Public Health England

Protecting and improving the nation's health

PHE-CRCE-56: Review of the UK's Regulatory Framework Governing the Management of Radioactive Liquids

Proposed changes to the current UK framework

Contents

This work was undertaken under the Radiation Assessments Department's Quality Management System, which has been approved by Lloyd's Register to the Quality Management Standard ISO 9001:2015, Approval No: ISO 9001 – 00002655.

Report version 2.1

Introduction

Government* is reviewing the radioactive waste management and environmental protection regulatory framework insofar as it applies to the management of radioactive liquids, particularly those containing very low levels of radionuclides. The purpose of the review is to ensure that the regulatory framework is: fit for purpose; reflects international standards, requirements and best practice; is underpinned by coherent policy; protects the public and environment; and does not place unnecessary burden on business or regulators. It is acknowledged that the occupational protection framework (for example, Ionising Radiations Regulations 2017 (UK Parliament, 2017)) and nuclear safety framework (for example, Nuclear Installations Act 1965 (UK Parliament, 1965)) may also impact on the management of radioactive liquids, but a review of these regulatory frameworks was outside the scope of this report.

This work was instigated by the strong support for a review of the policy and scientific issues associated with the regulation of liquids containing low levels of radioactivity given by respondents to the 2017 consultation undertaken by the Department for Business, Energy and Industrial Strategy (BEIS) on the transposition of the public exposures and justification aspects of the 2013 Euratom Basic Safety Standards Directive (BEIS et al, 2017).

Throughout this document the term 'radioactive substances regulations' (RSR) is used to refer to the principal UK radioactive waste management legislation, that is, the Radioactive Substances Act 1993 (RSA93) (Northern Ireland and offshore Scotland) (UK Parliament, 1993), the Environmental Permitting (England and Wales) Regulations (EPR16) 2016 (UK Parliament, 2016) and the Environmental Authorisations (Scotland) Regulations 2018 (EASR18) (Scottish Parliament, 2018). Where RSR is referred to, it can be assumed that the text applies to all these legislative instruments. Specific legislation is referred to where there are different provisions or arrangements that need highlighting. In this report, the term 'permitting' has been used throughout to apply to licenses issued under the RSR, that is, permits under EPR16, 'registrations' and 'authorisations' under RSA93 and 'registrations' and 'permits' under EASR18.

To give some background, the legislative developments in the UK are briefly discussed. The Radioactive Substances Act 1960 (RSA60) was the first piece of legislation specifically designed to regulate the management of radioactive waste. Subsequent amendments to RSA60 were later consolidated into the Radioactive Substances Act

* The term 'government' is used in this document to mean the UK government and the devolved administrations. Whilst radioactive waste management and environmental protection is a devolved matter, government is working together to undertake a joint review to maintain consistency across the UK where possible. It should be noted that although the UK government retains ultimate responsibility for compliance with international conventions, the devolved administrations are responsible for the detailed implementation and compliance in their respective countries, insofar as these relate to devolved matters.

1993 (RSA93). In April 2010, the Environmental Permitting (England and Wales) Regulations 2010 (EPR2010) came into force which incorporated and replaced RSA93. EPR10 modernised the legislative framework governing radioactive waste by introducing a common permitting framework for all pollution regulation regimes in England and Wales. Significantly for this review, this legislation also introduced new exemption provisions for aqueous liquids and the concept of relevant liquids (these are discussed further in the Section on the Application of key parts of the UK legislation framework). At this time, Scotland and Northern Ireland chose not to adopt this framework and retained RSA93 unchanged. To further modernise this framework in the UK, the scope of the legislation and its exemption framework were updated through amendments to EPR10 in England and Wales, and RSA93 and Exemption Orders in Scotland and Northern Ireland (Ashworth and Chandler, 2014). As discussed above, in 2018 the Scottish Parliament introduced EASR18 which aims ultimately to provide an integrated authorisation framework relating to water, waste management, radioactive substances and pollution prevention and control. Currently it only applies to radioactive substances activities.

Since it is over 8 years since the revised exemption regime came into effect, which introduced significant new provisions related to liquids, it is an appropriate time to review whether the regime is working as intended.

Documents outlining the UK regulatory framework for the management of radioactive liquids, stakeholder concerns with the current regime and proposals for potential improvements were circulated to interested parties with the intention of eliciting further comments where areas of concern have not already been identified.

Comments were received from the following sources

Responses to the BEIS consultation on Revised Requirements for Radiological Protection: Regulation of Public Exposures (BEIS et al, 2018b) and in particular those given to the specific question relating to the regulatory regime for liquid waste. There were 36 responses to the consultation on this topic from both individuals and from organisations. One group which provided detailed comments was the 'Clearance and Exemption Working Group' (CEWG) which brings together a wide range of representatives of nuclear operators across the UK.

Issues that the Regulators have identified through the course of their work for consideration.

Feedback elicited as part of this work from members of the Society for Radiological Protection, Oil and Gas UK, the Small Users Liaison Group, UK Onshore Oil and Gas, the Clearance and Exemption Working Group, the Environment Agencies Requirements Working Group, the Scottish Non-nuclear Industries Liaison Group, the Nuclear Industry

Group for Land Quality and the Nuclear Decommissioning Authority (NDA). Responses were received from Oil and Gas UK and UK Onshore Oil and Gas as well as from BAE Systems, MoD, Dstl, NDA, Urenco Nuclear Stewardship and Urenco UK Ltd and individual radioactive waste advisors (RWAs).

This report summarises comments received from interested parties, identifies the key issues and makes proposals for change. BEIS requested that any specific changes to the current regulatory framework should result in improvements that can be measured in terms of time, effort or cost savings and where possible this has been detailed. The report reflects the views of the project team and does not necessarily reflect those of PHE.

As part of this work the current UK regulatory approach and its international obligations and standards were reviewed and summarised with the intention of confirming that all the interested parties have the same understanding. This review is described in detail in Appendix A. The management of radioactive liquids in other countries was also reviewed to help identify potential improvements to the UK framework through the use of a questionnaire. This work is detailed in Appendices B to D.

International guidance and standards and UK policy documents

There is a significant amount of international legislation, guidance, standards and recommendations related to radiation protection and radioactive waste management. This international framework has been developed in close collaboration between international and national authorities. It therefore influences national legislation and in the case of legally binding instruments requires that certain measures be implemented and provides constraints within which the national framework must work.

International standards on the regulation of discharges to the environment are based on the fundamental principles of justification, optimisation and dose limitation set out in the International Commission on Radiological Protection (ICRP) recommendations (ICRP, 2007) and included in the International Atomic Energy Agency (IAEA) and Euratom Basic Safety Standards and UK legislation. However, most of the requirements in the international regulations relate to all types of waste and are not specific to liquid discharges. In particular, there is little international guidance on the application of the clearance or exemption concepts to liquids (as distinct to authorised discharges of liquids) and accordingly that there is no consistent approach to how these concepts are applied by the international community (see Appendix B for more details). It is also noted that this gap is likely to be addressed in the proposed IAEA safety standards 'Application of the Concept of Exemption' (working document number DS499) and 'Application of the

Concept of Clearance' (working document number DS500) which will replace IAEA RS-G-1.7 (IAEA, 2004).

An important element of the international framework is the concept of the graded approach which establishes that all aspects of the regulatory framework should be applied proportionately. The concepts of clearance and exemption are an important part of the graded approach and there are internationally agreed criteria which can be used as the basis to make clearance and exemption decisions. To date there has been limited work on the application of clearance and exemption to liquid wastes on a generic level as they are normally regulated as discharges on a site by site basis.

Specific constraints are placed on liquid discharges, in particular the OSPAR Convention (OSPAR Commission, 1992) and legislation relating to discharges to surface water and groundwater activities. To fulfil the provisions of the OSPAR Convention, the UK Government has produced the UK Strategy for Radioactive Discharges (DECC et al, 2009) which lays out policy on radioactive discharges. Although the UK Strategy does not set individual site limits for radioactive discharges, it describes the intended effects and outcomes at the sectoral level and therefore would need to be considered in any future recommendations relating to radioactive liquid discharges. More detailed discussion on these documents is provided in Appendix A.

Review of arrangements in other countries

As part of this work, arrangements for handling liquid radioactive wastes in other countries were reviewed. Appendix B describes how the information was gathered and outlines the key findings and compares them with the current regulatory regime in the UK.

A questionnaire was devised to elicit information on regulatory regimes for liquid radioactive waste. The 5 questions included in the questionnaire covered:

- whether there are exclusion, clearance or exemption provisions for liquid waste and the source of any values and what conditions, if any, are imposed on disposal rou
- whether specific industry sectors are exempted
- how non-exempt discharges are regulated
- whether radioactive liquids are classified according to properties other than their radioactive content
- wny requirements or guidance on when measurement should take place and any prescribed measurement methods

Questionnaires were sent to representatives either by direct contact or through networks such as the IAEA's Waste Safety Standards Committee (WASSC), the European NORM

Association, the OSPAR Radioactive Substances Committee and the European Radioprotection Authority Network. Responses were received from representatives of 21 countries, 15 of which were European Union Member States.

The survey results show that there is no consistent use of clearance and exemption values for liquids in the countries surveyed; furthermore, there is no consistent use of the terms clearance and exemption and they are often used interchangeably. This led to some difficulty in comparing practices in the countries that took part in the survey with those in the UK. The survey showed that some countries do not specify values for either clearing or exempting low activity liquids from regulatory control and that countries which have clearance and/or exemption values for artificial radionuclides in liquids generally take them from IAEA Basic Safety Standards (BSS) or Euratom Basic Safety Standards Directive (BSSD) (CEU, 2014; IAEA, 2014). A few countries have developed specific clearance levels; for example, Sweden, Germany and the Netherlands have developed clearance levels of liquids being disposed of by incineration, while Austria has created a set of unconditional clearance levels for liquids provided they are less than 100 m^3 per year and the Netherlands has screening levels for the disposal of Naturally Occurring Radioactive Materials (NORM) discharges (Bq y^{-1}) to water. By contrast, the UK has calculated specific exemption values for aqueous radioactive effluents. These findings are discussed in more detail in Appendix B.

Application of key parts of the UK legislation framework

To help better understand how the proposals made in this report fit into the current framework, this section gives a summary of the application of the key parts of the UK legislative framework that are relevant to the management of radioactive liquids. This topic is covered in more detail in Appendix A.

Table 1 compares the terminology used to refer to authorisation and exemption in the IAEA BSS and Euratom BSSD to the different UK regulatory regimes. It should be noted that EPR16 and RSA93 do not have notification as a separate process, but that notification is an inherent part of the permitting process.

Table 1. Comparison of terminology used to refer to authorisation and exemption

This table gives the terms used by the International Atomic Energy Agency and Euratom to refer to the exemption of radioactive materials and waste from regulations and its authorisation of use or disposal. Euratom is a treaty which sets standards for radiation protection in European Member states. The table relates those terms to the wording used in UK Radioactive Substances Regulations.

IAEA/Euratom		**EPR16**	**EASR18**	**RSA93**
Exclusion				
Exemption (from all requirements)		Out of scope	Out of scope	Out of scope
Conditional exemption (i.e. exemption from some requirements)		Exemption	General Binding Rule (GBR)	Exemption
Notification			Notification	
Authorisation	Registration	Standard rules permit	Registration	
	License	Bespoke permit	Permit	Registration/Authorisation

As discussed previously, the UK radioactive substances regulations use a graded or proportionate approach depending on the risk involved. In England and Wales (EPR16) and Northern Ireland (RSA93) there are 3 tiers of RSR:

- not within the scope of the legislation
- exempt from the requirement to have a permit provided conditions are met
- an environmental permit is required; under EPR16 this can be a Standard Rules permit for simpler operations or a bespoke permit

In Scotland (EASR18) radioactive material and radioactive waste may not fall within the scope of the legislation; however, if the material or waste does fall within the legislation there are 4 types of authorisation.

1. **General binding rules (GBRs):**
   Aset of mandatory rules that cover specific low risk activities based on exemptions given in RSA93.

2. **Notification**:
   For low risk activities where the Scottish Environment Protection Agency (SEPA) does not need to grant or refuse an authorisation but wants to know that the activity is being carried out, for example keeping and use of Category 5 sources that cannot be disposed of to the dustbin.
3. **Registration**:
   For activities where a simple assessment or screening is sufficient for SEPA to determine whether to allow the proposed activity to be carried out.
4. **Permitting:**
   For higher risk and/or non-standard activities which require SEPA to carry out a more rigorous assessment before they can grant or refuse a permit.

To understand some of the proposals it is important to define the term relevant liquid. The legislation defines a relevant liquid as a non-aqueous liquid, or an aqueous liquid with specified hazardous properties. In the legislation if a liquid is not a relevant liquid it is referred to as 'any other liquid'. Relevant liquid is an important definition as all other liquids containing either artificial radionuclides or NORM used for their radioactive, fertile or fissile properties (except for relevant liquids) are considered to be radioactive waste for the purposes of this legislation, irrespective of their activity concentration.

Liquid wastes are not classed as radioactive and are out of the scope of RSR if it satisfies any of the following conditions

The activity concentration of any natural radionuclide present in the liquid is lower than thresholds relevant for NORM industrial activities as defined in the legislation. Different values are provided for relevant liquids and aqueous liquids.

The activity concentration of any natural radionuclide in a relevant liquid that is processed or intended to be processed for its radioactive, fertile and fissile properties is below a specified threshold.

The activity concentration of any artificial radionuclide in any relevant liquid is below a specified threshold.

All radionuclides in the liquid waste are of short half-life (<100 seconds).

Its radioactivity is solely attributable to artificial background radiation[†].

It has been previously lawfully disposed of as a waste, or is contaminated as a result of such a disposal, unless subject to a process which causes an increase in radiation exposure.

[†] Artificial radionuclides which are present throughout the environment, for example, as a result of atmospheric weapons tests and accidents, are not considered to be radioactive material or radioactive waste.

It has arisen from the remediation of land which was contaminated by ^{226}Ra prior to 13 May 2000 and the activity concentrations of ^{226}Ra and its progeny are less than 1 Bq g^{-1} for relevant liquids or 1 Bq l^{-1} for any other liquid.

Consequently, all aqueous liquid wastes containing either artificial radionuclides or NORM used for their radioactive, fertile or fissile properties (except relevant liquids) are considered to be radioactive waste for the purposes of this legislation, irrespective of their activity concentrations unless they meet one of exclusion criteria.

If the liquid waste is in the scope of the legislation, it may be exempted from the requirement to have a permit. In England, Wales and Northern Ireland the legislation makes a distinction between activities involving radioactive materials and those involving radioactive waste; accordingly, there are 3 different exemptions applicable to the keeping, use and accumulation of liquids and 4 that relate to the discharge of liquid wastes. The latter are given in Table 2.

Table 2. Exemptions that are applicable to the disposal of radioactive waste in the form of a liquid

This table provides information on the exemptions from UK legislation of the disposal of liquid radioactive waste.There are 4 exemptions given which are limited by either maximum concentration of the radioactive liquid waste and/or the maximum quantity of radioactive liquid waste that can be disposed in a certain time period. Exemption is where radioactive material or waste is exempted from some aspects of legislation.

Radioactive waste	Maximum concentration of radionuclides	Maximum quantity of waste to be disposed of in the period stated
Disposal of aqueous radioactive waste up to 100 Bq ml^{-1} to sewer – this applies to waste as it is produced, ie prior to any dilution	Up to 100 Bq ml^{-1}	Maximum annual disposal activity of: 1 x 10^8 Bq for the sum of ^{3}H, ^{11}C, ^{14}C, ^{18}F, ^{32}P, ^{33}P, ^{35}S, ^{45}Ca, ^{51}Cr, ^{55}Fe, ^{67}Ga, ^{89}Sr, ^{90}Y, ^{99m}Tc, ^{111}In, ^{123}I, ^{125}I, ^{131}I, ^{153}Sm and ^{201}Tl; and 1 x 10^6 Bq for the sum of all other radionuclides
Aqueous liquid radioactive waste which is or contains uranium or thorium or prepared compounds of uranium or thorium in which the ^{235}U concentration is no more than 0.72% in the case of uranium, and the thorium is in its isotopic proportions found in nature - only	No limit	0.5 kg of uranium or thorium per year

disposal routes to sewers are exempt. It can include entrained solids or suspensions, provided that good practice has been used to attempt to remove them before disposal		
Radioactive waste in aqueous solution being human excreta	No limit	1×10^{10} Bq y^{-1} of ^{99m}Tc and 5×10^{9} Bq y^{-1} for the sum of all other radionuclides
Disposal of low concentration aqueous radioactive waste to sewer, river or sea*	Maximum concentration of each radionuclide set out in column 2 of Table 3.4 of the guidance (BEIS et al, 2018a).	Maximum annual activity of each radionuclide disposed of to qualify for exemption when the disposal route is to a sewer and to a watercourse other than a sewer are given in column 3 and column 4 of Table 3.4 respectively

*This exemption has not been transposed into the most recent Scottish legislation EASR18

As far as the disposal of aqueous radioactive waste up to 100 Bq ml^{-1} to sewer and low concentration aqueous radioactive waste to sewer, river or sea is concerned, the conditional exemption does not apply if the premises from which the waste disposal takes place are permitted for other aqueous waste streams. This is because most aqueous disposals from any one site are, to some extent, inter-related, and therefore these discharges need to be optimised across the site as a whole. However, where a permit is in place, the holder can apply for those waste streams which would otherwise be exempt to be included in the existing permit. These wastes are then subject to the conditions set out in the permit.

In Scotland, the legislation no longer makes the distinction between activities involving radioactive material and activities involving radioactive waste. All authorisations (GBRs, registrations, permits) contain all the conditions/allowed disposals in that authorisation. The GBRs are a set of mandatory rules that cover specific low risk activities. The activities relevant to radioactive liquids and their associated GBRs are similar to those for the rest of the UK and are given below. One of the main differences is that the exemption of the disposal of low concentration aqueous radioactive waste to sewer, river or sea included in the legislation in England, Wales and Northern Ireland (given in last row of Table 2) has not been replicated in EASR18, the reasoning being that this exemption is rarely (if ever) used.

If the radioactive liquid waste does not meet any of the exclusion or exemption criteria then the discharge requires a permit (England and Wales), a registration or permit (Scotland) or an authorisation (Northern Ireland).

The RSR legislation defines a relevant liquid as:

1. A non-aqueous liquid (for example mercury and oil), or
2. A liquid classified (or would be so classified in the absence of its radioactivity) under Council Regulation No. 1272/2008 (EP and CEU, 2008) as having any of the following hazard classes and hazard categories (as defined in that Regulation):
   (i) acute toxicity: categories 1, 2 or 3
   (ii) skin corrosion/irritation: category 1 corrosive, subcategories: 1A, 1B or 1C or
   (iii) hazardous to the aquatic environment: acute category 1 or chronic categories 1 or 2.

Key comments received and issues identified

This section discusses the key comments and issues raised during the review.

Nuclear sector

The nuclear sector submitted many comments to the BEIS consultation on 'Revised Requirements for Radiological Protection: Regulation of Public Exposures' (BEIS et al, 2018b) and in particular to the specific question on the regulatory regime for liquid waste. To elicit a more detailed understanding of the problems related to the management of radioactive liquids encountered by the nuclear sector, this review engaged with the Clearance and Exemption Working Group (a nuclear industry group which aims to share good practice across the nuclear sector) and specific nuclear sites. This section provides a summary of how liquids containing low levels of radioactivity originating from nuclear sites are currently managed and the proposals made by the nuclear industry to resolve the issues.

The nuclear sector generates various liquids containing low levels of radioactivity that need to be appropriately managed. These include:

- minor waste streams from operating reactors, in particular those containing tritium due to its mobility
- liquids that become contaminated as a result of coming into contact with contaminated surfaces or moving through contaminated soils, for example, surface water run-off, site drainage, groundwater
- waste water resulting from hand washing, barrier washing and laundry of protective clothing
- oils and other chemicals that have been used in an area where radionuclides were present

The nuclear industry contends that in many cases the management of these liquids is not proportionate to the risk that they pose in terms of cost and staff effort carrying out activities such as monitoring. In addition, the environmental implications of some treatment and disposal processes, such as additional transport costs, could be considered to outweigh any radiation protection benefits.

Four examples of the issues affecting the management of liquid wastes are given below.

Example 1
As part of the construction of a new nuclear build site, dewatering has been undertaken to lower the groundwater levels and allow excavation. Low concentrations of tritium have been detected in the groundwater of the neighbouring nuclear power station site and therefore, during dewatering, this contamination may migrate into the groundwater extracted in the new nuclear build site. The tritium concentrations are below the limit of detection, but because the groundwater cannot be guaranteed not to contain tritium, it is being managed as radioactive waste and discharged out to sea via the permitted discharge point. The total cost associated with the management of this liquid, including its radiochemical analysis, are several million pounds.

Example 2
Construction and decommissioning work on a nuclear licensed site means that the disposal of surface water run-off is required. Surface water run-off during these works may contain trace amounts of radioactivity due to low level contamination of the soil as well as containing heavy metals. Currently limited amounts (around 1000 m^3) of liquids have been sent for incineration at a cost of around £1000 per 1 m^3 of water, but in the future, larger volumes may require disposal.

Example 3
Some sites generate liquid wastes that contain other hazardous materials that prevent its discharge to the water environment without treatment. Analysis of this waste has also indicated low levels of tritium meaning that it is required to be sent to an RSR permitted treatment facility, for example, for incineration, despite the tritium posing negligible risk.

Example 4
At a particular site, liquids with low concentrations of tritium are passed through an effluent treatment plant because that it is the only permitted option. Passing large volumes of minimally contaminated liquids through ion exchange columns reduces the efficacy of the treatment procedure, with no expectation of reducing the tritium content. Reasons given for not applying for a variation in the permit were that the sampling infrastructure was already in place at the effluent treatment plant and that there were concerns about asking for any variation to the permit from a public perception point of view.

The nuclear industry highlighted several areas of the regulatory framework that they consider are contributing to disproportionate management decisions for liquids containing low levels of radioactivity and made proposals for improvement.

The specific proposals from the nuclear industry were:

1 Expand the definition of relevant liquids to include liquids which either by disposal route or chemical content demonstrably do not affect or impact the drinking water pathway since they are essentially treated as solid waste.
2 Introduce a mechanism by which the Competent Authority can agree to out of scope criteria if general clearance criteria as defined within Euratom BSSD Annex VII are met.
3 Include the aqueous waste conditional exemption within RSR permits/authorisations.
4 Amend conditional exemption criteria so that unlimited volumes of aqueous waste can be discharged to coastal waters.
5 Calculate specific out of scope activity concentrations for liquids for the radionuclides of concern, for example, ^{3}H.
6 Add additional routes to individual permits so that low activity liquids can be disposed of to a non-RSR permit holder (for example, local incinerator).

It is noted that there are significant differences between the on-site management of liquids with low levels of radioactivity at the permitted site where they are generated and the off-site management of liquids at a different site, for example, at an incinerator or at a water treatment facility. In the case of on-site management at nuclear facilities, the site always has a permit, therefore it should be possible to accommodate the proportionate management of the liquids in the permit if the regulators used a goal setting rather than a prescriptive approach. However, it would appear that proportionate management of liquids has not always been achieved.

