport. The requirements for predisposal management of radioactive waste apply to aspects of land quality and should be taken into consideration appropriately. Further guidance on management of radioactive waste is provided in the relevant TAG (NS-TAST-GD-024).
- 9.35 LQM activities will be integrated with decommissioning activities and as such LQM will contribute to satisfying the requirements under GSR Part 6 – Decommissioning of Facilities [11]. Further guidance on decommissioning is provided in the relevant TAG (NS-TAST-GD-026).

IAEA Guidance – Safety Report Series and Technical Report Series

9.36 The IAEA Safety Reports Series (SRS) and Technical Reports Series (TRS) [11] underpin the IAEA Safety Guides. The safety and technical reports listed here are not formally endorsed by ONR and are included for information purposes only but may provide inspectors with additional background information:

- SRS No. 44 Derivation of Activity Concentration Values for Exclusion, Exemption and Clearance – provides the methodology and parameters that were used to develop the activity concentration values provided in Safety Guide RS-G-1.7.
- SRS No. 64 Programmes and Systems for Source and Environmental Radiation Monitoring – provides detailed practical information on the design and operation of source and environmental monitoring programmes and systems, supporting Safety Guide RS-G-1.8.
- SRS No. 67 Monitoring for Compliance with Exemption and Clearance Levels – provides practical information on the application of the exemption and clearance levels set out in Safety Guide RS-G-1.7, and activities for the demonstration of compliance with these levels.
- SRS No. 72 Monitoring for Compliance with Remediation Criteria for Sites – provides practical advice on the development and implementation of strategies for monitoring for compliance with remediation criteria set out in WS-G-3.1 after completion of remediation activities.
- TRS No. 424 Remediation of Sites with Dispersed Radioactive Contamination – describes remediation techniques that are applicable to dispersed radioactive contamination at a variety of sites, including surface soil, the vadose zone, surface water, sediments and groundwater.
- TRS No. 445 Applicability of Monitored Natural Attenuation at Radioactively Contaminated Sites – discusses the mechanisms effecting natural attenuation, the applicability or otherwise of natural attenuation strategies, uncertainties in parameter estimation, Monitored Natural Attenuation (MNA) assessment methods and related monitoring requirements.
- TRS No. 475 Guidelines for Remediation Strategies to Reduce the Radiological Consequences of Environmental Contamination – provides information on available management options for remediation of land contaminated with radioactive substances, guidelines on the formulation of sustainable remediation strategies and guides readers to other relevant IAEA publications providing detailed information on different aspects of remediation