For off-site management, the lack of treatment facilities holding RSR permits constrains the possible liquid management options. It is the view of the authors that an off-site facility should be able to manage moderate quantities of radioactive liquid waste without the need for a permit, for example, under an exemption. This is further discussed in the Section on Key issues identified.

Offshore oil and gas sector

The oil and gas industry generates the most significant quantities of liquid NORM wastes. Most of this waste stream arises from offshore activities and offshore installations are permitted to discharge the waste waters produced directly back to the sea or, where suitable facilities exist, to re-inject back into the seabed or the hydrocarbon bearing formation. However, some liquid waste streams, such as oily slops from floating production storage and off-loading vessels (FPSOs), contain

concentrations of oil that prevent disposal at sea and must be sent to shore for treatment. Respondents to the request for data for the UK NORM strategy (DECC et al, 2014) indicated that onshore disposal of water produced from oil and gas installations was becoming a problem because of a lack of permitted onshore wastewater treatment facilities. The UK NORM strategy also noted that "there is some evidence that onshore treatment and disposal of produced water is becoming an issue for some industries (particularly oil and gas production) who generate NORM waste which cannot be classed as exempt radioactive waste". SEPA have commented that since the UK NORM strategy has been published, several more facilities have been permitted to accept radioactive liquid wastes but 2 of these are only permitted to accept the waste for transfer to a waste permitted person. Respondents commented that due to the limited availability of permitted UK sites able to process liquid wastes and the fact that other European countries have not classified such liquids as radioactive waste, there is greater availability of appropriate disposal routes outside the UK. However, to utilise such routes, a respondent has commented that general waste export regulations formalities need to be navigated and permit changes are often required. They commented that authorities in other countries such as the Netherlands considered oil levels in slops too low to be classed as a recovery operation so rather are defined as a disposal operation. However, this means that since it is considered a disposal operation, the export of slops is prohibited by the UK Waste Plan (Defra et al, 2012). An exception to the UK waste plan by Defra would be required to allow treatment of this type of waste overseas.

Further discussions identified that there are 3 current disposal routes for oily slops: incineration, which is expensive; treatment at a RSR permitted site, of which there are a limited number in the UK, and transfer to other countries such as the Netherlands for treatment following any required changes in UK permits. In the Netherlands there are several companies, for example, Nature International Slop Disposal, which processes offshore and maritime waste in the Port of Rotterdam. The slops can be offloaded to a barge and taken for treatment to remove excess oil while the remaining liquid is discharged to sea. The advantage of the oil treatment process is that the biocide content of the slops is not expected to adversely affect the oil treatment process to the same degree as the biological systems utilised at sewage treatment facilities. A respondent also argued that the final disposal to sea will have less of a radiological impact than the same discharge being made to a river and that the risk of a spill during barge transfers is also significantly lower than that posed by onshore operations involving multiple road tankers. The costs of oil treatment in the Netherlands were reported to be half those of the sewage treatment and disposal options. As discussed in Appendix C, under the Dutch Decree on Basic Safety Standards for Radiation Protection (ANVS, 2018) discharge screening levels were established for radionuclides of natural origin including liquids. The discharge screening levels are based on a dose criterion of 10 µSv y^{-1} for the individual dose to a member of the public and 1 manSv y^{-1} for the population. Discharges are only subject to licensing if the discharged radioactivity exceeds the

discharge screening levels. In discussions with a respondent they reported that the concentration levels in the slops are not likely to exceed these limits.

Respondents from the oil and gas industry also suggested that the definition of relevant liquid could be usefully revised to include produced water from offshore oil and gas installations containing hydrocarbons and entrained solid material. The presence of hydrocarbons and entrained solid material means that the waste cannot be disposed to sewers, river or the sea without being treated. Respondents commented that other legislation regulates discharges from oil and gas facilities and they believe that there is over-regulation in this area given that assessments supporting the permits show that the radiation doses to those likely to be the most highly exposed are estimated to be of the order of a few µSv y^{-1}.

The difference between the regulatory regime in England and Scotland was commented upon. Operators making discharges of NORM to sea in England require a bespoke permit, which is subject to higher fees than the standard rules permit and requires a radiological impact assessment. SEPA informed PHE that in Scotland there are plans to simplify the authorisation process for offshore oil and gas installations by removing the need to submit a radiological assessment and to issue authorisations that only contain standard conditions.

An additional comment was about differences in the data reported to the Environmental and Emissions Monitoring System (EEMS). EEMS is the environmental database of the offshore UK oil and gas industry and is run and administered by BEIS' Offshore Petroleum Regulator for Environment and Decommissioning and is the basis for reports to the OSPAR Commission. There are differences in reporting approaches between England and Scotland. When reporting discharges to Scottish Water to EEMS for submission to the OSPAR Convention, liquid discharges are estimated by multiplying the quarterly produced water sample measured by the mass of produced water discharged in that quarter. By contrast, in England all solids must be ground down to a particle size of less than 1 mm. The resulting discharge is considered by EA to be a liquid albeit one containing solids.

Non-nuclear sector

There was a request from the non-nuclear sector to expand the table of radioactive liquid wastes (Table 6 Schedule 3 (EPR16) or Table 3 Schedule 3 of the (The Radioactive Substances Exemption (Northern Ireland) Order (DOENI, 2011) or GBR 8 (EASR18)) to include fluid generated during the embalming of people who have undergone medical treatment using radioactive materials.

It was also commented that the activity limit for exemption from permitting of aqueous liquid radioactive waste that contains uranium or thorium or prepared compounds of

uranium or thorium was too high. Currently the exemption states that 0.5 kg of uranium or thorium per year can be disposed of as aqueous liquid waste. The assessment which underlies this exemption was checked with a more recent sewer model and the doses were still found to be trivial, that is, of the order of a few µSv y^{-1}.

Finally, there was a suggestion that the limits for relevant liquids be amended to those used for the exemption of solid very low level waste (VLLW) and that the list of specified radionuclides which can be disposed of under the conditional exemption of 100 Bq ml^{-1} to sewer be reviewed.

Key issues identified

From the comments received during this review 3 main issues related to the management of radioactive liquids were identified. These issues are discussed below with potential options to address them.

The first issue is that all aqueous liquid wastes containing either artificial radionuclides or NORM used for their radioactive, fertile or fissile properties (except for relevant liquids) are considered to be radioactive waste for the purposes of this legislation, irrespective of activity concentration. At regulated facilities there is not an agreed method or approach regarding the classification of liquids which may contain or are suspected of containing low levels of radionuclides. Feedback from operators of nuclear licensed sites indicates that where a liquid is believed to contain radioactivity it is classed as radioactive waste, irrespective of any measurement.

There are several potential options to address this issue:

1. Out of scope levels could be introduced for liquids based on a demonstration that doses to members of the public would be less than 10 µSv y^{-1} (the dose internationally considered to represent a trivial dose), measurability or a combination of both (see the Section on the Calculation of out of scope values for aqueous liquids for artificial radionuclides for more discussion).
2. It could be explicitly stated in legislation and guidance that liquids are not classed as radioactive if radionuclides are not positively measured, providing Best Available Techniques (BAT) or Best Practicable Means (BPM) are used for monitoring discharges.
3. Where a liquid is believed to contain radioactivity, it could be classed as a radioactive waste.

For aqueous liquids that have been classified as radioactive material or waste, there is no agreed method for clearance from regulatory control other than by disposal through an authorised route. This can result in management arrangements (for example, monitoring the waste, reporting the discharges, reporting any spills and ensuring that

staff are trained in dealing with radioactive waste) that are disproportionate to the hazard that they pose.

There are several potential options to address this issue:

4. As suggested in point 1, out of scope levels for could be introduced liquids (see the Section on the Calculation of out of scope values for aqueous liquids for artificial radionuclides for more discussion).
5. More flexibility could be provided on options available for the management of liquids containing low levels of radioactivity (or limited quantities of liquids), for example, use of exemption or equivalent in permits could be allowed (see the Section on the Inclusion of disposal of aqueous radioactive waste exemptions onto RSR permits for more discussion).

Finally, some radioactive liquids have non-radioactive properties which mean that that they cannot be treated and discharged on the site where they were generated. The only option currently available is to transfer the liquid wastes to a permitted facility for treatment. There are a limited number of such permitted facilities, most of which are incinerators. In many cases incineration of such liquids is not the best management option.

6. As suggested in point 1, out of scope levels could be introduced for liquids. This option would only solve the issue for those liquids in which the activity concentrations of radionuclides are below the out of scope concentration levels. The liquids would still need to be treated for their non-radioactive properties but the number of sites able to accept the waste and the treatment options available would be increased.
7. Limited quantities of liquid radioactive wastes could be allowed to be managed under exemption provisions. For example, the exemption values for moderate quantities given in the Euratom BSSD could be used for receipt, keeping, and accumulation and new exemption values could be provided for disposal of liquids based on total activity per year. In addition, permitted facilities could be allowed to send liquid wastes to exempt facilities as is currently the case for solid low-level waste.

Discussion on proposed changes

This section discusses possible changes to the current framework and gives the authors' views on these issues. The proposed changes were developed with input from environment agencies who formed part of the project review but should not be taken to mean that the environment agencies have officially agreed to them.

Revision of the definition of relevant liquids

As described in the Section on the Nuclear sector, requests were made to revise the definition of relevant liquids either to include additional descriptions of liquids (for example, grey water, machinery coolants and produced water) or to refer to disposal routes not having a demonstrable effect or impact on the drinking water pathway.

The report HPA-CRCE-006 (Mobbs, 2010) investigated whether the clearance levels (CLs) derived for solids in the EC report RP122 part 1 (EC, 2000) could be used for the exclusion or exemption of non-aqueous liquids from the provisions of the regulatory regime. These values were used for the clearance levels given in the 1996 Euratom BSSD (CEU, 1996). The non-aqueous liquids considered were scintillation liquids, oils and mercury. The report provided 4 options for calculating CLs or, as fifth option, suggested that a detailed dose assessment should be undertaken to derive levels specifically for non-aqueous liquids that correspond to the dose criterion of 10 µSv y^{-1}. It went on to state that the choice of the optimum approach depends on the balance of many factors, including estimates of the quantities of non-aqueous liquids that would be involved, the associated health impact and the results of a regulatory impact assessment.

During the update of UK legislation in 2010, the Department of Energy and Climate Change (DECC) project team decided that non-aqueous liquids containing levels of radioactivity below clearance levels derived for solids in RP122 part 1 (EC, 2000) would not be considered as radioactive for the purposes of the regulatory regime, and no controls would be placed on the quantities that can be disposed of. Additionally, the DECC project team decided that it was appropriate to extend the application of these CLs to aqueous liquids with specified hazardous properties (for example, strong acids such as hydrofluoric acid) that cannot be discharged directly to the water environment and therefore are unlikely to affect the drinking water pathway due to the treatment required to address the non-radioactive properties prior to discharge.

The BEIS guidance document 'Scope of and Exemptions from The Radioactive Substances Legislation in England, Wales and Northern Ireland' (BEIS et al, 2018a) discusses the definition of relevant liquid and states that: "the purpose of this definition is to allow such liquids to be treated, for the purposes of this legislation, as a solid because the exposure pathways are the same as those for solids." However, this is not strictly correct because as stated in the guidance on the interpretation of relevant liquids (NIEA et al, 2013) "relevant liquids are often treated to remove the hazardous component to enable clean water to be discharged to the water environment. Any operator carrying out such an operation should be aware that such treatment may generate radioactive waste, for example, solid residues or aqueous waste, the disposal of which may require permitting." This review has not uncovered any such treatment operations, but this is an important consideration in relation to the proposed additions of the definition.

The proposed new categories of relevant liquid are: grey water, machine coolant and produced water. Several suggestions of definitions of the term grey water were supplied in response to the BEIS consultation. However, subsequent investigations did not find any formal or widely accepted definition in the documents that could be accessed. Some of the suggested documents were not available due to their security classification but on further discussion it was agreed that they were unlikely to be suitable for use in legislation. Additionally, in all 3 cases the aqueous liquids in question, unlike non-aqueous liquids, are likely to be discharged to water following treatment. The assessments in HPA-CRCE-006 do not extend to this process; therefore, we do not recommend that the definition of relevant liquid be expanded to include these terms.

An alternative proposal was to change the definition of relevant liquids to refer to the impact on the drinking water pathway rather than focussing on the chemical characteristics of the liquids. In our view this would be a significant change in the regulatory regime with decisions effectively being made on a case by case basis. This would require effort from both the operator in developing proposed out of scope values and the regulator in assessing the validity of those proposals. The regulators would also need to ensure consistency of approach across different sites. If such decisions were required, the decision-making framework would be best managed through a permitting mechanism rather than the out of scope provision and for that reason it is not recommended that this proposal is taken forward.

In the authors' view, the definition of relevant liquids should not be expanded to cover a wider range of liquids given the basis of the derivation of out of scope values. Conversely, there is an argument that the definition should be narrowed to only cover non-aqueous liquids since a waste treatment operator may remove the hazardous component of the liquid and then discharge to the water environment. The operator should be aware that such treatment may generate radioactive waste which may require permitting. However, as there are no reported problems we do not recommend any change at this time.If out of scope values for aqueous liquids are developed it would be prudent to revisit the definition of relevant liquids.

In the meantime, the authors recommend that the BEIS guidance document is updated to reflect more accurately the rationale behind the definition of relevant liquids and to incorporate the relevant provision from the now withdrawn guidance produced by the environment agencies on relevant liquids.

Recommendation 1

BEIS should consider updating its guidance on exemption with any additional information provided by the environment agencies from their now withdrawn exemption guidance, particularly relating to the guidance on the definition of relevant liquids. The

BEIS guidance should also more accurately reflect the rationale behind the development of values related to relevant liquids.

Calculation of out of scope values for aqueous liquids for artificial radionuclides

Currently there are no out of scope values for aqueous liquids containing artificial radionuclides or NORM used for their radioactive, fertile or fissile properties. The current exemption values for low concentration aqueous radioactive waste are based on a simplified methodology detailed in report HPA-CRCE-005 (Ewers and Mobbs, 2010). Because of time constraints during the development of the legislation 10 years ago, this methodology was based on 3 exposure pathways for discharges to freshwater alone and, therefore, it would be reasonable to review it. The exemption levels for disposal of aqueous liquids were calculated based on a volume rate of 3000 m^3 y^{-1} to allow for sufficient dilution of the radionuclides in the effluent. Given the need to have a required volume rate, the DECC Exemption Order Review team decided that these values should be specified as exemption values rather than being used as out of scope values. The report also states that discharges to coastal waters would give rise to lower doses because of the additional dilution and hence there is no need for restrictions on the volume of water containing the activity concentrations that can be disposed of to coastal waters. However, at the time the DECC Exemption Order Review team decided to include a volume limit to rivers and seas to take account of factors such as concerns about demonstrating that the requirements of the OSPAR Convention and Water Framework Directive were met rather than the counter argument of whether this was over-regulation at trivial levels of dose.

The advantage of developing out of scope values would be a more proportionate approach to wastes containing low activity concentrations and activities. This would result in savings in terms of cost and staff effort in monitoring and managing the radioactive waste and would allow for more treatment options to be used; for example, treatment plants which are not permitted to accept radioactive discharges would be able to accept the liquid waste containing radionuclides with activity concentrations below the out of scope values. For some sites discharging liquid radioactive waste containing low concentrations, it would be preferable if this waste could be defined as non-radioactive which is not possible under the current RSR. In addition, out of scope values for activity concentrations exist for solids and therefore there is an argument that these values should also be calculated for liquids.

One of the arguments against the development of out of scope values has been that there is the potential for the radionuclides in liquid waste streams to be more easily concentrated than for solid wastes. Concentration of radionuclides could occur at treatment plants or sewage treatment works depending on the radionuclide and the process, with the exception of tritium in the form of tritiated water. Development of out of scope value for aqueous liquids could be perceived as a lowering of radiation protection standards, with concerns of whether unlimited volumes of aqueous liquids with low

concentrations would be allowed to be discharged and whether this would cause potential conflict with the UK Discharge Strategy and OSPAR commitments. When calculating the values, a range of possible exposure scenarios would need to be considered and any concentration of radionuclides in the environment accounted for. If requested by the regulators, the operators would need to explain the source of these liquids and that there has been no deliberate dilution of the waste stream. It would be helpful to keep OSPAR's Radioactive Substances Committee (RSC) informed of any potential UK developments in RSR.

When calculating the out of the scope values for all radionuclides for all discharges to sewers, rivers and coastal waters, the assessment will to need to ensure that doses are below 10 μSv y^{-1} and cautious assumptions related particularly to flow rates in sewers and rivers will be required. In addition, the assessment will need to cover all the relevant pathways including ingestion of terrestrial foods following the application to land of sewage or irrigated water and account of any concentration of radionuclides in the environment. Given the variability in transfer factors it would be appropriate to select cautious values for defining generic out of scope levels. For some radionuclides there may be processes during treatment of liquid discharges that result in the out of scope values being so low that the value would not be practically useable, that is, the activity concentration values given would be so low they could not be measured. However, for some radionuclides, which are known not to concentrate in treatment processes, notably tritiated water, useful values could be developed. In addition, there may be some radionuclides where insufficient data are available for transfers through the treatment process and in the wider environment. In these cases, it would also be better to err on the side of caution and make pessimistic assumptions or not present any value.
An alternative would be to develop out of scope value for coastal discharges, as suggested by some organisations. However, the environment agencies commented that in the majority of situations, some treatment of the liquid waste would be required before discharge; therefore, there is only limited disposal to coastal waters and out of scope values for coastal discharges alone would have limited value.

The parameter values used for assessing out of scope values could justifiably be more conservative than those used for the exemption values. The report HPA-CRCE-005 did consider the minimum detection levels but it would be useful to review some of the practical issues related to the chosen values once more. It would require significant effort to develop the values and update the legislation and accompanying guidance. However, this should result in a more proportionate approach to the risks associated with these discharges. The Clearance and Exemption Working Group estimate that the potential cost savings would be £9M-£11M over 10 years and would have the additional benefit of the waste not being considered radioactive.

In the authors' view, it would be of value to develop out of scope values for aqueous liquids to resolve some of the issues related to groundwater, surface run-off and general

effluents which contain low activity concentrations. The development of site-specific values, as has been suggested by some operators, would require effort from both the operator in developing the value and the regulator in assessing the validity of the values. The regulators would also need to ensure consistency of approach across different sites. Additionally, this would then require significant effort to set up a legal framework to create a register of exempted pathways or discharges. Given these caveats this option of developing site-specific values has not been considered further.

It is worth being aware that the development of out of scope values for liquids may also have consequences in relation to Office for Nuclear Regulation's (ONR) regulatory regime. There are some liquids that may fall under the definition of nuclear matter as defined in the Nuclear Installations Act 1965 (NIA65) as being fissile material or being made radioactive by exposure to radiation from fissile material, for example, groundwater containing ^{3}H from an existing nuclear site. As discussed in the Introduction, the requirements of NIA65 is outside the scope of this work. However, the ONR guide on the Consignment of Nuclear Matter (ONR, 2019) states that, whilst the Environmental Permitting Regulations (EPR16) for England and Wales and Environmental Authorisations (Scotland) Regulations 2018 make provision for some radioactive wastes containing very low levels of activity to be free from permitting under the environmental legislation, the out of scope material still meets the definition of nuclear matter as defined within NIA65. Since currently any liquid waste containing radioactivity is defined as radioactive waste, liquids are exempt from the requirement for an ONR consent to transfer to a non-relevant site, for example, an effluent treatment plant. However, if out of scope values for liquids are developed, consent from ONR for the transfer of any liquids defined as out of scope would then be required.

Recommendation 2

BEIS, in discussion with the environment agencies, should develop out of scope values for aqueous liquids for discharges to sewers/rivers/sea for introduction in the radioactive substance regulations. These values should be based on the full range of possible exposure scenarios. OSPAR's RSC should also be kept consulted on any developments in UK legislation.

Consolidation of conditional exemptions for aqueous liquids for artificial radionuclides

When developing out of scope values for aqueous liquids for artificial radionuclides for discharges, there could be an overlap of these values with the exemption values for low concentration aqueous radioactive waste. Therefore, it would be better if both out of scope values and exemption values for low concentration radioactive waste were developed and reviewed at the same time. The current exemption for aqueous liquids are given in **Table 3** below with ^{3}H given as an example to help the discussion and for

comparison with proposed changes given in **Error! Reference source not found.**. As shown in the table there are currently 3 exemptions which relate to aqueous liquids which have similar values and conditions.

Table 3. Current values in EPR16 and RSA93 (tritium given as an example)

This table provides information about the type of exemption from UK legislation for radioactive liquid waste. Exemption is where radioactive material or waste is exempted from some aspects of legislation. The values for the activity concentration and the annual limit for the radionuclide tritium are given as an example.

Type of exemption	Radioactive waste	Activity concentration (Bq l^{-1})	Annual limit (Bq y^{-1})
Out of scope	No value currently exists for aqueous liquids		
Exemption	Up to 100 Bq ml^{-1} to sewer	1 10^5	1 10^8
	Low concentration to sewer/river/sea	1 10^3	1 10^{10}
	Patient excreta to sewer	Unlimited	5 10^9

Table 4. Proposed values (tritium given as an example) for discharges to sewer, river or sea

This table proposes how to set values for determining whether discharges of radioactive liquids are out of the scope of UK legislation or exempt from some aspects of the legislation. It proposes that an activity concentration level should be given to determine whether a liquid is out of the scope of the legislation and an annual activity limit should be used to determine whether the liquid should be exempt from some regulatory requirements.

Type of exemption	Activity concentration (Bq l^{-1})	Annual limit (Bq y^{-1})
Out of scope	It is proposed that this number be calculated with new assessment	No value will be specified
Exemption	No value will be specified	A single value to be calculated which is representative for discharges to sewer/river/sea, for example, 1 10^{10} Bq y^{-1}. Monthly limits could be given and there would be a requirement to demonstrate no deliberate dilution to remove from regulatory control at the point of arisings. However, as for solid waste, at the point of disposal the waste disposer would need to ensure that the liquid radioactive waste was disposed of or sent for disposal with substantial quantities of non-radioactive waste otherwise it will require permitting

Any update in the legislation would be a good opportunity to consolidate these 3 exemptions into one and the inclusion of a clause for exempt aqueous discharges within the RSR permits would solve some of the issues identified. There was a suggestion from the non-nuclear sector to review the list of specified radionuclides which can be disposed of under the conditional exemption of 100 Bq ml^{-1} to sewer. Given developments in the use of radionuclides in medical treatments and research this list should be reviewed. PHE's Medical Exposures Group has suggested that based on the Institute of Physics and Engineering in Medicine advice note (IPEM, 2018) the following radionuclides could be also considered: ^{68}Ga, ^{75}Se, ^{124}I, ^{169}Er, ^{177}Lu, ^{186}Re and ^{188}Re. However, if the exemptions were consolidated as proposed, then this would mean that a greater list of radionuclides would be included.

Recommendation 3

BEIS, in discussion with the environment agencies, should consider simplifying and consolidating the current exemption values given for aqueous liquids to a single set of values based on activity per year.

Inclusion of disposal of aqueous radioactive waste exemptions onto RSR permits

In England, Wales and Northern Ireland, the current regulations include 2 exemptions to allow disposal of aqueous radioactive waste up to 100 Bq ml^{-1} to sewer and disposal of low concentration aqueous radioactive waste to sewer, river or sea. However, as discussed in the Section on International guidance and standards and UK policy documents, the legislation precludes these exemptions from being used by those who hold permits in relation to radioactive waste discharges. As stated in the BEIS guidance document on exemption (BEIS et al, 2018a), where a permit is in place, the holder can apply for those waste streams which would otherwise be exempt to be included in the existing permit. This would help solve many of the issues experienced by permitted sites which have waste streams with low activity concentrations.

A significant issue for some radioactive liquids is that they may also have non-radioactive properties which mean that that they cannot be treated and discharged on the site where they were generated. The only option currently available is to transfer them to a permitted facility for treatment. There are a limited number of such permitted facilities; those that exist tend to be for incineration and can involve transportation over considerable distances. In many cases incineration of such liquids is not the best management option.

It would help for consistency between sites if the clauses for exemption of aqueous discharges were specified within the permit templates.Two options could be considered:

1. The current aqueous exemption clauses could be included in the RSR permits. This task would be relatively straightforward and would require a change to the environment agencies permit and potentially an amendment to the RSR legislation to allow a waste permitted person to take receipt of the waste depending on the advice from the environment agencies legal teams. The Clearance and Exemption Working Group has estimated that the potential cost savings would be £5M – £9M over 10 years. It should be noted that, although the Scottish regulations EASR18 have included most of the exemption provisions related to the disposal of aqueous radioactive waste given in the Radioactive Substances Exemption (Scotland) Order 2011 (Scottish Parliament, 2011) as standard conditions in the permits and registrations, the values in Table 4 of the Exemption Order 2011 relating to the disposal of low concentration aqueous radioactive waste are not included in the EASR18. It is suggested that SEPA may want to consider whether it would be helpful to some sites to re-introduce this exemption as a standard condition or include it on each permit/registration's bespoke authorised table of disposals.

2. New exemption values for aqueous liquids could be calculated as discussed in the previous section and included in the RSR permits or, in the case of the EASR18, as one of the General Binding Rules.

Under the current wording of the legislation it appears that exempt radioactive liquid waste can only be transferred to a waste permitted person but not to an exempt person. Clarification would be helpful from BEIS and the legal teams of the environment agencies of this interpretation. If this is the correct interpretation, then it is recommended that the legislation should be amended to allow transfer of exempt waste to an exempt person. In addition, as discussed in point 7 of the Section on Key issues identified, more guidance should be provided in the BEIS guidance document on exemption, on the receiving and accumulation of radioactive liquid waste.

Recommendation 4

Following on from Recommendation 3, the environment agencies should consider putting in place a simple mechanism by which permitted facilities may use the exemption provisions including the circumstances where those provisions may be used. For example, including the exemption requirements as standard in permits but subject to conditions that they may only be used where the normal disposal/treatment route is not practicable.

Recommendation 5

BEIS should seek advice from their legal team and from those of the environment agencies on whether exempt radioactive liquid waste can be transferred to an exempt person. If the current interpretation does not allow this, BEIS should consider amending the legislation to allow these transfers.

Streamline application and permitting process for discharges from the offshore oil and gas sector

In Scotland, SEPA is planning to simplify the authorisation process for offshore oil and gas installations by removing the need to submit a radiological assessment and issue authorisations that contain standard conditions. The view of the authors is that the Environment Agency (EA) should consider developing a similar process; for example, it could develop a standard rules permit to allow discharges of NORM produced by the oil and gas industry to sea which is similar to SEPA's proposed authorisation. This would ensure a more consistent approach across the UK and provide cost savings for offshore oil and gas producers regulated by the EA, although these savings have not been estimated. SEPA intends to base the values in their standard permit limits on an assessment which has not yet been published, with the initial part of the assessment due to be finalised shortly (Toner, 2019). It would be of value if SEPA could publish this assessment as well as ensuring that the revised authorisation process for the offshore oil and gas installation is implemented. The development of a similar process by the EA would require staff time but a standard rules permit should not be too difficult to develop and implement.

Recommendation 6

The environment agencies should consider putting in place a streamlined permitting process for discharges from the offshore oil and gas sector. SEPA is in the process of doing so, and in order to promote consistency across the UK, the EA could also produce a standard rules permit to allow disposal of NORM produced by oil and gas industry to sea.

Development of exemption values for coastal discharges from onshore oil and gas facilities

Currently out of scope activity concentration values exist for relevant liquids and any other liquids from NORM industrial activities, which include production (but not storage, distribution or use) of oil and gas. The values were based on disposal of solid waste for relevant liquids and discharges to freshwater for other liquids. Therefore, the development of exemption values for discharges to coastal water from onshore oil and gas facilities for their discharges to sea may be more appropriate than the values currently available. A generic assessment of the annual activities of NORM discharged from onshore facilities should be undertaken based on a dose criterion of public doses being less than 300 µSv y^{-1}.

Other oil and gas producing European countries such as the Netherlands and Norway have specified levels above which the release of radioactive substances requires a permit. The Netherlands have derived screening levels for discharges (Bq y^{-1}) of all NORM (including liquids) to water on the basis of a reference dose level of 10 µSv y^{-1} for releases into a large river, although the exact details of the assessment are not known. Norway use values expressed both as total activity discharged per year (Bq y^{-1}) and activity concentration (Bq g^{-1}). The screening levels adopted in the Netherlands are higher than those used in both the UK and Norway.

As mentioned in the Section on the Offshore oil and gas sector, some of the respondents requested that the definition of relevant liquid be expanded to include produced water. It is recommended that it would be better to consider developing specific exemption values for NORM discharges into the marine environment than to refine the definition of relevant liquids to include produced water. SEPA has undertaken work related to the assessment of doses from NORM discharges into a marine environment and this work could be used to support the development of exemption values. The report does not address the comment about whether there is disproportionate control of produced water, as this is outside the scope of this review.

Recommendation 7

BEIS should consider developing exemption values for NORM discharges to coastal waters from onshore oil and gas facilities in discussion with the environment agencies.

Standardised reporting of offshore discharges to the Environmental and Emissions Monitoring System (EEMS)

As discussed in the Section on the Offshore oil and gas sector, it would be more consistent and efficient if the data requested by the different regulators from the oil and gas operators related to offshore discharges were collated using the same approach for reporting to EEMS.

Recommendation 8

The environment agencies and BEIS's Offshore Petroleum Regulator for Environment and Decommissioning (OPRED) should work together to put in place single discharge reporting arrangements for offshore discharges using the Environmental and Emissions Monitoring System (EEMS).

Review of availability of NORM treatment plants in the UK

According to information from the oil and gas industry, there is a lack of onshore facilities that accept NORM waste either as oil slops or water used from jet-washing scale off decommissioned oil and gas installations. As the rate of decommissioning of oil and gas installations increases it will become more important that the number of waste facilities able to accept NORM waste increases. During the review, it was reported that the oil and gas industry is considering moving NORM liquid waste large distances to be incinerated or transported overseas to be treated at oil treatment sites. It is suggested that the environment agencies should consider whether transport and incineration of liquids or transport for disposal to other countries is the best environmental option. BEIS should also consider how the oil and gas operators can be encouraged to find solutions for managing and disposing of radioactive waste from their industry and how UK waste disposal companies can be encouraged to develop sites that can accept NORM waste discharges.

Recommendation 9

BEIS should encourage the oil and gas industry to find solutions for managing and disposing of radioactive waste from their industry and encourage the UK waste disposal sector to develop sites that can accept NORM liquid waste discharges. The environment agencies should consider whether the transport and incineration of liquids or transport for disposal to other countries is the best environmental option.

Conclusions and recommendations

This report contains a review of the application of the radioactive waste management and environmental protection regulatory framework to the management of radioactive liquids, particularly those containing very low levels of radionuclides. As part of this review, comments on issues relating to the current regulatory regime were sought from interested parties. In addition, a survey of arrangements in other countries was conducted to determine if the UK could learn from their approaches and experiences. International standards and guidance give limited recommendations and advice specific to radioactive liquids particularly on the application of the clearance or exemption concepts to liquids. This gap is likely to be addressed in the proposed IAEA safety standards Application of the Concept of Exemption and Application of the Concept of Clearance, working document numbers DS499 and DS500 respectively which will replace IAEA RS-G-1.7 (IAEA, 2004). If values are provided in these documents for the clearance and exemption of liquids from regulatory control then it is likely that many countries will adopt them. The target date for publication is August 2022 but significant delays can occur.

A survey of other countries showed that, in the absence of international values, some countries do not specify values for either clearing or exempting low activity liquids from regulatory control whilst others use values generally taken from IAEA BSS or Euratom BSSD (CEU, 2014; IAEA, 2014). The values given in IAEA BSS and Euratom BSSD for exemption or clearance of materials are identical. The values for bulk amounts of solid material for radionuclides of artificial origin were taken from IAEA RS-G-1.7 (IAEA, 2004) and were not intended to be applied to the control of discharges, but have been adopted by many countries. A few countries have developed specific clearance levels for certain types of liquids (those that cannot be concentrated and those disposed of by incineration) or levels above which a permit is required for discharges of radioactivity (including liquids) to water or unconditional clearance levels for small volumes of liquids. The UK legislation does not give values at which liquids will be out of the scope of the legislation for any liquids except relevant and NORM liquids, but does specify exemption values for aqueous radioactive effluents.

The review demonstrated that the UK regulatory framework and its application are consistent with the international standards and guidance and ensures a high level of protection of the public and the environment from radioactive substances. The UK is advanced in its thinking on the management of liquids containing low concentrations of radionuclides and is well placed to influence international developments on this topic. However, there is some evidence that in relation to liquids containing low concentrations of radionuclides, the framework or its application is disproportionate and not consistent with the philosophy of using a graded approach to regulate radioactive materials and waste; such as the tiered approach of RSR depending on the risk involved. For example,

currently liquids containing low concentrations of radionuclides with other hazardous properties are being transported long distances to a limited number of permitted facilities. These permitted facilities are typically incinerators which in many cases are not likely to be the best environmental management option for disposal.

The following recommendations are made to tackle the need to deal with liquids containing low concentrations of radionuclides in a more proportionate way and address some of the issues identified by interested parties.

Recommendation 1

BEIS should should consider updating its guidance on exemption with any additional information provided by the environment agencies from their now withdrawn exemption guidance, particularly relating to the guidance on the definition of relevant liquids. The BEIS guidance should also more accurately reflect the rationale behind the development of values related to relevant liquids.

Recommendation 2

BEIS, in discussion with the environment agencies, should consider developing out of scope values for aqueous liquids for discharges to sewers/rivers/sea for introduction in the radioactive substance regulations. These values should be based on the full range of possible exposure scenarios. OSPAR's RSC should also be kept consulted on any developments in UK legislation.

Recommendation 3

BEIS, in discussion with the environment agencies, should consider simplifying and consolidating the current exemption values given for aqueous liquids to a single set of values based on activity per year.

Recommendation 4

Following on from Recommendation 3, the environment agencies should consider puttin in place a simple mechanism by which permitted facilities may use the exemption provisions including the circumstances where those provisions may be used. For example, including the exemption requirements as standard in permits but subject to conditions that they may only be used where the normal disposal/treatment route is not practicable.

Recommendation 5

BEIS should seek advice from their legal team and from those of the environment agencies on whether exempt radioactive liquid waste can be transferred to an exempt person. If the current interpretation does not allow this, BEIS should consider amending the legislation to allow these transfers.

Recommendation 6

The environment agencies should consider putting in place a streamlined permitting process for discharges from the offshore oil and gas sector. SEPA is in the process of doing so, and in order to promote consistency across the UK, the EA could also produce a standard rules permit to allow disposal of NORM produced by oil and gas industry to sea.

Recommendation 7

BEIS should consider developing exemption values for NORM discharges to coastal waters from onshore oil and gas facilities in discussion with the environment agencies.

Recommendation 8

The environment agencies and BEIS's Offshore Petroleum Regulator for Environment and Decommissioning (OPRED) should work together to put in place single discharge reporting arrangements for offshore discharges using the Environmental and Emissions Monitoring System (EEMS).

Recommendation 9

BEIS should encourage the oil and gas industry to find solutions for managing and disposing of radioactive waste from their industry and encourage the UK waste disposal sector to develop sites that can accept NORM liquid waste discharges. The environment agencies should consider whether the transport and incineration of liquids or transport for disposal to other countries is the best environmental option.

Recommendation 10

When the Government updates the policy document Cm 2919 "A Review of Radioactive Waste Management Policy Final conclusions" (DOE et al, 1995) any agreed outcomes from this review should be incorporated.

References

ANVS (2018). *Decree on Basic Safety Standards for Radiation Protection*. (IenM/BSK-2017/135624)

Ashworth A and Chandler S (2014). Radioactive substances legislative amendments in the UK: concepts employed in the development of the new exclusion and exemption regime. *Journal of Radiological Protection* **34**(1), 161.

BEIS, Defra, Welsh Government and DAERA (NI) (2018a). *Scope of and exemptions from the radioactive substances legislation in England, Wales and Northern Ireland.* Department for Business, Energy & Industrial Strategy, London.

BEIS, Scottish Government, Welsh Government and DAERA (NI) (2017). *Revised requirements for radiological protection: regulation of public exposures and the justification of practices.* London.

BEIS, Scottish Government, Welsh Government and DAERA (NI) (2018b). *Response to the consultation on revised requirements for radiological protection: regulation of public exposures and the justification of practices: Transposition of the Basic Safety Standards Directive (2013/59/EURATOM).* London.

CEU (1996). Council Directive 96/29/Euratom of 13 May 1996 laying down the basic safety standards for the protection of the health of workers and the general public against the dangers arising from ionizing radiation. *Official Journal of the European Communities* **39**(L159), 1.

CEU (2014). Council Directive 2013/59/Euratom of 5 December 2013 Laying Down Basic Safety Standards for Protection Aginst the Dangers Arising from Exposure to Ionising Radiation, and Repealing Directives 89/618/Euratom, 90/641/Euratom, 96/29/Euratom, 97/43/Euratom and 2003/122/Euratom. *Official Journal of the European Union* **57**(L13), 1-73.

DECC, Welsh Assembly Government, DOENI and Scottish Government (2009). *UK Strategy for Radioactive Discharges.* Department of Energy and Climate Change, London.

DECC, Welsh Government, DOENI and Scottish Government (2014). *Strategy for the management of Naturally Occurring Radioactive Material (NORM) waste in the United Kingdom.* Scottish Government, Edinburgh.

Defra, Welsh Government, DOENI and Scottish Government (2012). *UK Plan for Shipments of Waste.*

DOE, Scottish Office and Welsh Office (1995). *Review of Radioactive Waste Management Policy. Final Conclusions.* Command Paper (Cm) 2919.

DOENI (2011). *The Radioactive Substances Exemption (Northern Ireland) Order 2011*. (No. 289)

EC (2000). *Practical use of the concepts of clearance and exemption - Part I: Guidance on general clearance levels for practices.* European Commission, Luxembourg, Radiation Protection 122.

EP and CEU (2008). Regulation (EC) No 1272/2008 of the European Parliament and of the Council of 16 December 2008 on classification, labelling and packaging of substances and mixtures, amending and repealing Directives 67/548/EEC and 1999/45/EC, and amending Regulation (EC) No 1907/2006. *Official Journal of the European Union* **51**(L353), 1-1355.

Ewers LW and Mobbs SF (2010). *Derivation of Liquid Exclusion or Exemption Levels to Support the RSA93 Exemption Order Review.* Health Protection Agency, Chilton, UK, HPA-CRCE-005.

IAEA (2004). *Application of the Concepts of Exclusion, Exemption and Clearance.* International Atomic Energy Agency, Vienna, RS-G-1.7.

IAEA (2014). *Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards.* International Atomic Energy Agency, Vienna, General Safety Requirements Part 3 (GSR Part 3).

ICRP (2007). The 2007 Recommendations of the International Commission on Radiological Protection. ICRP Publication 103. *Annals of the ICRP* **37**(2-4).

IPEM (2018). Advice Notice: Excretion Factors: the percentage of administered radioactivity released to sewer for routinely used radiopharmaceuticals. Institute of Physics and Engineering in Medicine.

Mobbs SF (2010). *Investigation of possible exemption or exclusion levels for non-aqueous liquids to support the RSA93 Exemption Order Review.* Health Protection Agency, Chilton, UK, HPA-CRCE-006.

NIEA, SEPA and EA (2013). *Exemption Guidance: Guidance on interpretation of "Relevant Liquid".* February 2013, Version 1.

ONR (2019). *LC5 Consignment Of Nuclear Matter.* ONR, Bootle, NS-INSP-GD-005 Revision 3.

OSPAR Commission (1992). *1992 OSPAR Convention: Convention for the Protection of the Marine Environment of the North-East Atlantic.* OSPAR Commission, Text as amended on 24 July 1998, updated 9 May 2002, 7 February 2005 and 18 May 2006. Amendments to Annexes II and III adopted at OSPAR 2007.

Scottish Parliament (2011). *The Radioactive Substances Exemption (Scotland) Order 2011*. (No. 147)

Scottish Parliament (2018). *Environmental Protection: The Environmental Authorisations (Scotland) Regulations 2018*. (No. 219)
Toner M (2019). [Private communication, SEPA]
UK Parliament (1960). *Radioactive Substances Act 1960*. (Chapter 34)
UK Parliament (1965). *Nuclear Installations Act 1965*. (Chapter 57)
UK Parliament (1993). *The Radioactive Substances Act 1993*. (Chapter 12)
UK Parliament (2010). *The Environmental Permitting (England and Wales) Regulations 2010*. (SI 2010/675)
UK Parliament (2016). *The Environmental Permitting (England and Wales) Regulations 2016*. (SI 2016/1151)
UK Parliament (2017). *The Ionising Radiations Regulations 2017*. (SI 2017/1075)

Appendix A Review of current UK approach and regulatory framework and its relationship to international policy constraints and standards

A.1 Introduction

This appendix summarises the current UK regulatory approach and the UK's current international obligations and international standards as these act as constraints or give the context within which the UK must work.

Section A.2 gives a general overview of the main international documents for radiation protection safety. Section A.3 discusses UK policy documents with relation to radioactive waste and discharges, while Section A.4 refers to the application of key parts of the UK approach to regulating radioactive liquid discharges. Section A.5 discusses nuclear safeguard arrangements and Section A.6 gives the legislative requirements for non-radiological hazardous properties of the liquids. Section A.7 records other relevant standards and policies.

A.2 International guidance and standards

This section of the report reviews international recommendations, standards and guidance that relate to radiation protection as well as relevant international conventions and treaties to which the UK is a signatory. The purpose of this section is to identify those international documents relevant to the management of radioactive liquids, their associated requirements and the UK's obligations.

A.2.1 ICRP recommendations and the system of radiation protection

The International Commission on Radiological Protection (ICRP) is an advisory body that offers its recommendations to regulators and advisory bodies on guidance on the fundamental principles on which appropriate radiological protection can be based. The primary aim of the Commission's Recommendations is to contribute to an appropriate level of protection for people and the environment against the detrimental effects of radiation exposure without unduly limiting the desirable human actions that may be associated with such exposure.

National and international regulations of radioactive waste are based on the ICRP system of radiological protection and its recommendations, which is based on 3 principles (ICRP, 2007a):

1. Justification

Any decision that alters the radiation exposure situation should do more good than harm.

2. Optimisation

The likelihood of incurring exposure, the number of people exposed, and the magnitude of their individual doses should all be kept as low as reasonably achievable, taking into account economic and societal factors (ALARA). A key role in this principle is the use of dose constraints. For public exposure, the dose constraint is an upper bound on the annual doses that members of the public should receive from the planned operation of any controlled source. For the control of public exposure from waste disposal ICRP recommends that a value for the dose constraint for members of the public of no more than 0.3 mSv y^{-1} would be appropriate.

3. Dose limitation

The value of the effective dose or the equivalent dose to individuals from planned exposure situations that shall not be exceeded. For members of the public ICRP recommends an effective dose limit of 1 mSv y^{-1}.

The latest recommendations (ICRP, 2007a) make it clear that not all exposures, sources or human actions should be considered when developing a national regulatory system for radiological protection. The concepts of exclusion and exemption are introduced to help identify those exposures, sources or human action that may not need control.

Exclusion in the ICRP context applies to sources which are uncontrollable (for example, ^{40}K in the human body) and those that are not amenable to control, (for example, exposure to cosmic rays at ground level). Exemption refers to waiving regulatory control requirements if not warranted, often on the basis that the effort to control is judged to be excessive compared to the associated risk. ICRP recommends that a legislative system for radiological protection should first establish what should be within the legal system, and what should be outside it and therefore excluded from the law and its regulations. Secondly, the system should establish what could be exempted from some or all regulatory requirements because regulatory action is unwarranted.

It is also noted that the distinction between exclusion and exemption is not absolute; regulatory authorities in different countries may take different decisions about whether to exempt or exclude a specific source or situation.

Further discussion about the concepts of clearance, exclusion and exemption are given in ICRP 104 (ICRP, 2007b). ICRP 104 also gives another example of sources that are not amenable to control as that of radioactive releases that were lawfully discharged to the environment from regulated human activity, but which may have become unamenable to further control.

ICRP has also been developing a framework to demonstrate radiological protection of the environment. ICRP 103 states that calculated doses to reference animals and plants could be compared with doses known to have specific biological effects and with dose rates normally experienced in the natural environment. The Commission, however, does not propose to set any form of dose limits for environmental protection.

A.2.2 IAEA Standards, Guidance and Convention

The International Atomic Energy Agency (IAEA) is an international body that has been established to promote the safe, secure and peaceful use of nuclear technologies. Its statute also authorises it to establish safety standards to protect health and minimise danger to life and property. The IAEA has produced a comprehensive library of standards and guidance; those that are considered most relevant to this review are:

- 'Fundamental Safety Principles SF-1' (IAEA, 2006)
- 'Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards GSR Part '3 (IAEA, 2014)
- 'Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management' (IAEA, 1997)

A.2.2.1. IAEA Fundamental Safety Principles SF-1

The IAEA Fundamental Safety Principles (IAEA, 2006) is a high-level document that underpins all other IAEA safety standards. The document states the fundamental safety objective and 10 associated safety principles, which includes the ICRP's 3 principles of radiation protection, and briefly describes their intent and purpose. The fundamental safety objective: to protect people and the environment from harmful effects of ionizing radiation -applies to all circumstances that give rise to radiation risks.
The safety principles provide the basis for requirements and measures for the protection of people and the environment against radiation risks and for the safety of facilities and activities that give rise to those risks. These include nuclear installations and uses of radiation and radioactive sources, the transport of radioactive material and the management of radioactive waste.

A.2.2.2. IAEA Basic Safety Standards GSR Part 3

The IAEA's International Basic Safety Standards (BSS), published as Safety Standards Series No. GSR Part 3, Radiation Protection and Safety of Radiation Sources (IAEA, 2014) builds on the IAEA Fundamental Safety Principles (IAEA, 2006) and the system of radiation protection recommended by ICRP. The IAEA BSS are generally recognised as the international benchmark for radiation safety requirements.

In keeping with the ICRP recommendations, the BSS do not apply to any radiation exposures that are not amenable to control (that is, they implement the concept of exclusion). The need to apply the standards proportionately is embodied in Requirement 6: The Graded Approach, which states that "the application of the requirements of these Standards in planned exposure situations shall be commensurate with the characteristics of the practice or the source within a practice, and with the likelihood and magnitude of exposures."

The IAEA BSS require that the graded approach is applied not only to the design of the regulatory system, that is, responsibilities, notification, authorisation (registration and licensing) and clearance and exemption (Requirements 3, 7 and 8) but also to all aspects of the regulatory framework from the type and complexity of inspection to the type and complexity of information that an authorised person needs to produce and maintain.

The requirements of the IAEA BSS are in the most part generic and apply to all types of facilities and radioactive waste rather than having separate requirements for solids and liquids, with the exception of radioactive discharges, both in liquid or gaseous form, for which there are specific requirements relating to public exposures.

The elements of the BSS that are most relevant to this review are requirements 29-32. Requirement 29 requires the regulatory body to establish or approve operational limits and conditions relating to public exposure, including authorised limits for discharges. These operational limits and conditions:

1. Shall be used by registrants and licensees as the criteria for demonstration of compliance after the commencement of operation of a source.
2. Shall correspond to doses below the dose limits with account taken of the results of optimization of protection and safety.
3. Shall reflect good practice in the operation of similar facilities or activities.
4. Shall allow for operational flexibility.
5. Shall take into account the results of the prospective assessment for radiological environmental impacts.

It also requires appropriate information sharing and consultation if a discharge could cause public exposures in another state.

Requirement 30 places responsibilities on operators and requires the following to be taken into account when applying the principle of optimisation.

1. Possible changes in any conditions that could affect exposure of members of the public, such as changes in the characteristics and use of the source, changes in environmental dispersion conditions, changes in exposure pathways or changes in values of parameters used for the determination of the representative person.
2. Good practice in the operation of similar sources or the conduct of similar practices.
3. Possible build-up and accumulation in the environment of radioactive substances from discharges during the lifetime of the source.
4. Uncertainties in the assessment of doses, especially uncertainties in contributions to doses if the source and the representative person are separated in space or in time.

Requirement 31 addresses radioactive waste and discharges and requires waste minimisation (both in in terms of volume and activity), ensuring the appropriate segregation of wastes to facilitate future management, maintenance of an appropriate inventory of all radioactive waste generated and development and implementation of radioactive waste management strategy. Specifically, for discharges the registrant or licensee are required to undertake appropriate characterisation of the discharge, understand all significant exposure pathways, assess the doses to the representative person, consider the radiological environmental impacts and review discharge control measures taking into account operating experience and changes in exposure pathways or the characteristics of the representative person.

Requirement 32 deals with monitoring and reporting. As far as clearance and exemption levels are concerned, the IAEA defines them as:

- clearance levels are activity concentration values at or below which materials arising from any practice subject to notification or authorisation may be released from regulatory control
- exemption levels are activity concentration values or total activity values at or below which a radiation source is not subject to notification or authorisation

Schedule I of the BSS gives the general criteria which can be considered when granting clearance and exemption

1. Radiation risks arising from the practice or from a source within the practice are sufficiently low as not to warrant regulatory control, with no appreciable likelihood of situations arising that could lead to a failure to meet the general criterion for exemption; or

2. Regulatory control of the practice or the source would yield no net benefit, in that no reasonable measures for regulatory control would achieve a worthwhile return in terms of reduction of individual doses or of health risks.

3. A practice or a source within a practice may be exempted without further consideration from some or all of the requirements of these Standards under the terms of the first paragraph provided that under all reasonably foreseeable circumstances the effective dose expected to be incurred by any individual (normally evaluated on the basis of a safety assessment) owing to the exempt practice or the exempt source within the practice is of the order of 10 μSv or less in a year. To take into account low probability scenarios, a different criterion could be used, namely that the effective dose expected to be incurred by any individual for such low probability scenarios does not exceed 1 mSv in a year.

4. For radionuclides of natural origin, exemption of bulk amounts of material is necessarily considered on a case by case basis by using a dose criterion of the order of 1 mSv in a year, commensurate with typical doses due to natural background levels of radiation.

In addition, 2 tables of values are provided. The first table provides exemption levels for moderate amounts of material without further consideration taken from EC RP-65 (EC, 1993) and the second provides exemption or clearance levels of bulk amounts of solid material without further consideration for radionuclides of artificial origin taken from IAEA RS-G-1.7 (IAEA, 2004). These values are not intended to be applied to the control of discharges. However, by definition, if a practice is exempted from regulatory control any discharges arising from that practice are also exempted.

Two points should be noted in relation to the use of dose criteria. Firstly, both sets of values in EC RP-65 and IAEA RS-G-1.7 used the collective dose criterion of 1 man Sv per year of the practice. However, since the individual dose criterion was, in most cases, found to be more restrictive than collective dose considerations, the IAEA does not include this collective dose criterion in its most recent BSS. Secondly, the dose criteria for exemption or clearance of bulk amounts of solid material without further consideration for radionuclides of artificial origin were developed in 1988 and did not consider low probability scenarios.

Schedule I also states that radioactive material arising from authorised discharges is exempt from any requirements for notification, registration or licensing unless otherwise specified by the regulatory body.

A.2.2.3. Joint Convention on the safety of spent fuel management and on the safety of radioactive waste management (Joint Convention)

The UK is a contracting party to the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (IAEA, 1997), a treaty established in 1997 by the International Atomic Energy Agency.

The Joint Convention places legal requirements on the contracting parties which are consistent with the IAEA Safety Fundamentals (IAEA, 2006) and the IAEA BSS (IAEA, 2014). The definition of radioactive waste makes it clear that the Joint Convention applies to the management of liquid radioactive wastes.

The Joint Convention contains specific provisions relating to discharges:

1. Contracting Parties shall take appropriate steps to ensure that the design and construction of spent fuel and radioactive waste management facility provide for suitable measures to limit possible radiological impacts on individuals, society and the environment from discharges. (Art 7 and 14)

2. Contracting Parties shall take appropriate steps to ensure that discharges (including from decommissioning installations) shall be limited:

(i) to keep exposure to radiation as low as reasonably achievable, economic and social factors being taken into account; and

(ii) so that no individual shall be exposed, in normal situations, to radiation doses which exceed national prescriptions for dose limitation which have due regard to internationally endorsed standards on radiation protection. (Art 24 and 26).

The general safety requirements in Articles 4 and 11 are also applicable to liquid waste radioactive waste management. For example, Contracting Parties are required to take the appropriate steps to:

- ensure the generation of waste is kept to the minimum practicable
- take into account interdependencies among the different steps in radioactive waste management
- provide for effective protection of individuals, society and the environment
- take into account the biological, chemical and other hazards that may be associated with radioactive waste management

A.2.2.4. Other IAEA relevant documents

Another relevant document is IAEA-TECDOC-1000 on clearance of materials resulting from the use of radionuclide in medicine, industry and research (IAEA, 1998). The scope of this TECDOC is clearance from regulatory control of liquid, airborne and solid waste containing very low levels of radioactive materials originating from practices not linked to the nuclear fuel cycle; spent sealed sources and wastes arising from practices where naturally occurring radionuclides are present are not covered.

IAEA-TECDOC-1000 describes waste types, noting that liquids are usually aqueous and organic liquids. It describes the common disposal route for aqueous liquids as discharge directly to sewer or water bodies, whereas incineration is more common for organic liquids. The TECDOC considers a significant proportion of radioactive waste produced in hospitals and research institutes to be of very low specific activity and therefore amenable to clearance from regulatory control. For short-lived radionuclides, decay storage (that is, storage while the activity decays to a level at which it can be cleared from control) is suggested. The TECDOC discusses the dose assessment and gives derived generic clearance levels for liquid releases to sewers or freshwater bodies based on a dose criterion of 10 μSv or less in a year. These values have been used by a number of countries (see Appendix B).

A.2.2.5. EURATOM Treaty

The UK was a member of the Euratom community until January 2020 but the transition period means that the UK will continue to comply with the legislation and instruments made under the Euratom Treaty (EU, 2010) until the end of 2020. Of most relevance to this review is the Basic Safety Standards Directive (BSSD), which is discussed in the next section. Other important pieces of legislation are the Spent Fuel and Radioactive Waste Directive (SFRWD) and the recommendation of application of Article 37 of the Euratom Treaty.

The provisions of SFRWD are essentially the same as the Joint Convention and are not discussed further in this report. Article 37 of the Euratom Treaty is similar to Article 6 of the Joint Convention and requirement 29 of the IAEA BSS in that it addresses transboundary impacts of facilities and discharges. The Article 37 recommendation provides guidance to EU Member States on when a submission is required in relation to facilities that may have a radiological impact on other Member States. The recommendation specifies the types of installations for which a submission is required and the information that should be provided to the European Commission.

A.2.2.6. The Basic Safety Standards Directive (2013/59/EURATOM)

The Basic Safety Standards Directive (BSSD) (CEU, 2014) consolidates and updates existing Euratom radiation safety legislation. The BSSD was developed in conjunction with the IAEA BSS and as stated above, compliance with the BSSD should ensure compliance with the IAEA BSS.

The BSSD reflects the IAEA requirement to have a graded approach through a tiered approach of regulation; clearance/exemption, notification, registration and licensing with these tiers becoming progressively more prescriptive. The BSSD uses the terminology of the IAEA BSS and collectively refers to registration or licensing of a practice as an authorisation.

Article 24 states that: "Member States shall require practices to be subject to regulatory control for the purpose of radiation protection, by way of notification, authorisation and appropriate inspections, commensurate with the magnitude and likelihood of exposures resulting from the practice, and commensurate with the impact that regulatory control may have in reducing such exposures or improving radiological safety."

This Article also states that Member States may establish general exemptions or allow the competent authority to decide to exempt notified practices from the requirement of authorisation on the basis of the general criteria specified in Annex VII. The criteria for exemption from regulatory control and values given are the same as those in the IAEA BSS except that no reference is made to low probability scenarios. There is a provision to release solid material from regulatory control provided the activity concentration is below the values given in Annex VII, Table A. For all materials, practices may be exempted if the total activity involved in a practice is below the values in Annex VII, Table B, column 3, or the activity concentration is below the values in column 2 of the same table.

The BSSD requires licensing of any practice where there are significant discharges of liquid or gaseous radioactive effluent. No distinction is made for different types of liquid and the definition of significant discharges is not given. The Directive defines radioactive material as a substance that contains radioactivity at a level that "cannot be disregarded from a radiation protection point of view" (Article 27). It is left to Member States' discretion to decide where that level of radioactivity lies; they would also need to take into account the exemption criteria described above.

The BSSD also requires that "for public exposure, the dose constraint shall be set for the individual dose that members of the public receive from the planned operation of a specified radiation source" (Article 6).

Article 30, Release from Regulatory Control, states that "Member States shall not permit the deliberate dilution of radioactive materials for the purpose of them being released from regulatory control." It also clarifies that "the mixing of materials that takes place in normal operations where radioactivity is not a consideration is not subject to this prohibition."

A.2.2.7 The OSPAR Convention

The UK is a signatory to the 1992 OSPAR Convention (OSPAR Commission, 1992) along with 14 other governments and the European Union. The aim of the Convention is to protect the marine environment of the North-East Atlantic. It requires all signatories to take all possible steps to prevent and eliminate pollution from land-based sources, dumping and offshore sources, including radioactive waste.

Specifically, the Convention requires that "point source discharges to the maritime area, and releases into water or air which reach and may affect the maritime area, shall be strictly subject to authorisation or regulation by the competent authorities of the contracting parties. Such authorisation or regulation shall, in particular, implement relevant decisions of the Commission which bind the relevant Contracting Party. The Contracting Party should be supplemented by a system of regular monitoring and inspection to assess compliance with authorisations and regulations of releases into water or air."

Contracting Parties are also required to apply the precautionary principle and the polluter pays principle and to ensure that Best Available Techniques (BAT) and Best Environmental Practices (BEP) are applied. It is explicit in the Convention that protection of the North-East Atlantic maritime area should not be at the expense of increasing pollution to other parts of the environment.

In terms of taking action in relation to radioactive substances there is a specific requirement that Contracting Parties must take account of the recommendations of other appropriate international organisations and agencies, such as the ICRP, the IAEA and the Euratom Community.

In order to implement the OSPAR Convention the Contracting Parties have jointly developed a Radioactive Substances Strategy (RSS). The key objective of the RSS is to prevent pollution of the OSPAR maritime environment by "progressive and substantial" reductions in discharges and emissions in order to achieve concentrations in the environment of near background levels for naturally occurring radionuclides and near zero levels for artificial radionuclides.

As part of its commitment to OSPAR, the UK has to report on a 4-yearly basis on the implementation of BAT in nuclear industries in order to minimise and, as appropriate,

eliminate any pollution caused by radioactive discharges from all nuclear industries. All Contracting Parties are required to submit such reports on a rolling cycle. The UK report (OSPAR Commission, 2013) reviewed the current practices and application of BAT in the UK nuclear industry. It concludes that the regulatory requirements to demonstrate that BAT is applied, or that Best Practicable Means (BPM) have been employed to minimise discharges, and the periodic review of permits and authorisations effectively ensures that the application of BAT in UK nuclear facilities is incorporated in UK regulatory practice.

The OSPAR Commission has set out a methodology for deriving criteria for the radiological environmental assessment of concentrations of radioactive substances in the marine environment (OSPAR Commission, 2016). The methodology is based on the one that was developed by the IAEA (IAEA, 2013) to assess the radiological impact on humans and non-human biota. The criteria are in the form of reference activity concentrations in filtered seawater (Bq l^{-1}) which equate to whichever is the lower of the activity concentrations that would give rise to:

1. an annual radiation dose of 1 millisievert (mSv) to humans;
2. a radiation dose rate at the lower bound of the relevant Derived Consideration Reference Level (DCRL) as defined by the ICRP for key marine Reference Animals and Plants (ICRP, 2008).

A.2.2.8 Other key concepts discussed in international documents

In addition to the radiation protection principles and the graded approach, other key elements of the international framework that should be considered in the national regulatory framework are:

1. An authorisation regime supported by appropriate inspections.
2. The concept of waste avoidance and minimisation with the need for an appropriate radioactive waste management plan. It is also important to take account of interdependencies between different wastes and different radioactive waste management options.
3. The need to take account of the non-radiological properties of radioactive waste and to protect the environment (not only humans) from radiological impacts.
4. Prohibition of deliberate dilution to avoid regulatory control.

A.3 UK policy documents

This section of the report reviews UK policy documents relevant to the management of radioactive liquids and compares them to the international framework discussed in Section A2. The purpose is to identify any differences or additional requirements that are placed on the management of radioactive liquids.

Two key UK policy documents discussed in this section are the Cm 2919 White Paper (DOE et al, 1995), and the UK Strategy for Radioactive Discharges (DECC et al, 2009). The latter document is important to demonstrate the UK's commitment to the 1992 OSPAR Convention (OSPAR Commission, 1992).

A.3.1 Cm 2919, Review of waste management policy 1995

Although much of Cm 2919 has been superseded by more recent documents, key elements of the text remain as an important statement on the UK Government's position on dealing with all types of radioactive waste. Specifically, Cm 2919 states that: "radioactive wastes should be managed and disposed of in ways which protect the public, workforce and the environment" and that the policy and regulatory framework should "ensure that:

1. Radioactive wastes are not unnecessarily created;
2. Such wastes as are created are safely and appropriately managed and treated;
3. They are then safely disposed of at appropriate times and in appropriate ways.
4. So as to 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. The environment agencies are tasked with ensuring that this framework is properly implemented in accordance with their statutory powers.

Cm 2919 also contains a statement that the IAEA Fundamental Safety Principles are fully reflected in government policy and an explanation of how the ICRP principles of radiological protection are accommodated and implemented within the UK regulatory framework. In relation to optimisation, the concept of the threshold for optimisation or lower bound to optimisation is introduced. This is discussed further in Section 4.5.2. According to this concept, if exposures are calculated to be below 0.02 mSv y^{-1}, the regulators should not seek to secure further reductions in the exposure of members of the public, provided they are satisfied that the operator is using the best practicable means to limit discharges. However, the regulators will still need to ensure that discharges are properly controlled and monitored and that the radiological assessments submitted by operators are appropriate.

A.3.2. UK Strategy for Radioactive Discharges in relation to the OSPAR Convention

To implement the provisions of the OSPAR Convention and in particular to demonstrate its commitment to contributing to the delivery of the OSPAR Radioactive Substances Strategy, the UK produced a strategy for radioactive discharges in 2002. The UK strategy was updated in 2009 (DECC et al, 2009) to expand its scope by including the non-nuclear sector as well as the nuclear sector and reviewed in 2018 (BEIS, 2018) to ensure that it remained appropriate.

The UK Strategy for Radioactive Discharges lays out the UK Government policy on radioactive discharges based on the tenet that the unnecessary introduction of radioactivity into the environment is undesirable, even at levels where doses to humans and other species are low and, on the basis of current knowledge, are unlikely to cause harm. The UK Strategy does not set individual site limits for radioactive discharges but describes discharge reductions at the sectoral level, for example, nuclear energy production and defence sectors which are expected to be achieved by 2020 and by 2030 respectively and incorporates a strategic framework for addressing progressive radioactive discharges over the next 20 years.

The UK Strategy has adopted the OSPAR definition of BAT for the regulation of radioactive substances (equivalent to Best Practicable Means in Scotland and Northern Ireland) to prevent and, where this is not practicable, minimise waste generation and discharges to the environment.The Strategy is also based on the following principles:

- the precautionary principle
- the polluter pays principle
- the preferred use of the 'concentrate and contain' approach in the management of radioactive waste over the 'dilute and disperse' approach in cases where there would be a definite benefit in reducing environmental pollution, provided that BAT, or Best Practicable Means (BPM), is being applied and worker dose is taken into account

The environment agencies have been issued with statutory guidance that requires them to take account of the UK Strategy for Radioactive Discharges when exercising their statutory functions ((Scottish Government, 2008), (DECC, 2009)).

A.4 Application of key parts of the UK legislative framework

A comprehensive radioactive waste management regulatory framework has been in place in the UK since the 1960 Radioactive Substances Act (UK Parliament, 1960) came into force in 1963. This Act put in place a system of prior authorisation for any undertaking which intended to keep or use radioactive material or accumulate or dispose of radioactive waste. It also included exclusion and exemption provisions. The legislation was not prescriptive with regards to how the regulator should carry out its functions; for example, it allowed the regulator to impose any limits and condition that it saw fit in the authorisations that it issued, thus allowing the regulator to adopt a graded approach to regulation.

The Radioactive Substances Act (60 and then 93) (UK Parliament, 1960; UK Parliament, 1993) has been replaced with more general environmental protection legislation (Scottish Parliament, 2018; UK Parliament, 2016a), except in Northern Ireland. However, even though there have been revisions and updates to this regulatory

framework to reflect international developments, the underlying framework that provides for exemption and authorisation in a manner consistent with the graded approach remains the same.

The Section on the Application of key parts of the UK legislation framework of the main report compares terms used to refer to authorisation and exemption between IAEA, Euratom and UK legislation. It also discusses the tiers of radioactive substances regulations (RSR) which reflect the use of a graded approach.

A.4.1. Relevant liquids

The definition of relevant liquids is provided in the Section on the Application of key parts of the UK legislation framework. Guidance on the definition of relevant liquids (NIEA et al, 2013) gives advice on what is a non-aqueous liquid. It says that "non-aqueous liquids are those where the primary constituent is not water. Another way of considering this is that water is not acting as the solvent."

The guidance also discusses cut-off values for hazard categories. Council Regulation No. 1272/2008 (EP and CEU, 2008c) states that "cut-off values indicate when the presence of a substance needs to be taken into account for the purposes of classification of a substance or a mixture containing that hazardous substance, whether as an identified impurity, additive, or individual constituent". Cut-off values may therefore be used as a screening method to determine whether or not a mixture may be a relevant liquid.

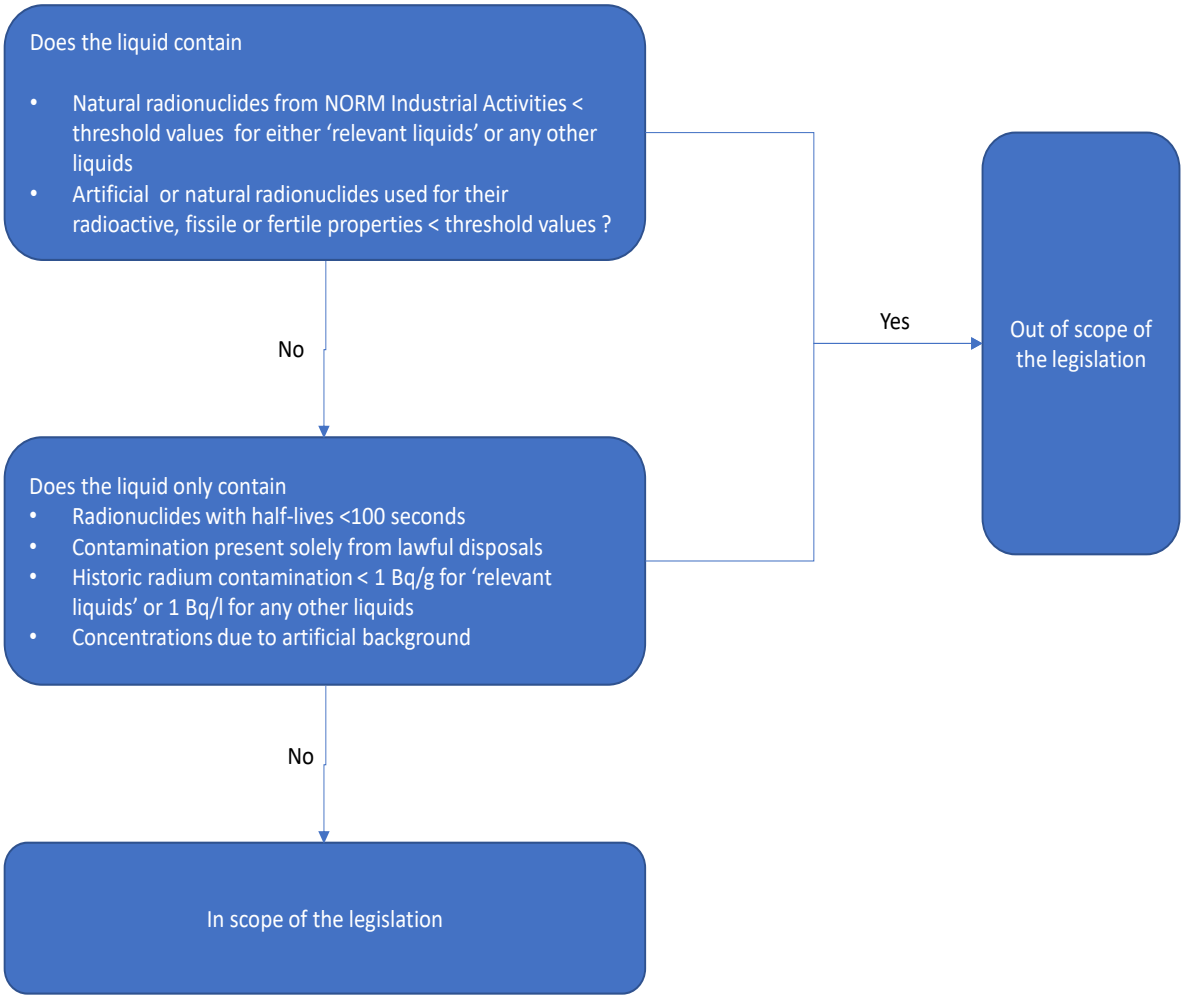
The guidance document Scope of and Exemptions from The Radioactive Substances Legislation in England, Wales and Northern Ireland (BEIS et al, 2018) states that "the purpose of this definition is to allow such liquids to be treated, for the purposes of this legislation, as a solid because the exposure pathways are the same as those for solids". However, the guidance on the definition of relevant liquids (NIEA et al, 2013) which was withdrawn in August 2019 states that "relevant liquids are often treated to remove the hazardous component to enable clean water to be discharged to the water environment. Any operator carrying out such an operation should be aware that such treatment may generate radioactive waste, for example, solid residues or aqueous waste, the disposal of which may require permitting". This statement more accurately reflects the fate of many liquids defined as relevant liquids so it is recommended that the text in the Department for Business, Energy and Industrial Strategy (BEIS) guidance is updated to reflect this situation.

A.4.2 Is it out of scope of the legislation?

Whether a substance is in or out of scope of the UK regulatory framework depends on whether or not it falls within the definition of radioactive material or radioactive waste. Except for some minor differences‡ there is a common definition of radioactive material and radioactive waste in all UK RSR. The definition is a combination of descriptive and numerical criteria. This document only considers the definitions as they apply to liquids. The criteria to define liquid wastes are given in the Section on the Application of key parts of the UK legislation framework of the main part of this report and is also given in **Figure A.1.**

Figure A.1. Flow diagram to determine whether a liquid is in or out of the scope of RSR

This is a flow diagram used to determine whether a liquid falls into the scope of the UK's Radioactive Substances Regulations.



‡ In EASR contaminated materials remaining on the premises where they were contaminated and NORM materials are classed as radioactive material unlike in EPR and RSA where they are out of scope.

The requirement not to deliberately dilute waste to below the regulatory thresholds contained in Article 30 of the Euratom BSSD has been carried through to the UK radioactive substance regulations for both artificial and Naturally Occurring Radioactive Material (NORM) waste, meaning that if a waste was deliberately diluted to be below the threshold values it would continue to be classed as radioactive waste.

A.4.3. Derivation of out of scope values

As discussed above, the IAEA BSS and Euratom BSSD do not provide specific exemption or clearance values for liquids. Therefore, the UK has derived its own out of scope values for relevant liquids and for other liquids containing naturally occurring radionuclides from NORM industrial activities. There are no out of scope values for other liquids containing artificial radionuclides or NORM used for its fertile, fissile or radioactive properties in the UK regulations.

For relevant liquids, the out of scope values for solid have been used. For NORM Industrial Activities an activity concentration of 1 Bq g^{-1} for the natural decay chains was taken from IAEA RS-G-1.7 (IAEA, 2004) with values for some of the decay chain segments being taken from EC RP122 Part 2 (EC, 2002). Out of scope values for liquid wastes classed as any other liquid were taken from HPA-CRCE-005 (Ewers and Mobbs, 2010). These values are based on the Generalised Derived Limits (GDLs) (NRPB, 2005) for freshwater using a dose criterion of 10 µSv y^{-1} and were assessed for the exposure pathways for ingestion of river water and freshwater fish and external exposure from shoreline sediment. It should be noted that GDLs will be very cautious if the discharge is made to coastal or marine waters, that is, where significant dilution occurs.

A.4.4 Is liquid management exempted from the requirement to have a permit?

A.4.4.1 England, Wales and Northern Ireland

In England, Wales and Northern Ireland the legislation makes a distinction between activities involving radioactive materials and those involving radioactive waste; accordingly, there are different exemptions for the keeping and use of radioactive material and for the accumulation and disposal of radioactive waste. The relevant exemptions are detailed in this section.

There are 3 exemption provisions applicable to the keeping, use and accumulation of liquids and 4 that relate to the discharge of liquids. The provisions on the keeping, use and accumulation of liquids are summarised in **Table A.1**. All of the exemptions are conditional and subject to conditions such as adequate record keeping and holding the substances safely and securely. It is also a requirement that radioactive waste is disposed of as soon as reasonably practicable after it has become waste. The

government guidance on the scope of and exemptions from the radioactive substances legislation (BEIS et al, 2018) provides further detail.

Table A.1. Exemptions that are applicable to the keeping and use of radioactive material and the accumulation of radioactive waste in the form of a liquid

There are 3 exemption provisions given in UK legislation which relate to the keeping, use and accumulation of radioactive liquids and 4 that relate to the discharge. The table summarises the provisions on the keeping, use and accumulation of radioactive liquids. Exemption is where radioactive material or waste is exempted from some aspects of legislation.

Radioactive material/waste	Maximum concentration of radionuclide in the liquid	Maximum quantity of radionuclide that can be kept or accumulated on the premises
General exemption	The concentration values in column 3 Table 3.1 of the government guidance	The activity values in column 2 of Table 3.1 of the government guidance.
A uranium or thorium compound	No limit	Up to a total of 5 kg of uranium and thorium
A substance or article (other than a sealed source) which is intended for use for medical or veterinary diagnosis or treatment or clinical or veterinary trials.	No limit	1×10^9 Bq of ^{99m}Tc and 2×10^8 Bq for all other radionuclides with no more than 1×10^8 Bq being contained in material.

Exemption provisions for disposal or transfer of liquids to a waste permitted person are provided in Table 2 in the main part of the report. They cover the following categories of waste disposal:

- aqueous liquid uranium or thorium compounds
- aqueous liquid human excreta
- aqueous waste up to 100 Bq/ml to sewer
- low concentration aqueous waste to sewer, river or sea

Provisions for all 4 categories have the following common conditions

The waste must not be diluted with the intention that the waste has a concentration of radioactivity which is below that given in the exemption. This condition relates to the requirement in Article 30 of the Euratom BSSD, Release from Regulatory Control, that

"Member States shall not permit the deliberate dilution of radioactive materials for the purpose of them being released from regulatory control".

All practicable measures available must be used to minimise the quantity of radionuclides generated as waste. The wording in the legislation (Sch23 Part 6, 21 (4)(b)) is that the exemption does not apply "where the person who generated that waste did not minimise the quantity of radionuclides generated as waste to the extent reasonably practicable". This condition relates to Requirement 31 in the IAEA BSS that "Registrants and licensees ... shall ensure that any radioactive waste generated is kept to the minimum practicable in terms of both activity and volume"

An adequate record of the waste which is disposed of from any premises must be kept. This condition relates to Requirement 31 in the IAEA BSS that "Registrants and licensees ... shall maintain an inventory of all radioactive waste that is generated, stored, transferred or disposed of"

The regulator must be allowed access to such records or such premises as the regulator may request in order to determine that all of the conditions that apply are complied with. This condition relates to the Requirement 3 in the IAEA BSS, Responsibilities of the regulatory body, which states that "The regulatory body shall make provision for establishing, maintaining and retrieving adequate records relating to facilities and activities."

The waste must be disposed to a relevant sewer or to a waste permitted person. A relevant sewer is defined as a public sewer or a disposal main which leads to a sewage disposal works that:

a) has the capacity to handle a minimum of 100 m^3 of effluent per day, and
b) discharges treated effluent only to the sea or to a relevant river.

A relevant river means a river or a part of a river which:

a) is not a part of the sea, and
b) at the place and time of any disposal into it of aqueous radioactive waste from a sewage disposal works or directly from premises, has a flow-rate which is not less than 1 m^3 s^{-1}.

As discussed in the Section on the Application of key parts of the UK legislation framework, the conditional exemptions for aqueous waste up to 100 Bq ml^{-1} to sewer and low concentration aqueous waste to sewer, river or sea cannot be used for permitted premises. These wastes are then subject to the conditions set out in the permit. This condition has been the subject of much concern with some operators. However, the conditional exemptions for aqueous liquid radioactive waste which is or contains uranium or thorium or prepared compounds of uranium or thorium and

radioactive waste in aqueous solution being human excreta can be used for premises which hold a permit or authorisation for other aqueous waste streams.

A.4.4.2 Scotland

In Scotland, the General Binding Rules (GBR), which are a set of mandatory rules that cover specific low risk activities, are described in Schedule 9 of Environmental Authorisations (Scotland) Regulations 2018 (EASR18). By complying with these rules, the person or business is authorised to carry out radioactive substances activities and does not need to apply for any other authorisation. The activities relevant to radioactive liquids and their associated GBRs are given below and are similar to those for the rest of the UK.

One of the main differences with the regulations in other parts of the UK is that the exemption of the disposal of low concentration aqueous radioactive waste to sewer, river or sea exemption given in the legislation in England, Wales and Northern Ireland (given in last row of Table 2) has not been replicated in EASR18, because Scottish Environment Protection Agency (SEPA) considered that this type of exemption has rarely been used.

Table A.2. General Binding Rules in place in Scotland as described in Schedule 9 of EASR18

In Scotland, the General Binding Rules are a set of mandatory rules that cover specific low risk activities under the Environmental Authorisations (Scotland) Regulations 2018. Schedule 9 of the Environmental Authorisations (Scotland) Regulations 2018 gives the rules for radioactive substances activities. The table gives the activities relevant to radioactive liquids and their associated General Binding Rules.

Activity	General Binding Rules
7. The management of a uranium or thorium compound.	(d) a uranium or thorium compound which is aqueous waste must be disposed of to a relevant sewer; (e) the total quantity of uranium or thorium in a uranium or thorium compound disposed of from a premises to a relevant sewer must not exceed 0.5 kilogrammes per year.
8. The management of a medical or veterinary radioactive substance	(b) a medical or veterinary radioactive substance must only be— (i) disposed of in normal refuse; or (ii) disposed into— (aa) a relevant sewer;

Activity	General Binding Rules
	(bb) a river, which at the time of any disposal into it of aqueous radioactive waste has a flow rate which is not less than 1 $m^3 s^{-1}$; or (cc) the sea; (f) if the medical or veterinary waste consists of human excreta, the total activity of liquid aqueous waste disposed of from a premises to a relevant sewer in a year must not exceed— (i) 1 x 10^{10} becquerels for ^{99m}Tc; or (ii) 5 x 10^9 becquerels for the sum of all other radionuclides; (g) if the medical or veterinary waste does not consist of human excreta, the total activity of liquid aqueous waste disposed of from a premises to a relevant sewer in a year must not exceed— (i) 1 x 10^8 becquerels for the sum of the following radionuclides: ^3H, ^{11}C, ^{14}C, ^{18}F, ^{32}P, ^{33}P, ^{35}S, ^{45}Ca, ^{51}Cr, ^{55}Fe, ^{67}Ga, ^{89}Sr, ^{90}Y, ^{99m}Tc, ^{111}In, ^{123}I, ^{125}I, ^{131}I, ^{153}Sm and ^{201}Tl; or (ii) 1 x 10^6 becquerels for the sum of all other radionuclides; (h) if the waste does not consist of human excreta, the concentration of liquid aqueous waste disposed of from a premises to a relevant sewer must not exceed 100 becquerels per millilitre.
11. Any other radioactive substances activity, not falling within any other activity description in this schedule, where— (a) the total activity of a radionuclide does not exceed the value specified in column 2 of Table 2; or (b) the concentration of radioactivity of a radionuclide does not exceed the value specified in column 3 of Table 2.	(e) an aqueous liquid radioactive substance must only be disposed of into— (i) a relevant sewer; (ii) a river, which at the time of any disposal into it of aqueous radioactive waste has a flow rate which is not less than 1 $m^3 s^{-1}$; or (iii) the sea; (f) the total activity of liquid aqueous radioactive waste disposed of from a premises in a year must not exceed— (i) 1 x 10^8 becquerels for the sum of the following radionuclides: : ^3H, ^{11}C, ^{14}C, ^{18}F, ^{32}P, ^{33}P, ^{35}S, ^{45}Ca, ^{51}Cr, ^{55}Fe, ^{67}Ga, ^{89}Sr, ^{90}Y, ^{99m}Tc, ^{111}In, ^{123}I, ^{125}I, ^{131}I, ^{153}Sm and ^{201}Tl; or (ii) 1 x 10^6 becquerels for the sum of all other radionuclides; (g) the concentration of liquid aqueous radioactive waste disposed of from a premises must not exceed 100 becquerels per millilitre;

A.4.4.3 Derivation of the exemption values

The IAEA BSS and Euratom BSSD do not give exemption values for moderate quantities specifically for liquids. However the values given in both IAEA BSS and Euratom BSSD are taken from EC RP-65 (EC, 1993) which considered sources in different physical forms including liquids. Since the only public exposure scenario considered in EC RP-65 was a member of the public visiting a landfill site, the decision was taken that the UK would derive values based on discharges to freshwater and relevant exposure pathways, for example, intake of drinking water, ingestion of fish and external dose from radionuclides in sediment. For aqueous radioactive waste the values were taken from HPA-CRCE-005 (Ewers and Mobbs, 2010) which were based on the methodology for calculating GDLs for freshwater (NRPB, 2005) and a dose criterion of 10 μSv y^{-1} to the most highly exposed member of the public.

A.4.5. What are the requirements for permitting?

When applying for a registration a range of documentation is required including provision of radiological assessments for aqueous discharges to sewers or water courses and for discharges to air. Typical permit conditions include:

- records of all radioactive wastes, including that being accumulated, that discharged directly, for example, to sewer or to air, and that transferred
- the operator shall use the best available techniques or best practicable means in respect of the disposal of radioactive waste to minimise the activity of gaseous and aqueous radioactive waste disposed of by discharge to the environment
- the operator shall use the best available techniques or best practicable means to exclude all entrained solids, gases and non-aqueous liquids from radioactive aqueous waste prior to discharge to the environment

There are other typical permit conditions related to monitoring and record keeping requirements related to such things as the maintenance schedule, operator training and management system.

In Scotland, all registrations or permits for unsealed sources contain the standard condition G4.1, Disposal of radioactive aqueous liquid disposal – small quantities. This condition is the equivalent to some of the rules in the GBR for the management of a medical or veterinary substance (Activity 8) and of any other radioactive substances not falling within any other activity description (Activity 11). Any site which has a permit would be able to use this disposal condition. This differs from the rest of the UK where currently the aqueous exemptions do not apply if the premises from which the waste disposal takes place are permitted for other aqueous waste streams.

However, as stated in the BEIS guidance document on exemption (BEIS et al, 2018), for the rest of the UK, where a permit is in place, the holder can apply for those waste streams which would otherwise be exempt to be included in the existing permit. These wastes will then be subject to the conditions set out in the permit.

A.4.5.1. Guidance on performing optimisation

The environment agencies have produced a number of guidance documents related to optimisation which develop ICRP's principle and the IAEA requirement that radioactive waste generated is kept to the minimum practicable in terms of both activity and volume.

A review of the application of BPM for managing radioactive wastes (SNIFFER, 2005) states that "whereas ALARA stems from the ICRP optimisation principle and relates to doses whereas Best Practicable Means (BPM) applies to the optimisation of radioactive waste management." It also states that "as a matter of principle, the Agencies define no lower threshold of dose or environmental contamination below which BPM or BAT does not apply. Operators are thus required to minimise discharges to the point to which it would not be sensible to reduce them any further, whilst taking into account factors such as cost-effectiveness, technological status, operational safety and social and environmental factors. This concept, referred to as proportionality, is thus fundamental to the assessment of what constitutes BPM. The Agencies apply this concept by ensuring that operators do not expend effort, whether in time, trouble or money, that would be grossly disproportionate to the resulting benefits (for example, reduction in discharges, environmental protection, reduction in radiological dose, and so on)."

SEPA's guidance document 'Satisfying the ALARA requirement and the role of Best Practicable Means' (SEPA, 2012) sets out how SEPA complies with the requirement placed on it to ensure that exposures to ionising radiation of the public are kept as low as reasonably achievable (ALARA) and the role that Best Practicable Means (BPM) fulfils in satisfying that requirement.

In order to satisfy the requirement to keep public exposures ALARA, 3 related BPM requirements are imposed on radioactive substances users by SEPA:

1. Use of BPM to minimise the activity and volume of radioactive waste generated;
2. Use of BPM to minimise the total activity of radioactive waste that is discharged to the environment;
3. Use of BPM to minimise the radiological effects of radioactive discharges on the environment and members of the public.

EASR18 provides for 4 possible tiers of authorisation; GBRs, notification, registration and permit. Activities are regulated at the lowest appropriate tier. The GBRs are similar to existing conditional exemptions in EPR16 (UK Parliament, 2016a) and (DOENI,

2011). The regulations contain the provision that disapply the GBRs if the person who generated the waste did not take all practicable measures to minimise the quantity of radionuclides generated as waste.

The EA's 'Radioactive Substances Regulation: Environmental Principles' (EA, 2010) updated the terminology from BPM to BAT. Principle RSMDP6 Application of BAT states that "a technique will not be BAT if its costs are grossly disproportionate to its environmental benefits. Costs include time, trouble, money and all other resources. All benefits and potential benefits should be taken into account."

A.4.5.2 Optimisation of discharges

Although the terminology used is slightly different, optimisation and the application of keeping doses as low as reasonably achievable (ALARA) are a key requirement of many of the UK policy and guidance documents. The requirement of optimisation in relation to radioactive waste is set out in EPR16 (UK Parliament, 2016a) which states that the regulator must ensure that "all exposures to ionising radiation of any member of the public and of the population as a whole resulting from the disposal of radioactive waste are kept as low as reasonably achievable, taking into account economic and social factors." EASR18 (Scottish Parliament, 2018) states that "SEPA must exercise its relevant functions in relation to radioactive substances activities to ensure that the radiation protection of individuals subject to public exposures is optimised." EASR18 also states that SEPA, when setting authorisation conditions for discharge limits should "take into account the results of any optimisation of radiation protection"."

The IAEA BSS (IAEA, 2014) talks about protection being optimised to provide the highest level of safety that can reasonably be achieved. It also stresses the need for taking a graded approach to the regulatory control of radiation exposure, so that the application of regulatory requirements is commensurate with the radiation risks associated with the exposure situation.

As discussed in Section A3.1, in Cm 2919 (DOE et al, 1995), the Government introduced a threshold or lower bound on optimisation for radioactive waste discharges. The value for this threshold was set at 0.02 mSv y^{-1}. If exposures are calculated to be below 0.02 mSv y^{-1}, the regulators in Scotland and Northern Ireland are advised in Cm 2919 that they should not seek to secure further reductions in the exposure of members of the public, provided they are satisfied that the operator is using BPM to limit discharges. The statutory guidance to the Environment Agency concerning the regulation of radioactive discharges into the environment (DECC, 2009) states that "where the prospective dose to the most exposed group of members of the public from discharges from a site at its current discharge limits is below 10 µSv y^{-1} (0.01 mSv y^{-1}) the Environment Agency should not seek to reduce further the discharge limits that are in place, provided that the holder of the permit or authorisation applies and continues to

apply BAT". This guidance also discussed the change in terminology from Best Practicable Means (BPM) and Best Practicable Environmental Option (BPEO) to Best Available Techniques (BAT). BAT replaced BPM and BPEO in order to ensure the terminology used is consistent with environmental protection terminology used in England and Wales and in other countries.

As stated by the Principles for the Assessment of Prospective Public Doses arising from Authorised Discharges of Radioactive Waste to the Environment (EA et al, 2012), the Statutory Guidance (DECC, 2009) "would lead to 0.01 mSv y^{-1} being adopted in England and Wales and 0.02 mSv y^{-1} in Scotland and Northern Ireland as the threshold below which the dose assessment process does not require further refinement. However, 0.01 and 0.02 mSv y^{-1} can be considered to be broadly equivalent for the purposes of this principle and so 0.02 mSv y^{-1} has been retained to ensure consistency of this guidance across the UK and with the approach adopted previously."

A.4.5.3 Dose constraints and discharge limits

Article 6 of the Euratom BSSD (CEU, 2014) on dose constraint for public exposure states that the dose constraint shall be set for the individual doses that members of the public receive from the planned operation of a specified radiation source. This article has been transposed into UK legislation (Northern Ireland Assembly, 2003; Scottish Parliament, 2018; UK Parliament, 2016a) as:

"For the planning stage of radiation protection, the regulator must have regard to the following maximum doses to individuals which may result from a defined source:

1. 0.3 millisieverts per year from any source from which radioactive discharges are first made on, or after, 13th May 2000; or
2. 0.5 millisieverts per year from the discharges from any single site."

A.4.5.4 Setting discharge limits

In the EA's 'Radioactive Substances Regulation: Environmental Principles,' Principle RSMDP12 Limits and Levels on Discharges states that: "Limits should be based on the level of releases achievable through the use of BAT by operators". This principle is discussed further in the guidance document 'Criteria for setting limits on the discharge of radioactive waste from nuclear sites' (EA, 2012). This document states that: "Regulators should aim to set the minimum number of limits and levels consistent with ensuring adequate control of discharges and adequate monitoring of process performance. Regulators should also take into account the practicability and cost of monitoring when choosing the radionuclides to be limited."

The EA normally establishes annual discharge limits for normal operations at a site for each radionuclide, or group of radionuclides, that:

1. "are significant in terms of radiological impact on people (that is, the dose to the most exposed group at the proposed limit exceeds 1 μSv per year);
2. are significant in terms of radiological impact on non-human species (this only needs to be considered where the impact on reference organisms from the discharges of all radionuclides at the proposed limits exceeds 40 μGy/hour);
3. are significant in terms of the quantity of radioactivity discharged (that is, the discharge of a radionuclide exceeds 1 TBq per year);
4. may contribute significantly to collective dose (this only needs to be considered where the collective dose truncated at 500 years from the discharges of all radionuclides at the proposed limits exceeds 1 man-sievert per year to any of the UK, European or World populations);
5. are constrained under national or international agreements or is of concern internationally".

The guidance document also clarifies that site limits are set "regardless of whether the total prospective impact to people is above or below 10 μSv y^{-1}".

For the purposes of limit-setting, impacts will be assessed on a prospective basis for the total discharge of each radionuclide from a site at the limits proposed in the application".

A.4.5.5 Discharges related to NORM Industrial Activities

In the UK NORM Strategy (DECC et al, 2014) 3 industry sectors were identified that generate liquid NORM wastes. The most significant of these is the oil and gas industry, which generates in excess of 200 million m^3 of produced water every year. The majority of this waste arises on offshore installations. These installations are permitted to discharge their produced water directly to sea or re-inject it back into the seabed or hydrocarbon bearing formation where suitable facilities exist. The second sector is titanium dioxide manufacture – one of the titanium dioxide manufacturers is permitted to dispose of significant quantities of liquid waste. The third industry discharging NORM liquid wastes include facilities using small quantities of uranium and thorium compounds. The quantities being disposed of are small enough that they may be disposed to sewer under the exemption provisions.

A4.5.5.1 Oil and gas industry

As for all waste from NORM industrial activities defined in the legislation, an oil or gas installation requires an environmental permit if the wastes produced have a NORM content above the out of scope or exemption levels. Given the location of oil and gas installations onshore and offshore in the UK, the focus of SEPA regulations and

guidance has been on offshore installations whereas, in England, the EA has produced guidance related to onshore oil and gas installations.

Regulation for offshore installations is not a devolved matter and therefore in Scotland the Radioactive Substance Act 93 remains in force, with the implementation of EASR18 requiring an additional legislative order from the UK government. In Scotland there are plans to simplify the authorisation process for offshore oil and gas installations by removing the need to submit a radiological assessment and to issue authorisations that only contain standard conditions. The standard conditions applicable to Offshore Installation Registrations (SEPA, 2018) state that:

1. An operator is authorised to dispose of radioactive waste arising from the production of oil and gas, excluding any waste that has been sent to an offshore installation from land. Guidance on this topic (Scottish Parliament, 2018) states that "the exclusion of waste that has been sent to an offshore installation from land prevents waste which had been sent to land for disposal from being sent back offshore for disposal".
2. If an operator has any reason to believe that the activity concentration of ^{226}Ra in produced water has exceeded 0.1 Bq g^{-1} of produced water, the operator must inform SEPA without delay in accordance with Schedule 3 of these standard conditions. The guidance (Scottish Parliament, 2018) states that "the generic disposal limits have been assessed based on an assumed concentration of radium-226 in the produced water. If this threshold is exceeded, SEPA will need to carry out further, more detailed assessments to ensure that the disposals at these higher concentrations do not result in an unplanned exposure of a member of the public or harm to the environment."

It also states that the operator must not in any year discharge radioactive waste arising from decontamination or cleaning operations in which the activity of any radionuclide exceeds the relevant limit set out in Table K-1 (reproduced in Table A.3 below)

Table A.3. Radionuclide annual limit (GBq)

The Table gives the annual discharge limits for radioactive waste arising from decontamination or cleaning operations given as a standard condition in the Scottish Environment Protection Agency's Offshore Installation Registrations. The values in the table are for radium-226, radium-228, lead-210 and polonium-210.

Radionuclide	Annual limit (GBq)
^{226}Ra	2
^{228}Ra	2
^{210}Pb	2
^{210}Po	2

SEPA has assessed the doses for humans and biota for typical exposure pathways resulting from the discharges given in Table A.3 from offshore installations to demonstrate that the doses are below the level of regulatory concern. Results of this assessment could be used to derive exemption levels for liquids discussed in the Section on the Development of exemption values for coastal discharges from onshore oil and gas facilities and Recommendation 8.

It should be noted that in Scotland, under EASR18, an assessment of the impact due to discharges of NORM to water from an onshore installation would be required as for radioactive discharges to water from any other facility.

In England, the EA has produced guidance for the onshore oil and gas sector (EA, 2019b) which sets out when an operator requires a radioactive substances permit. Operators need to have a radioactive substances permit except in the case where the produced water is reinjected for production support[§] or the activity concentration is below the out of the scope NORM values. Re-injection of produced water for disposal from a different site is also allowed but a permit for radioactive substances activity is required. The guidance explains that if the activity does not fall within the standard rules permit (known as SR2014) for NORM wastes from the production of oil and gas (EA, 2014) then the operator needs to apply for a bespoke radioactive substances permit. SR2014 gives limits of 30 MBq for ^{226}Ra and ^{228}Ra[**] in aqueous radioactive waste that can be accumulated on the premises at any one time, for a maximum retention period of 3 months.

For aqueous radioactive waste the following disposal routes are possible:

- transfer to the holder of an environmental permit for the receipt and disposal of aqueous radioactive waste
- disposal in the rock formation adjacent to the well bore for 1) well stimulation fluid remaining in situ and 2) water containing substances resulting from the operation of the production of oil and gas (produced water).

Since currently SR2014 rules do not include disposal to sea, all NORM disposals requiring a permit need to be bespoke and have an accompanying radiological impact assessment.

A.5 Nuclear safeguard requirements

The UK is signatory to the Treaty on the Non-Proliferation of Nuclear Weapons which means that the UK has agreed that the IAEA can, as a consequence of its voluntary offer safeguards agreement, apply safeguards on all civil nuclear material at UK facilities

[§] reinjection for production support is not a waste activity so the liquid is not considered to be radioactive waste.
[**] Limits apply to the specified radionuclides only and do not include decay products

(essentially all forms of uranium, plutonium and thorium). In addition, all civil nuclear material in the Member States of the European Union is subject to the safeguards provisions of Chapter VII of the Euratom Treaty. The safeguards reporting requirements that derive from the Euratom Treaty are detailed in Commission Regulation (Euratom) 302/2005 (CEC, 2005). Regulation 302/2005 includes provision for reduced safeguards oversight for organisations with smaller inventories of material. Euratom safeguards can be terminated for nuclear material that has been irrevocably discarded to the environment as the result of a planned discharge or for holders of end products used for non-nuclear purposes which incorporate nuclear materials that are, in practice, irrecoverable. Operators can request a derogation in the form and frequency of their reporting.

A.6 Other legislative requirements related to the protection of water

When regulating the disposal of liquid waste, the environment agencies also take account of other legislation on the protection of the water environment. This section provides an overview of the main regulations that apply.

A.6.1 Water Framework and Groundwater Directive

The Water Framework Directive (WFD) (EP and CEU, 2000) is concerned with the protection of groundwater against pollution, prevention and limitation of inputs of pollutants to groundwater and prevention of deterioration of status of groundwater bodies. The Directive requires the development and implementation of a strategic framework for the management of the water environment and establishes a common approach to protecting and setting environmental objectives for groundwaters and surface waters within the European Community.

The WFD sets out general provisions for the protection and conservation of groundwater. It sets objectives for groundwater quality, including an objective to meet "good chemical status" by 2015, an objective on pollution trends, and an objective to prevent or limit the input of pollutants to groundwater. The 2006 Groundwater Directive (EC 2006/118/EC; (EP and CEU, 2006)) clarifies these objectives and sets out specific measures to prevent and control groundwater pollution. The goal of good water quality status for all inland and coastal waters will be realised through a range of measures, including the use of environmental quality standards (EQSs) for a number of individual chemicals. There is a general paucity of effects data for many chemicals, often with only short-term laboratory derived toxicity data being available. Where this is the case, a safety factor approach is commonly applied to derive a predicted no effect concentration, which is defined as “a concentration below which an unacceptable effect will most likely not occur” (EC, 2003).

A.6.2 Groundwater protection

The EU Water Framework Directive (WFD) (2000/60/EC) (EP and CEU, 2000) and the Groundwater Directive (2006/118/EC) (EP and CEU, 2006), are implemented in Scotland, Northern Ireland, Wales and England through several legislative instruments referred to in the following sections of this appendix as groundwater protection legislation. Relevant national guidance for England and Wales can be found at (Defra and Welsh Assembly Government, 2010) and (EA, 2019a) and for Scotland at (SEPA, 2014) and (SEPA, 2019). For Northern Ireland, it is available at NI DAERA (DAERA (NI), 2019).

In the UK the regulatory provisions of the groundwater protection legislation for radioactive substances are delivered through RSR permits. For the purposes of the groundwater protection legislation, radioactive substances are considered 'hazardous substances'. Materials or waste that are out-of-scope of the radioactive substances regulations, are not defined as radioactive substances and should be treated as conventional materials or non-radioactive waste (commonly referred to as 'directive waste' under the Waste Framework Directive 2008/98/EC (EP and CEU, 2008b)) in accordance with their non-radioactive properties.

Radioactive waste may contain non-radioactive substances or groups of substances that are considered hazardous substances because they are toxic, persistent and liable to bioaccumulate or because they give rise to an equivalent level of concern. Any other non-radioactive substances or groups of substances in the waste, capable of causing pollution, are considered 'non-hazardous pollutants'.

Groundwater protection legislation requires that:

- inputs of hazardous substances to groundwater are prevented
- inputs of non-hazardous pollutants are limited so as to ensure that pollution of groundwater does not occur

Inputs of radioactive substances to groundwater should be considered in terms of the radiation dose which might be received by people and non-human organisms through the groundwater pathway and any subsequent secondary pathways Defra and Welsh Assembly (Defra and Welsh Assembly Government, 2010; SEPA, 2014).

A.6.2.1 Groundwater regulation in England and Wales

In England and Wales, inputs to groundwater containing radioactive substances that are out-of-scope of the relevant radioactive substances legislation are also considered to be of a "quantity and concentration so small as to obviate any present or future danger of deterioration in the quality of the receiving groundwater". Such an input is therefore not a

groundwater activity under Schedule 22 to EPR16 (UK Parliament, 2016a), based on its radioactive properties. However, the same inputs could still contain pollutants that constitute a groundwater activity based on the non-radioactive properties of the pollutants.

For radioactive substances that are 'in scope' of the relevant radioactive substances regulations, consideration will be given to whether "all necessary and reasonable measures to avoid the entry of hazardous substances into groundwater have been taken" (Defra and Welsh Assembly Government, 2010). In determining which measures are 'reasonable', the principle of optimisation should be observed such that radiation exposures to people through inputs to groundwater are ALARA, taking into account economic and social factors.

Determination of whether the prevention and limitation requirements of the groundwater protection legislation are met in the case of non-radioactive substances associated with radioactive waste should be undertaken using the normal approaches and methods adopted for conventional pollutants, as described in the collection of EA guidance on groundwater protection (EA, 2019a). The other environmental objectives for groundwater set out in Article 4(1)(b) of the WFD, such as preventing deterioration, good status and trends, and for protected areas in Article 4(1)(c), must also be met. Compliance with the prevention and limitation requirements outlined above should enable these objectives to be achieved.

The WFD prohibits the direct discharge of pollutants into groundwater and this is transposed in the Water Environment (Water Framework Directive) (England and Wales) Regulations 2017 (UK Parliament, 2017b). The EA may permit certain direct inputs for a number of specific activities; these are set out in paragraph 8 of Schedule 22 to EPR16 (UK Parliament, 2016a).

A.6.2.2 Groundwater regulation in Scotland

Guidance on the application of the WFD to radioactive substances and to other pollutants is provided for Scotland by the SEPA Position Statement (SEPA, 2014).

In Scotland, the input of hazardous substances to groundwater should be controlled so that they do not pose a risk of deterioration and the input of non-hazardous substances should be limited so that they do not cause pollution.

Radioactive material and radioactive waste are considered to be hazardous pollutants in groundwater. Environmental impact is assessed by comparing the potential radiation exposure people may receive via all pathways from all radioactive substances in a source (or group of sources) against the relevant risk and dose guidance levels.

Assessment of the impact of non-radioactive substances associated with radioactive waste should be undertaken using the normal approaches and methods adopted for conventional pollutants, as described in the SEPA position statement (SEPA, 2014). The statement describes an approach based on compliance with pollutant-specific groundwater quality standards. Inputs above these standards can be permitted by SEPA if they meet a relevant exemption from the measures required to prevent or limit inputs to groundwater set out in the EU Water Framework Directive.

Ground can often be contaminated by both radioactive and non-radioactive substances. Where the groundwater standards for both the radioactive and non-radioactive contamination are being breached, decisions about remedial action and the applicability of an exemption should take account of the joint overall impact from all the contaminants present in the ground in a holistic manner.

A.6.2.3 Groundwater Regulation in Northern Ireland

The WFD and GWD directives are transposed into Legislation in Northern Ireland as the Groundwater Regulations (Northern Ireland) 2009 and subsequent (DOENI, 2009b; DOENI, 2009a) . A central element to groundwater quality protection is the so-called 'prevent and limit' objective: prevent the input of any hazardous substances and limit the input of non-hazardous pollutants into groundwater. Radioactive substances are considered as hazardous substances and therefore their input into groundwater should be prevented. This also includes prohibition of direct discharge into groundwater.

A.6.2.4 Protection of the water environment

In England and Wales, the Water Resources Act 1991 (UK Parliament, 1991b) and EPR16 (UK Parliament, 2016a), in Scotland the Water Environment (Controlled Activities) (Scotland) Regulations 2011 (Scottish Parliament, 2011) and in Northern Ireland the Water Environment (Water Framework Directive) Regulations (Northern Ireland) 2017 (DAERA (NI), 2017a) implement provisions of the Water Framework Directive to regulate activities such as discharges to surface water.

The Water Industry Act 1991 (UK Parliament, 1991a) sets out the main powers and duties of the water and sewerage companies. This Act defines trade effluent as "any liquid, either with or without particles of matter in suspension in the liquid, which is wholly or partly produced in the course of any trade or industry carried on at a trade premises." Trade effluent discharge consents are required for all discharges to sewer covered by the Water Industry Act 1991 with consent provided by the relevant water company. It should be noted that this does not include radioactive discharges since the relevant environment agency regulates the disposal of radioactive waste into a sewer or drain, that is, sewerage undertakers do not have the powers to control the radioactive content of any discharge.

A.6.2.5 Drinking water

The Drinking Water Directive 2013/15/Euratom (CEU, 2013) provides a framework for controlling radioactivity in drinking water and the radiation dose received from the consumption of different forms of drinking water. The Directive applies to tap water and to water in bottles or containers intended for human consumption. The Directive lays down values for radon, tritium, and the 'indicative dose'[††]. The values have an indicative function: they are not limits. Where a value is exceeded the situation will need to be examined more closely. The Directive covers the monitoring requirements for indicator parameters and are reproduced in the Table below.

Table A.4. Parameters for monitoring for radioactivity in drinking water

The Table reproduce the parameters required to be monitored in the Drinking Water Directive 2013/15/Euratom. The Directive applies to tap water and to water in bottles or containers intended for human consumption. The Directive lays down values for radon, tritium, and the 'indicative dose'. Indicative dose is the activity concentration based on an intake of 2 litres per day of drinking water for 1 year that results in an effective dose of 0.1 milli Sievert per year for members of the public.

Parameters	Specification concentration or value	Units of measurement
Indicative dose	0.10	mSv
(a) gross alpha	0.1	Bq l^{-1}
(b) gross beta	1	Bq l^{-1}
Radon	100	Bq l^{-1}
Tritium (for radioactivity)	100	Bq l^{-1}

The Euratom requirements are implemented in the following legislation:

- England – the Water Supply (Water Quality) Regulations 2016 (SI 2016/614) (UK Parliament, 2016b), as amended in 2018 (SI 2018/706)
- Wales – the Water Supply (Water Quality) Regulations (Wales) 2018 (SI 647 (W.121)) (National Assembly for Wales, 2018)
- Scotland – the Private and Public Water Supplies (Miscellaneous Amendments) (Scotland) Regulations 2015 (Scottish Parliament, 2015)
- Northern Ireland – the Water Supply (Water Quality) Regulations (Northern Ireland) 2017 (DAERA (NI), 2017b)

[††] Indicative dose is the activity concentration based on an intake of 2 l d^{-1} of drinking water for 1 year that results in an effective dose of 0.1 mSv y^{-1} for members of the public

Although not a legislative requirement, a comparison of activity concentrations (Bq l^{-1}) of the guidance levels given in the WHO Guidelines for Drinking-water quality (WHO, 2011) with the NORM industrial activities liquids is given below for reference.

Table A.5. Comparison of activity concentrations for NORM liquids

This table gives a comparison of activity concentrations for naturally occurring radioactive liquids, Becquerels per litre, between the guidance levels given in the World Health Organization Guidelines for Drinking-water Quality and the values given in UK legislation for defining whether it is a radioactive material.

Radionuclide	WHO Guidance level (Bq l^{-1})*	NORM industrial activities 'Any other liquid' (Bq l^{-1})
^{238}U	10	0.1
^{234}U	1	10
^{230}Th	1	10
^{226}Ra	1	1
^{210}Pb	0.1	0.1
^{210}Po	0.1	0.1
^{232}Th	1	10
^{228}Ra	0.1	0.1

*At an intake of 2 l d^{-1} for a year that results in an effective dose of 1 mSv y^{-1}

A.6.2.6 Discussion

The regulatory approaches to the liquid discharges of radioactive and non-radioactive hazardous substances are different. The risks from radioactive discharges are limited and optimised in terms of dose whereas the risks from non-radioactive hazardous substances are limited through the use of Environmental Quality Standards which are based on observed effects with safety factors having been applied. There are no out of scope values for either radioactive or non-radioactive liquid discharges (except for naturally occurring radionuclides), but conditional exemption values do exist for radionuclides. The list of hazardous substances to surface waters and groundwater is continually being developed by the UK advisory groups with no definitive list given in UK legislation and permitting of non-radioactive hazardous discharges being done on a case by case basis. This creates a difficulty in developing an alternative definition of a relevant liquid.

A.7 Other relevant standards and policies

A.7.1 Directive 2010/75/EU on industrial emissions (integrated pollution prevention and control)

This is the main directive (EP and CEU, 2010) regulating pollutant emissions from industrial installations. The Industrial Emissions Directive (IED) is based on several pillars, such as an integrated approach, the use of best available techniques, flexibility, inspections and public participation.

The requirements of the IED were transposed into Environmental Permitting (England and Wales) Regulations 2010 (UK Parliament, 2010) but does not have any major impact on the section of that legislation related to radioactive substances activities.

A.7.2 Directive 2008/56/EC establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive)

The Marine Directive (EP and CEU, 2008a) aims to achieve Good Environmental Status (GES) of the EU's marine waters by 2020. In order to achieve GES by 2020, each Member State is required to develop a strategy for its marine waters (or Marine Strategy). The Directive lists 4 European marine regions, one of which is the North-East Atlantic Ocean. OSPAR has played the primary role in coordinating the implementation of the Directive in this marine region (see Section on OSPAR for further details).

A.7.3 Directive 1992/43/EEC on the conservation of natural habitats and of wild fauna and flora (Habitats Directive)

The Council Directive 92/43/EEC (the Habitats Directive (CEC, 1992)) on the conservation of natural habitats and of wild fauna and flora requires competent authorities to carry out an appropriate assessment in circumstances where a plan or project is likely to significantly affect a European site or a European Marine site. The environment agencies are required to undertake Habitat Regulations Assessment for these designated sites‡‡ called collectively Natura 2000 sites under the Conservation of Habitats and Species Regulations 2017 (Habitats Regulations) (UK Parliament, 2017a). In Scotland, the Habitats Directive is transposed through a combination of the Habitats Regulations 2017 (UK Parliament, 2017a) (in relation to reserved matters) and the Conservation (Natural Habitats &c.) Regulations 1994 (UK Parliament, 1994).

‡‡ These include, Special Areas of Conservation (SACs) which are designated under the EC Habitats Directive for important high quality habitat sites, and Special Protection Areas (SPAs), designated under the EC Birds Directive, classified for rare and vulnerable birds (as listed on Annex I of the Directive), and for regularly occurring migratory species, Ramsar sites are wetlands of international importance designated under the Ramsar Convention and Government policy gives Ramsar sites broad equivalence to those designated under the Birds and Habitats Directives. Collectively they are known as Natura 2000 sites.

The Conservation (Natural Habitats, and so on). Regulations (Northern Ireland) 1995 (as amended) (DOENI, 1995) transpose the Habitats Directive in relation to Northern Ireland.

Under the Habitats Regulations, the EA, Natural Resources Wales and SEPA have obligations to review existing authorisations/permits to ensure that no authorised activity or permission results in an adverse effect, either directly or indirectly, on the integrity of Natura 2000 habitat sites. In England and Wales, total dose rates were assessed for Natura 2000 sites and were compared to a threshold of 40 μGy h^{-1}. This was the dose rate below which the EA, Natural England and the Countryside Council for Wales agreed there would be no adverse effect to the integrity of a Natura 2000 site (Allott et al, 2009). This dose rate ties in with the derived consideration reference level bands given by ICRP (ICRP, 2014).

SEPA has carried out a Pressures and Impacts Assessment from radioactive substances on Scotland's water environment. The study concluded that there was no adverse impact on the aquatic environment as a result of authorised discharges of radioactive substances, although it recognised that there may be a need for further data to support this conclusion (SEPA, 2004). The report provides 2 sets of screening levels that should be used for the assessment: those produced by the US Department of Environment (US DoE, 2002) and those produced by the Environment Agency (Copplestone et al, 2001). SEPA has included a specific habitats assessment in any new authorisation granted by the agency.

A.8 References

Allott R, Copplestone D, Merrill P and Oliver S (2009). *Habitats assessment for radioactive substances.* Environment Agency, Bristol, SC060083/SR1.

BEIS (2018). *UK Strategy for Radioactive Discharges: 2018 Review of the 2009 Strategy.* Department for Business, Energy & Industrial Strategy, London.

BEIS, Defra, Welsh Government and DAERA (NI) (2018). *Scope of and exemptions from the radioactive substances legislation in England, Wales and Northern Ireland.* Department for Business, Energy & Industrial Strategy, London.

CEC (1992). Council Directive 92 /43 /EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora (Habitats Directive). *Official Journal of the European Communities* **35**(L206), 7-50.

CEC (2005). Commission Regulation (Euratom) No 302/2005 of 8 February 2005 on the application of Euratom safeguards. *Official Journal of the European Union* **48**(L54), 1-71.

CEU (2013). Council Directive 2013/51/Euratom laying down requirements for the provision of the health of the general public with regards to radioactive substances in water intended for human consumption. *Official Journal of the European Union* **56**(L296), 12-21.

CEU (2014). Council Directive 2013/59/Euratom of 5 December 2013 Laying Down Basic Safety Standards for Protection Aginst the Dangers Arising from Exposure to Ionising Radiation, and Repealing Directives 89/618/Euratom, 90/641/Euratom, 96/29/Euratom, 97/43/Euratom and 2003/122/Euratom. *Official Journal of the European Union* **57**(L13), 1-73.

Copplestone D, Bielby S, Jones SR, Patton D, Daniel P and Gize I (2001). *Impact assessment of ionising radiation on wildlife.* Environment Agency, Bristol, R&D Publication 128.

DAERA (NI) (2017a). *Water Environment (Water Framework Directive) Regulations (Northern Ireland) 2017*. (2017 No. 81)

DAERA (NI) (2017b). *The Water Supply (Water Quality) Regulations (Northern Ireland) 2017*. (2017 No. 212)

DAERA (NI) (2019). *Groundwater Hazardous Substances Standards.* [Online] Available at https://www.daera-ni.gov.uk/publications/groundwater-hazardous-substances-standards [accessed 30-Mar-2019]

DECC (2009). *Statutory Guidance to the Environment Agency concerning the regulation of radioactive discharges into the environment.*

DECC, Welsh Assembly Government, DOENI and Scottish Government (2009). *UK Strategy for Radioactive Discharges.* Department of Energy and Climate Change, London.

DECC, Welsh Government, DOENI and Scottish Government (2014). *Strategy for the management of Naturally Occurring Radioactive Material (NORM) waste in the United Kingdom.* Scottish Government, Edinburgh.

Defra and Welsh Assembly Government (2010). *Environmental Permitting Guidance Groundwater Activities.* Department for Environment, Food and Rural Affairs, London, Version 1.0.

DOE, Scottish Office and Welsh Office (1995). *Review of Radioactive Waste Management Policy. Final Conclusions.* Command Paper (Cm) 2919.

DOENI (1995). *The. Conservation (Natural Habitats, etc.) Regulations (Northern lreland) 1995*. (No.380)

DOENI (2009a). *Groundwater (Amendment) Regulations (Northern Ireland) 2009*. (2009 No. 359)

DOENI (2009b). *Groundwater Regulations (Northern Ireland) 2009*. (2009 No. 254)

DOENI (2011). *The Radioactive Substances Exemption (Northern Ireland) Order 2011*. (No. 289)

EA (2010). *Radioactive Substances Regulation – Environmental Principles.* Environment Agency, Bristol, Regulatory Guidance Series No RSR 1.

EA (2012). *Criteria for setting limits on the discharge of radioactive waste from nuclear sites.* Environment Agency, Bristol, Version 1.

EA (2014). *Accumulation and disposal of radioactive waste from the NORM Industrial Activity of the production of oil and gas.* Environment Agency, Standard Rules SR2014 No 4.

EA (2019a). *The collection of Environment Agency guidance on groundwater protection.* [Online] Available at https://www.gov.uk/government/collections/groundwater-protection [accessed 2019]

EA (2019b). *Onshore oil and gas sector guidance: Radioactive substances activity permits.* [Online] Available at https://www.gov.uk/guidance/onshore-oil-and-gas-sector-guidance/4-radioactive-substances-activity-permits [accessed 2019]

EA, SEPA, NIEA, HPA and FSA (2012). *Principles for the Assessment of Prospective Public Doses arising from Authorised Discharges of Radioactive Waste to the Environment.* Environment Agency, Penrith, August 2012.

EC (1993). *Principles and Methods for Establishing Concentrations and Quantities (Exemption values) Below which Reporting is not Required in the European Directive.* European Commission, Luxembourg, Radiation Protection 65.

EC (2002). *Practical use of the concepts of clearance and exemption - Part II: Application of the concepts of exemption and clearance to natural radiation sources.* European Commission, Luxembourg, Radiation Protection 122.

EC (2003). *Technical Guidance Document on Risk Assessment in support of Commission Directive 93/67/EEC on risk assessment for new notified substances and Commission Regulation (EC) No 1488/94 on risk assessment for existing substances, Directive 98/8/EC of the European Parliament and of the Council concerning the placing of biocidal products on the market. Part II.* Luxembourh.

EP and CEU (2000). Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy. *Official Journal of the European Communities* **43**(L327).

EP and CEU (2006). Directive 2006/118/EC of the European Parliament and of the Council of 12 December 2006 on the protection of groundwater against pollution and deterioration. *Official Journal of the European Union* **49**(L372), 19-31.

EP and CEU (2008a). Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive). *Official Journal of the European Union* **L164**, 19-40.

EP and CEU (2008b). Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives Text with EEA relevance. *Official Journal of the European Union* **51**(L312), 3-30.

EP and CEU (2008c). Regulation (EC) No 1272/2008 of the European Parliament and of the Council of 16 December 2008 on classification, labelling and packaging of substances and mixtures, amending and repealing Directives 67/548/EEC and 1999/45/EC, and amending Regulation (EC) No 1907/2006. *Official Journal of the European Union* **51**(L353), 1-1355.

EP and CEU (2010). Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control) (Recast). *Official Journal of the European Union* **53**(L334), 17-119.

EU (2010). *The EURATOM Treaty Consolidated Version.* Publications Office of the European Union, Luxembourg.

Ewers LW and Mobbs SF (2010). *Derivation of Liquid Exclusion or Exemption Levels to Support the RSA93 Exemption Order Review.* Health Protection Agency, Chilton, UK, HPA-CRCE-005.

IAEA (1997). *Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management.* International Atomic Energy Agency, Vienna, INFCIRC/546.

IAEA (1998). *Clearance of materials resulting from the use of radionuclides in medicine, industry and research.* International Atomic Energy Agency, Vienna, IAEA-TECDOC-1000.

IAEA (2004). *Application of the Concepts of Exclusion, Exemption and Clearance.* International Atomic Energy Agency, Vienna, RS-G-1.7.

IAEA (2006). *Fundamental Safety Principles.* International Atomic Energy Agency, Vienna, IAEA Safety Standards No SF-1.

IAEA (2013). *Definition of Radiological Environmental Assessment Criteria for the OSPAR Convention: a Proposal by the IAEA for Consideration by the RSC – IAEA Contribution to RSC 2013.* International Atomic Energy Agency, Vienna, Ref. RSC 13/7/1.

IAEA (2014). *Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards.* International Atomic Energy Agency, Vienna, General Safety Requirements Part 3 (GSR Part 3).

ICRP (2007a). The 2007 Recommendations of the International Commission on Radiological Protection. ICRP Publication 103. *Annals of the ICRP* **37**(2-4).

ICRP (2007b). Scope of Radiological Protection Control Measures. ICRP Publication 104. *Annals of the ICRP* **37**(5), 1-106.

ICRP (2008). Environmental Protection: the Concept and Use of Reference Animals and Plants. ICRP Publication 108. *Annals of the ICRP* **38**(4–6), 19-39.

ICRP (2014). Protection of the environment under different exposure situations. ICRP Publication 124. *Annals of the ICRP* **43**(1), 1-58.

National Assembly for Wales (2018). *The Water Supply (Water Quality) Regulations 2018*. (2018 No. 647 (W.121))

NIEA, SEPA and EA (2013). *Exemption Guidance: Guidance on interpretation of "Relevant Liquid".* February 2013, Version 1.

Northern Ireland Assembly (2003). *Radioactive Substances (Basic Safety Standards) Regulations (Northern Ireland) 2003*. (NISR 2003/208)

NRPB (2005). Generalised Derived Limits for Radioisotopes of Hydrogen, Carbon, Phosphorus, Sulphur, Chromium, Manganese, Cobalt, Zinc, Selenium, Technetium, Antimony, Thorium and Neptunium. *Documents of the NRPB* **16**(3), 45.

OSPAR Commission (1992). *1992 OSPAR Convention: Convention for the Protection of the Marine Environment of the North-East Atlantic.* OSPAR Commission, Text as amended on 24 July 1998, updated 9 May 2002, 7 February 2005 and 18 May 2006. Amendments to Annexes II and III adopted at OSPAR 2007.

OSPAR Commission (2013). *UK Report on application of Best Available Techniques (BAT) in civil nuclear facilities (2008-2011).* OSPAR commission, London, Publication number: 592/2013.

OSPAR Commission (2016). *Agreement on a methodology for deriving environmental assessment criteria and their application.* OSPAR commission, London, OSPAR Agreement 2016-07.

Scottish Government (2008). *Environment Act 1995: The UK Strategy for Radioactive Discharges: Statutory Guidance.* Scottish Government, Edinburgh, SG/2008/13.

Scottish Parliament (2011). *The Water Environment (Controlled Activities) (Scotland) Regulations 2011*. (2011 No. 209)

Scottish Parliament (2015). *The Private and Public Water Supplies (Miscellaneous Amendments) (Scotland) Regulations 2015*. (No. 346)

Scottish Parliament (2018). *Environmental Protection: The Environmental Authorisations (Scotland) Regulations 2018*. (No. 219)

SEPA (2004). *Water Framework Directive – Assessment of pressures and impacts on Scotland's water environment from radioactive substances.*

SEPA (2012). *Satisfying the ALARA requirement and the role of Best Practicable Means.* Scottish Environment Protection Agency, Issue 1.1.

SEPA (2014). *Assigning Groundwater Assessment Criteria for Pollutant Inputs.* Scottish Environment Protection Agency, Position Statement (WAT-PS-10-01): Version 3.0.

SEPA (2018). *Environmental Authorisations (Scotland) Regulations 2018: Standard Conditions for radioactive substances activities.* Scottish Environment Protection Agency, RS-S-100.

SEPA (2019). *SEPA guidance on water protection.* [Online] Available at https://www.sepa.org.uk/regulations/water/pollution-control/pollution-control-guidance [accessed]
SNIFFER (2005). *A Review of the Application of 'Best Practicable Means' within a Regulatory Framework for Managing Radioactive Wastes.* Scotland & Northern Ireland Forum for Environmental Research, Edinburgh, UKRSR05.
UK Parliament (1960). *Radioactive Substances Act 1960*. (Chapter 34)
UK Parliament (1991a). *The Water Industry Act 1991*. (Chapter 56)
UK Parliament (1991b). *The Water Resources Act 1991*. (Chapter 57)
UK Parliament (1993). *The Radioactive Substances Act 1993*. (Chapter 12)
UK Parliament (1994). *The. Conservation (Natural Habitats, etc.) Regulations 1994*. (No. 2719)
UK Parliament (2010). *The Environmental Permitting (England and Wales) Regulations 2010*. (SI 2010/675)
UK Parliament (2016a). *The Environmental Permitting (England and Wales) Regulations 2016*. (SI 2016/1151)
UK Parliament (2016b). *The Water Supply (Water Quality) Regulations 2016*. (2016 No. 614)
UK Parliament (2017a). *The Conservation of Habitats and Species Regulations 2017*. (2017 No.1012)
UK Parliament (2017b). *The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017*. (2017 No. 407)
US DoE (2002). *A Graded Approach For Evaluating Radiation Doses To Aquatic And Terrestrial Biota.* US Department of Energy, Washington, DOE-STD-1153-2002.
WHO (2011). *Guidelines for Drinking-water Quality. Fourth Edition.* World Health Organization, Geneva.

Appendix B Review of arrangements in other countries

B.1 Background

The United Kingdom, through a project commissioned by the UK's Department for Business, Energy and Industrial Strategy (BEIS), is reviewing its approach to regulating radioactive liquid discharges, particularly those containing very low levels of radionuclides, to ensure that it is fit for purpose; it reflects international standards, requirements and best practice; it is underpinned by coherent policy; it protects the public and environment; and it does not place unnecessary burden on business or regulators.

As part of this work, arrangements for handling liquid radioactive wastes in other countries were reviewed. This document describes how the information was gathered and outlines the key points found and compares the findings with the current regulatory regime in the UK as part of the final summary.

A questionnaire was devised to elicit information on regulatory regimes for liquid radioactive waste. The 5 questions included in the questionnaire covered:

- whether there are exclusion, exemption or clearance provisions for liquid waste and the source of any values (Questions 1 and 2)
- whether specific industry sectors are exempted (Questions 1 and 2)
- what conditions, if any, are imposed on disposal routes (Questions 1 and 2)
- how are non-exempt discharges regulated (Question 3)
- whether radioactive liquids are classified according to properties other than their radioactive content (Question 4)
- any requirements or guidance on when measurement should take place and any prescribed measurement methods (Question 5)

In order to help the responders complete the questionnaire, an example of a questionnaire completed from the perspective of the UK was also provided. The full text of the questionnaire is reproduced in Appendix C along with the UK's example answers.

Questionnaires were sent to representatives either by direct contact or through networks such as the International Atomic Energy Agency's (IAEA) Waste Safety Standards Committee (WASSC), the European NORM Association, the OSPAR Radioactive Substances Committee and the European Radioprotection Authority Network.

B.2 Responses received

Responses were received from representatives of 21 countries, 15 of which were European Union Member States. For the majority of countries, a single response was received from the authority that regulates radioactive discharges or nuclear safety, or, in a few cases, from technical supporting organisations. The exceptions were: Germany, from which there were 5 responses, one from the Federal Office for Radiation Protection (Bundesamt für Strahlenschutz, BfS) and others from consultants with expertise in the area; and Belgium, from which there were 2 responses, both from the Federal Agency for Nuclear Control (Federaal Agentschap voor Nucleaire Controle, FANC). The responding countries and organisations are given in **Table B.1**.

Table B.1. Responding countries and organisations

This table give the organisations and their country of origin who responded to the questionnaire on their regulatory regimes for dealing with liquid radioactive waste.

Country	Responding organisation
Argentina	Nuclear Regulatory Authority (Autoridad Regulatoria Nuclear, ARN)
Australia	Australian Radiation Protection and Nuclear Safety Agency (ARPANSA)
Austria	Agency for Health and Food Safety (Agentur für Gesundheit und Ernährungssicherheit GmbH, AGES)
Belgium	Federal Agency for Nuclear Control (Federaal Agentschap voor Nucleaire Controle, FANC) (2 responses)
Bulgaria	Nuclear Regulatory Agency (Agentsiyata za yadreno regulirane, NRA)
Canada	Canadian Nuclear Safety Commission (CNSC/CCSN)
Czech Republic	State Office for Nuclear Safety (Státní úřad pro jadernou bezpečnost, SÚJB)
France	Nuclear Safety Authority (Autorité de sûreté nucléaire, ASN)
Germany	Brenk Systemplanung GmbH
Germany	Federal Office for Radiation Protection (Bundesamt für Strahlenschutz, BfS)
Germany	(consultant)
Germany	Federal Ministry for the Environment Nature Conservation and Nuclear Safety (Bundesministerium für Umwelt, Naturschutz und nukleare Sicherheit, BMU), Society for Plant and Reactor Safety (Gesellschaft für Anlagen- und Reaktorsicherheit, GRS) (joint response)
Germany	IAF-Radioökologie GmbH
Hungary	Hungarian Atomic Energy Authority (Országos Atomenergia Hivatal, HAEA)
Ireland	Environmental Protection Agency (EPA)

Country	Responding organisation
Italy	Environmental Protection Agency of Veneto (Agenzia Regionale per la Prevenzione e Protezione Ambientale del Veneto, ARPAV), National Institute of Health (Istituto Superiore di Sanità, ISS) (joint response)
Latvia	State Environmental Service Radiation Safety Centre (Valsts vides dienesta Radiācijas drošības centrs, VVD RDC)
Lithuania	Radiation Protection Centre (Radiacinės saugos centras, RSC)
The Netherlands	National Institute for Public Health and Environment (Rijksinstituut voor Volksgezondheid en Milieu, RIVM), Authority for Nuclear Safety and Radiation Protection (Autoriteit Nucleaire Veiligheid en Stralingsbescherming, ANVS) (joint response)
Norway	Norwegian Radiation Protection Authority (Statens strålevern, NRPA)
Romania	National Commission for Nuclear Activities Control (Comisia Nationala pentru Controlul Activitatilor Nucleare, CNCAN)
Spain	Nuclear Safety Council (Consejo de Seguridad Nuclear, CSN)
Sweden	Swedish Radiation Safety Authority (Strålsäkerhetsmyndigheten, SSM)
Switzerland	Federal Office of Public Health Division of Radiological Protection (Bundesamt für Gesundheit, BAG)
USA	United States Nuclear Regulatory Commission (U.S. NRC)

The verbatim answers received are presented in Appendix D along with responses to supplemental queries where relevant. The responses to each question are summarised in the following sub-sections and, where possible, similar responses have been grouped together. It should be noted that in some cases the terms clearance and exemption have been used interchangeably, as have the terms dose criterion, dose constraint and dose limit.

B.2.1 Question 1: Liquids containing small amounts of artificial radionuclides

Most respondents provided details about both exemption and clearance levels and responses have been grouped accordingly. Additionally, a few respondents provided information on exempt practices. The Czech Republic provided no response to this question and is therefore not listed in the summaries below.

B.2.1.1 Clearance values

Nine of the responding countries have clearance levels for liquids based on the IAEA Basic Safety Standards (IAEA GSR Part 3) (IAEA, 2014) or, in the case of the 6 EU Member States, the Euratom Basic Safety Standards Directive (Euratom BSSD) CEU, 2014 (CEU, 2014). The values in these documents are identical and derive from the IAEA Safety Guide 'Application of the Concepts of Exclusion, Exemption and Clearance'

(IAEA RS-G-1.7) (IAEA, 2004) and are intended for application to solids only. Some responding countries have additional criteria (for example, Germany restricts clearance to certain types of liquid) and Switzerland has an extended set of clearance levels. Of the remaining responding countries, 6 have no clearance values or no provisions for clearance of liquids, and the remaining 5 have adopted a variety of processes for clearing liquids containing small amounts of artificial radionuclides.

The bullets below give a brief summary of the approaches of all the responding countries:

- countries with no clearance values and/or provisions for liquids
    - Argentina, Latvia, Spain
    - Italy has no clearance values but does have unconditional exemption values (see Section B3.1.2)
    - Lithuania has no specific clearance levels but effluents may be discharged from authorised non-nuclear practices if activity is below IAEA-TECDOC-1000 (IAEA, 1998)
    - There are no clearance values in the USA but legislation allows for case-by-case clearance taking potential impacts to humans and the environment into consideration
- countries with clearance values based on IAEA BSS or Euratom BSSD (IAEA RS-G-1.7 artificial radionuclides) (CEU, 2014; IAEA, 2004; IAEA, 2014)
    - Australia (from mid-2019), Bulgaria, Canada, Ireland, Romania
    - Belgium currently has no generic clearance levels for liquids, but the implementation of the Euratom BSSD will introduce clearance levels for moderate quantities (defined as < 1 tonne per year in Belgian legislation) of non-aqueous waste; for larger quantities or activity concentrations above clearance levels, a clearance licence may be issued if an impact study shows that doses are below 10 μSv y^{-1}
    - Germany has clearance levels for oils, oil-based liquids, organic solvents and coolants on the basis they will not be concentrated; for aqueous discharges the operator must demonstrate that the effluent will not be concentrated. There are also clearance levels specifically for disposal to incineration for all liquids
    - Sweden additionally has levels for clearance to incineration of hazardous waste which are based on 10 × clearance levels in RP 122 Part I (EC, 2000)
    - Switzerland has clearance levels based on the interim edition of IAEA BSS (IAEA, 2011) and extended by work detailed in Brenk Systemplanung (2012)
- countries with alternative arrangements
    - Austria uses unconditional clearance values calculated in Brenk Systemplanung (2018). The report was commissioned by Germany's

Bundesamt für Strahlenschutz (BfS) in preparation for implementing the new Euratom BSSD. The report concludes that, for the values for aqueous liquid releases, provided they are less than 100 m^3 per year, are released to sewer or for irrigation of green areas, and the levels are below those in Appendix VII, Table 4, Column 3 of the Radiation Protection Ordinance, then it can be demonstrated that the dose to a member of the public will never exceed 10 µSv y^{-1}

- France uses decay storage to less than 10 Bq l^{-1} followed by disposal to sewer for radionuclides with half-life less than 100 days[§§]. Liquids containing radionuclides with longer half-lives are considered radioactive waste and handled as such
- Hungary allows for clearance of ampoule quantities if the activity has decayed below exemption levels. For hazardous liquids that cannot be discharged to sewer or surface water and with very low levels of activity, the liquid can be cleared if the activity has decayed below the exemption level or doses from management of the waste are below 30 µSv y^{-1}
- The Netherlands has clearance levels for any material (including liquids) for 64 radionuclides, based on very conservative calculations and dose criteria of 1 µSv y^{-1} for inhalation and ingestion, 10 µSv y^{-1} for external exposure and 10 µSv y^{-1} for skin exposure. Any material can also be cleared for incineration based on clearance levels in Annex VII Table A part 1 of the Euratom BSSD (CEU, 2014) and in its extension by Brenk Systemplanung (2012)
- Norway has activity constraints for both activity and activity concentration and a discharge permit is required to discharge any material (including liquids) if either the activity or activity concentration constraints are exceeded

B.2.1.2 Exemption values

Respondents described a wider variety in approaches to exemption compared to clearance. Argentina and Spain have no provisions for exemption (as with clearance), although Argentina does use values from IAEA BSS (IAEA, 2014) for very low volumes. Two countries do not specifically mention exemption, although (as noted above) some respondents used the terms clearance and exemption interchangeably and it may be that they are the same for these countries. By far the largest group has exemption values based on the EC report 'Principles and Methods for Establishing Concentrations and Quantities (Exemption values) Below which Reporting is not Required in the European Directive' (RP 65) (EC, 1993), or on Table B, Annex VII of the Euratom BSSD (CEU, 2014; EC, 1993), which were derived from RP 65.

[§§] A later clarification indicated that this applied specifically to medical isotopes but no further comments were received

The provisions and approaches to exemption are summarised in the bullets below:

- countries that did not specifically mention exemption
    - Austria, France
- countries with no specific provision for exemption
    - Spain
    - Argentina has no specific exemption values but uses IAEA BSS (IAEA, 2014) for very low volumes
- countries with the same arrangements as for clearance
    - Lithuania, Norway, Switzerland
- countries that have exemption values but do not give their source
    - USA
- countries with values based on the former or current Euratom BSSD or RP 65 (CEU, 1996; CEU, 2014; EC, 1993)
    - Belgium, Bulgaria, Germany, Ireland, Romania, Sweden
    - Australia has additional dose criteria that must be satisfied if activity or activity concentration is above RP 65 values
    - Latvia has the same values as Annex VII Table B of the Euratom BSSD (CEU, 2014). The values have been in legislation since before the Directive was introduced and may, therefore, have been taken from the former Euratom BSSD (CEU, 1996)
    - The Netherlands also has an extended set of radionuclides based on NRPB-R306 (Mobbs and Harvey, 1999)
- countries with alternative arrangements
    - Canada uses IAEA BSS (IAEA, 2014) Table I.1 for volumes of less than 1 tonne and Table I.2 for volumes greater
    - Italy unconditionally exempts liquid effluents where the half-life of the radionuclide is less than 75 days and the activity concentration is less than 1 Bq g^{-1}
    - Hungary has values based on current Euratom BSSD and IAEA BSS (CEU, 2014; IAEA, 2014) for moderate amounts (less than 1 tonne) of any type of material and applies the exemption levels for bulk amounts to both solid and liquid materials

B.2.1.3.Exempted practices

Australia, Ireland and Switzerland were the only respondents to explicitly address exempted practices. Their responses are summarised in the bullets below:

- Australia also exempts practices on the same basis as materials
- Ireland exempts practices if it can be shown that
    - they involve handling small amounts of radioactivity below the exemption values.

    - or workers should not be classified as exposed workers and dose criteria for members of the public are met in all reasonable circumstances.
- Switzerland, practices can use higher exemption values if there are no discharges

B.2.2 Question 2: Liquids containing small amounts of NORM

Responses concerning liquids containing small amounts of NORM were less amenable to grouping and, in general, respondents did not identify separate provisions for clearance, exclusion and exemption. The straightforward groupings were those who took values from IAEA BSS or the Euratom BSSD (CEU, 2014; IAEA, 2014) (9 countries) and those who used values from the EC report 'Practical use of the concepts of clearance and exemption' (RP 122) (EC, 2000; EC, 2002) (two countries). The remaining 9 countries have a variety of approaches. The responses are summarised below, including explicit mentions of clearance and exemption:

- countries with values from IAEA BSS or Euratom BSSD (CEU, 2014; IAEA, 2014)
    - Argentina, for very low volumes of liquids.
    - Australia (clearance), Belgium (currently implementing into national legislation), Hungary, Sweden (exemption).
    - Bulgaria additionally has activity limits for surface and groundwater from uranium mining and milling operations.
    - Latvia states that there is no industry that creates NORM-containing liquids; nevertheless, legislation includes provision for exemption if the practice does concentrate its activity, the activity concentration is below 1 Bq g^{-1} and dose is below 1 mSv y^{-1}.
    - Romania for non-nuclear NORM only; all nuclear NORM waste must be licensed.
    - Switzerland, with extra conditions (dose constraint of 0.3 mSv y^{-1} for publicly accessible water, radionuclide-specific activity limits for drinking water).
- countries with values from RP 122 Part I or II (EC, 2000; EC, 2002)
    - The Netherlands has specific clearance values for disposal to specified landfill of wet sludge produced by the oil and gas industry based on RP 122 Part II.
    - Sweden has general clearance values based on RP 122 Part I and clearance values for hazardous waste to incineration or disposal based on 10 times RP 122 Part I values.
- countries with alternative arrangements
    - Australia excludes exposures not amenable to control and has exemption levels based on IAEA Safety Series No. 115 (IAEA, 1996)
    - Austria requires no authorisation below 1.5 Bq l^{-1}; above requires assessment showing doses are below 0.3 mSv y^{-1}.

- Canada has limits for discharge of water soluble effluents from nuclear industry based on IAEA-TECDOC-1000 (IAEA, 1998), non-nuclear sectors are exempt unless material is being transported or imported/exported when relevant regulations apply.
- Czech Republic has clearance levels based on a dose limit of 1 mSv y^{-1} for consumption of surface water. For disposal into surface water resulting activity concentrations are $\alpha < 0.5$ Bq l^{-1} and $\beta < 1$ Bq l^{-1} after deduction of contribution from ^{40}K. For disposal into the sewer system, the resulting activity concentrations are $\alpha < 50$ Bq l^{-1} and $\beta < 100$ Bq l^{-1} after deduction of contribution from ^{40}K.
- France uses decay storage to less than 10 Bq l^{-1} followed by disposal to sewer for radionuclides with half-life less than 100 days. (A later clarification indicated that this applied specifically to medical isotopes but no further comments were received.) Liquids containing radionuclides with longer half-lives are considered radioactive waste and handled as such.
- Germany has no specific regulation for NORM liquids but note that no liquid can be disposed of to landfill and must be solidified.
- Ireland has no nuclear sector; sector-specific surveys of non-nuclear sector demonstrated that worker doses were below 1 mSv y^{-1} and public doses considerably lower, therefore there is no perceived need for regulation.
- Italy excludes liquid effluents containing NORM unless they are from a NORM industrial practice as defined in Italian legislation and derived from the former Euratom BSSD (CEU, 1996). For NORM industrial practices there is an action level of 300 µSv y^{-1} to members of the public which includes liquids; national guidelines refer to screening levels in the EC report *Effluent and Dose control from European Union NORM industries. Assessment of current situation and proposal for harmonised Community approach* (RP 135) (EC, 2003).
- Lithuania stated that it has no NORM industry and therefore no NORM legislation.
- The Netherlands has screening levels for discharges of all NORM (including liquids) to water given in Table B3, based on a dose criterion of 10 µSv per year for a member of the public and 1 manSv per year for the population.
- Norway has activity constraints for both activity and activity concentration and a discharge permit is required to discharge any material (including liquids) if either the activity or activity concentration constraints are exceeded.
- Spain excludes non-nuclear industries; nuclear industries can dispose under licence with a dose constraint of 0.3 mSv y^{-1}.

- USA exempts materials (for example, liquids, alloys, and so on) where the NORM content by mass is less than 0.05% of the mass of the substance.

B.2.3 Question 3: Permitting/authorisation regime

Twelve of the 20 responding countries grant permits or authorisations on a case-by-case basis only and 4 have general release values. Three countries (Canada, Germany and Hungary) distinguish between large or special facilities which are granted permits on a case-by-case basis and smaller facilities which can make use of general release values. Switzerland has a tiered approach for authorised practices which incorporates general release limits and a drinking water dose criterion. The Netherlands has screening levels in total activity per year for discharges to water (including liquids) and discharges above these limits require licensing.

All the responses are grouped and summarised in the bullet points below:

(Note that the Czech Republic response did not give details of the permitting or authorisation regime and is not included in the discussion below).

- countries where permits or authorisations are granted on a case-by-case basis
  - Argentina, Australia, Austria, France (authorisations include limits), Italy (a dose limit of 10 μSv y^{-1} is applied), Lithuania (a dose constraint 0.2 mSv y^{-1} is applied), the Netherlands (licences include discharge limits), Romania.
  - Belgium requires registration for NORM discharges below activity levels in RP 135 (EC, 2003) and licensing above RP 135 levels up to a dose limit of 0.3 mSv y^{-1}. No methodology/dose constraint is given for artificial radionuclides.
  - Canada includes a Derived Release Limit (DRL), based on a dose constraint of 1 mSv y^{-1}, in authorisations for most facilities.
  - Germany applies a dose limit of 1 mSv y^{-1} to an installation and all its nearby sources. A guideline (laid down in a General Administrative Procedure) describes how to model and calculate doses for gaseous and liquid discharges. The guideline is conservative and includes parameter values.
  - Hungary's competent environmental protection authority approves annual discharge limits for 'special facilities' (for example, nuclear facility, uranium mine, radioactive waste facility, level A laboratory). The calculations should take account of all possible discharge routes and are based on dose criteria set by the competent radiation safety authority.
  - Norway issues discharge permits that have an upper annual discharge limit. Discharge limits are based on dose constraints, for example, public dose limit for sewage workers for liquids discharged to the sewer system.
  - Spain applies a dose criterion of 0.1 mSv y^{-1} plus the liquid must be water soluble/easily dispersible. Activity concentration must be less than (adult

drinking water limit) divided by (adult drinking water ingestion rate). The sum rule applies for mixtures of radionuclides with annual limits of 10 GBq for ^{3}H, 1 GBq for ^{14}C and 1 GBq for the sum of all others.

- Sweden has a dose constraint of 0.1 mSv y^{-1} plus limits on activity in each release (must be less than column 3, Table B, Annex VII, Euratom BSSD) and per month (must be less than 10 × column 3, Table B, Annex VII, Euratom BSSD) (CEU, 2014).

- countries with generic limits for discharges
  - Bulgaria has generic discharge limits based on IAEA TECDOC 1000 (IAEA, 1998).
  - Germany has generic discharge limits for 'small installations', that is, medical, industrial or technical users. The discharge limits are derived on a conservative basis, not using IAEA-TECDOC-1000 but a similar methodology.
  - Hungary has general annual discharge limits for all other facilities (see above for 'special facilities'). The limits are based on one-fifth of the discharge that would give a dose of 30 µSv to the reference group living 500 m from the point of inflow to surface water and minimal flow less than 10 m^3 s^{-1}. For minimal water flow up to 100 m^3 s^{-1} the discharge rates are multiplied by 5, and for minimal flow above 100 m^3 s^{-1} the discharge rates are multiplied by 30.
  - Ireland has additional conditions that the sum rule must be used for mixtures of radionuclides, the disposal method must not concentrate activity, and the waste is soluble/miscible in water and is disposed of directly to sewers.
  - Latvia, in addition to annual discharge limits for 54 radionuclides, has conditions on possible disposal routes.
  - Canada, for smaller facilities where releases would be orders of magnitude smaller than their DRL (see above), sets release limits based on IAEA-TECDOC-1000 (IAEA, 1998) or derived from site-specific data and a dose criterion of 10 µSv y^{-1}.
  - USA has liquid effluent release limits (µCi ml^{-1}) in legislation that are derived from conservative calculations based on drinking 2 litres per day of the effluent over a year producing a total effective dose equivalent of 0.5 mSv.
- countries with other regimes:
  - Switzerland allows authorised practices to discharge up to the equivalent of 10 kg per week at the clearance/exemption levels without an additional licence for discharge. Discharges above this rate require authorisation on a case-by-case basis, with limits fixed by the regulatory authority based on a drinking water dose criterion of 0.3 mSv y^{-1}.

B.2.4 Question 4: Classification of liquids

In general, liquids with hazardous properties other than radioactivity (for example, acidity, toxicity) also require authorisation from the relevant regulator or disposing of according to the relevant legislation. Ten of the responding countries do not distinguish liquids on any properties other than their radioactive or hazardous content.

Of the remaining 11, most distinguish between aqueous and non-aqueous liquids:

- countries that distinguish between aqueous and non-aqueous liquids for discharge purposes
    - France.
    - Argentina, Australia, Austria and Canada only allow for discharges of aqueous liquids, although Canada also allows discharge of non-aqueous liquids on a case-by-case basis.
    - Germany identifies 2 categories of liquids: those that cannot be concentrated (oils, oil-containing liquids, organic solvents and coolants) and other liquids. Clearance levels for unconditional clearance only apply to liquids that cannot be concentrated; clearance for all other liquids is granted on a case-by-case basis.
    - Ireland, Romania, Spain and USA also have restrictions on miscibility, dispersibility and solubility in water.
    - Belgium currently has no clearance levels for liquids but new legislation is being drafted that implements the EU BSS and this includes provisions for clearance of liquids not suitable for release to sewers or surface waters.

B.2.4 Question 5: Guidance and/or requirements

Of the responding countries, 14 have no generic requirements or guidance on frequency of measurements, measurement techniques or limits of detection, although in Austria this only applies to artificial radionuclides. Several of those countries require methods to be best available technique or technology (BAT) and Latvia has an additional requirement that the laboratory is appropriately accredited. Norway has no prescription; however there has historically been a problem with NORM industries not recognising that they are producing radioactive waste and an outreach/educational programme has been established to overcome this.

Four of the responding countries have measurement techniques or limits of detection based on national or international standards. In Austria this only applies to NORM. In Australia and Switzerland, measurement techniques depend on the level and type of radiation. Uniquely, Spain applies Recommendation 2004/2/EURATOM (CEC, 2004) to limits of detection.

Responses are summarised in the bullet points below:

- countries with no prescribed measurement techniques or limit of detection (LoD)
    - Belgium, Ireland, Lithuania, Norway, Romania (liquids only).
    - Austria (artificial radionuclides), Canada, France, Hungary, Italy, the Netherlands and Sweden additionally require best available technique/technology (BAT):
    - Argentina is in the process of defining guidance for medical laboratories which will include prescription of measurement techniques and/or LoD.
    - Latvia also requires the measuring laboratory to be accredited.
- countries with guidance or requirements based on national or ISO standards
    - Austria has national standards for NORM.
    - Bulgaria requires laboratory accreditation to ISO/IEC 17020 or ISO/IEC 17025 (ISO, 2012; ISO, 2017).
    - Germany has national standards which are, in turn, based on ISO/IEC 11929 (ISO, 2010).
    - USA uses the Multi-Agency Radiological Laboratory Analytical Protocols (MARLAP) (US EPA et al, 2004).
- countries where measurement techniques are required to be commensurate with/dependent on the type and amount of radioactivity
    - Australia, Switzerland.
- countries with other regimes
    - Czech Republic has recommendations but did not provide details.
    - Spain bases limits of detection for nuclear power plants on Recommendation 2004/2/EURATOM (CEC, 2004).

B.2.4 Comparison of key findings with current UK regulation

The survey results show that there is no consistent use of clearance and exemption values for liquids in the countries surveyed; furthermore, there is no consistent use of the terms clearance and exemption and they are often used interchangeably. This led to some difficulty in comparing responding countries' practices with those in the UK.

Whilst most countries have clearance and/or exemption values for artificial radionuclides in liquids taken from IAEA BSS or Euratom BSSD (CEU, 2014; IAEA, 2014), some do not have values for either clearing or exempting low activity liquids from regulatory control. By contrast, the UK has specifically calculated its own exemption values for aqueous radioactive effluents (Ewers and Mobbs, 2010). For clearance of bulk amounts of material, defined as more than the order of a tonne (EC, 1993), the values in IAEA BSS (Table I.2) and Euratom BSSD (Table A Part 1) were derived from IAEA RS-G-1.7 (Table 2) (IAEA, 2004). In all 3 documents, the values for clearance are applied explicitly to solid materials since the scenarios on which the calculations were based did not include liquid discharges (IAEA, 2005) and it is unclear how appropriate it is to use these

values for liquids. Nevertheless, the regulatory regimes of 6 or 7 countries apply these values to clearance and/or exemption of liquids (the response from Romania did not explicitly state which values in the Euratom BSSD were being used). For exemption of moderate amounts of materials, at least 8 countries make use of the values in IAEA BSS (Table I.1) and Euratom BSSD (Table B), which were derived from RP 65 (EC, 1993). Table B2 compares clearance and exemption values for ^{3}H and ^{14}C given in a selection of reports and legislation from other countries with those in UK legislation. The table shows that most countries have values that are a similar order of magnitude to the values from IAEA RS-G-1.7 (IAEA, 2004); in contrast, the UK values are at least an order of magnitude lower.

Table B.2. Exemption and clearance values (Bq l^{-1}) for ^{3}H and ^{14}C

This table compare the values given for exemption and clearance for tritium and carbon-14 in international standards, US and German legislation with the values given in UK legislation. Exemption is where radioactive material is exempted from some aspects of legislation whereas clearance is where a material is removed from regulatory control.

	Exemption and clearance values (Bq l^{-1})	
Source of values	**^{3}H**	**^{14}C**
IAEA RS-G-1.7 (used for exemption of bulk quantities and clearance values for solid materials)	10^5	10^3
EC RP65 (used for exemption of moderate quantities)	10^9	10^7
UK EPR 2016 Exemption (aqueous)	10^3	0.1
German RPO (2016) Unrestricted clearance	10^6	$8\ 10^4$
German RPO (2016) liquids up to 100 t/a to be disposed of in an incineration facility	10^9	10^7
German RPO (2016) liquids up to 1000 t/a to be disposed of in an incineration facility	10^9	10^7
US NRC 10 CFR 30.70 Schedule A Exemption	$1.1\ 10^6$	$2.96\ 10^5$

For discharges of liquids containing NORM most countries refer to the exemption and clearance value of 1 Bq g^{-1} of material containing the U and Th decay series given in IAEA BSS and Euratom BSSD (CEU, 2014; IAEA, 2014). Where this value is not used, values are typically based on a 300 µSv y^{-1} dose criterion. In the UK, for non-aqueous and certain types of hazardous liquids, the value of 1 Bq g^{-1} for the natural decay chains from IAEA RS-G-1.7 is also used[***] to determine whether liquids can be excluded from the regulatory regime. Values for other aqueous liquids have been derived using a 300 µSv y^{-1} dose criterion. A few countries exclude discharges of NORM from regulatory control completely unless they are from a specified NORM industrial practice, which is the same as the UK approach. Uniquely, the

[***] Values for some of the decay chain segments have been taken from RP 122 Part II (EC, 2002).

Netherlands has screening levels in total activity per year for discharges of NORM (including liquids) to water; the screening levels are based on a dose criterion of 10 μSv y^{-1} to members of the public and 1 manSv per year to the population.

Table B.3 lists the screening levels alongside the UK exemption levels for disposal of aqueous wastes to a sewer or to a relevant river or the sea.

Table B.3. Comparison of levels for disposal to water adopted in Norway and the Netherlands with UK exemption levels for disposal of aqueous waste

This table compares the values used to allow disposal of liquids containing naturally occurring radioactive materials in Norway and the Netherlands with values in UK legislation given to determine whether liquids should be exempt from some regulatory requirements.

Radionuclide	Levels below which permit not required in Norway (DSA, 2010) (Bq y^{-1})	Screening level in the Netherlands (Bq y^{-1})	UK exemption levels	
			Relevant sewer (Bq y^{-1})	Relevant river or sea (Bq y^{-1})
^{210}Pb	10^3	10^{10}*	10^4	10^4
^{210}Po	10^3	10^{10}	10^4	10^4
^{223}Ra	10^4	10^{12}*	10^5	10^5
^{224}Ra+	10^4	10^{12}	10^5	10^5
^{226}Ra+	10^3	10^{10}	10^5	10^5
^{228}Ra	10^4	10^{11}*	10^5	10^5
^{227}Ac	-	10^{11}*	10^6	10^6
^{227}Th	10^3	10^{12}	10^5	10^5
^{228}Th	10^3	10^{12}*	10^7	10^7
^{230}Th	10^3	10^{11}	10^7	10^7
^{232}Th	10^2	10^{11}*	10^6	10^7
^{234}Th	10^4	10^{13}*	10^6	10^6
^{231}Pa	10^2	10^{13}	10^5	10^5
^{234}U	10^3	10^{12}	10^6	10^6
^{235}U	10^3	10^{12}*	10^6	10^6
^{238}U+	10^3	10^{12}*	10^6	10^6
* Screening levels take the effects of progeny into account				

For radioactive liquid discharges where a permit or authorisation is required, many countries determine the discharge limits on a case-by-case basis with some countries having used IAEA-TECDOC-1000 to derive general release values (IAEA, 1998). The dose criterion for determining release values varies from 0.01 mSv y^{-1} to 1 mSv y^{-1} with most countries using 0.3 mSv y^{-1} which is also the maximum dose constraint specified in the UK for proposed controlled sources (HPA, 2009). Most of the responses indicate a similar approach to that of the UK, which requires a permit or an authorisation to discharge, which includes discharge limits, if no exemptions are applicable, and requests for authorisation are assessed on a case-by-case basis.

The review also found that over half of the responding countries distinguish between aqueous and non-aqueous liquids for discharge purposes but do not provide a more detailed definition of the difference between an aqueous and non-aqueous liquid. The UK makes a distinction between aqueous and non-aqueous liquids or liquids classified according to certain hazardous properties, but is the only country to refer to Regulation (EC) No 1272/2008 of the European Parliament and of the Council on classification, labelling and packaging of substances and mixtures (EP and CEU, 2008). Germany identify 2 categories of liquids: those that cannot be concentrated (oils, oil-containing liquids, organic solvents and coolants) and other liquids.

On the question of whether countries have requirements or guidance in relation to when an undertaking should carry out measurement to determine if a liquid is classed as radioactive, most of the responses indicated that they do not, but several, including the UK, do require best available techniques (BAT) to be used. Four of the responding countries have measurement techniques or limits of detection based on national or international standards and uniquely Spain applies Recommendation 2004/2/EURATOM (CEC, 2004) to limits of detection.

Table B.4. Summary of documents on which exemption/clearance values and discharge limits are based

This table summarises the documents on which exemption/clearance values and discharge limits are based to help understand the information in a different way.

Document	Country	Used for
EU and EC		
	Belgium	Clearance levels for artificial radionuclides in non-aqueous waste (to be introduced) Exemption values for NORM (to be introduced)
	Bulgaria	Exemption/clearance values for artificial radionuclides and NORM

Document	Country	Used for
Directive 2013/59/Euratom (CEU, 2014). The values given in this directive are taken from other documents which are detailed below. (i) Activity concentration values for exemption or clearance of materials which can be applied by default to any amount and to any solid material: - Table A Part 1 (artificial) - Table A Part 2 (naturally occurring) Both taken from IAEA RS-G-1.7 (IAEA, 2004) (ii) Total activity values for exemption (column 3) and exemption values for the activity concentrations in moderate amounts of any type of material (column 2): - Table B Values taken from RP 65 (EC, 1993)	Germany	Unconditional clearance for certain liquids, will be changed to Table A1 values Exemption mass values will be changed to Table A1 values Exposure limit of 1 mSv y^{-1} from multiple sources
	Hungary	Exemption levels for artificial radionuclides and NORM
	Ireland	Exemption levels for artificial radionuclides
	Latvia	Exemption values for artificial radionuclides (Table B)
	The Netherlands	Exemption of moderate amount of material containing artificial radionuclides (Table B) Clearance to incineration of artificial radionuclides (Table A)
	Romania	Clearance/exemption levels for artificial radionuclides and non-nuclear NORM
	Sweden	Exemption for artificial radionuclides and NORM (Tables A and B) Clearance for artificial radionuclides (Table A) Non-nuclear permitted sewer discharge limits if < Table B (col3) per-release and x10 for monthly
	Switzerland	Clearance/exemption of NORM (Table A2)
Directive 96/29/Euratom (CEU, 1996)	Italy	Definition of NORM industrial practice
RP 65 (EC, 1993)	Australia	Exemption levels for artificial radionuclides
RP 122 Part I (EC, 2000)	Sweden	Clearance of hazardous waste to incineration General clearance levels of NORM liquids from nuclear industry
RP 122 Part II (EC, 2002)	The Netherlands	Specific clearance of oil and gas industry wet sludge for disposal to specified landfill
RP 135 (EC, 2003)	Belgium	Screening levels for non-exempt NORM discharges
	Italy	Exclusion for liquid effluents from NORM industrial practices
Recommendation 2004/2/Euratom (CEC, 2004)	Spain	Limits of detection for effluents from nuclear power plants

IAEA

IAEA BSS (IAEA, 2014)	Argentina	Exemption values for artificial radionuclides and NORM
	Australia	Clearance levels for artificial radionuclides and NORM (from mid-2019)
	Canada	Exemption levels for artificial radionuclides
IAEA BSS (Interim) (IAEA, 2011) – the values given in this document are the same as one above	Switzerland	Clearance/exemption values for artificial radionuclides
IAEA RS-G-1.7 (IAEA, 2004)	Canada	Dose limit for low probability events
IAEA-TECDOC-1000 (IAEA, 1998)	Argentina	Reference levels for clearance
	Bulgaria	General release values for non-exempt practices
	Canada	Discharge limits for water soluble effluents
	Lithuania	Activity concentration limits for discharges from non-nuclear practices
Safety Series No. 115 (IAEA, 1996)	Australia	Exemption levels for artificial radionuclides and NORM (to be replaced mid-2019)
International Standards Organisation		
ISO/IEC 11929 (ISO, 2010)	Germany	Calculation methodology for limits of detection
ISO/IEC 17020 (ISO, 2012)	Bulgaria	Required laboratory accreditation
ISO/IEC 17025 (ISO, 2017)	Bulgaria	Required laboratory accreditation
Others		
Brenk Systemplanung (2012)	The Netherlands	Clearance to incineration for artificial radionuclides
	Switzerland	Extension of exemption/clearance levels for artificial radionuclides
Brenk Systemplanung (2018) (methodology based on IAEA (1998))	Austria	Calculation methodology and values for unconditional exemption of artificial radionuclides
	Germany	Unconditional clearance values for some artificial radionuclides
NRPB-R306 (Mobbs and Harvey, 1999)	Australia	Exemption levels for artificial radionuclides and NORM (to be replaced mid-2019)
	The Netherlands	Extension of exemption of moderate amounts of materials containing artificial radionuclides
NUREG-1576 (US EPA et al, 2004)	USA	Establishing limits of detection

B.4 References

ANVS (2018). *Decree on Basic Safety Standards for Radiation Protection*. (IenM/BSK-2017/135624)

Brenk Systemplanung (2012). *Berechnung von Freigrenzen und Freigabewerten für Nuklide, für die keine Werte in den IAEA-BSS vorliegen. [Calculation of exemption limits and clearance levels for nuclides for which there are no values in the IAEA-BSS.]* Bundesamt für Gesundheit (BAG), Bern.

Brenk Systemplanung (2018). *Überarbeitung der Strahlenschutzverordnung bzgl. der Regelungen zur Freigabe künstlicher radioaktiver Stoffe zur Umsetzung der neuen Euratom-Grundnormen in deutsches Recht – Konzept zur Umsetzung. [Revision of the Radiation Protection Ordinance with regard to the regulations on the release of artificial radioactive substances for the implementation of the new Euratom basic standards in German law - Concept for implementation.]* Bundesamt für Strahlenschutz (BfS), Salzgitter, BfS RESFOR-132/18.

CEC (2004). Commission Recommendation of 18 December 2003 on standardised information on radioactive airborne and liquid discharges into the environment from nuclear power reactors and reprocessing plants in normal operation (notified under document number C(2003) 4832) (2004/2/Euratom). *Official Journal of the European Union* **47**(L2), 36-46.

CEU (1996). Council Directive 96/29/Euratom of 13 May 1996 laying down the basic safety standards for the protection of the health of workers and the general public against the dangers arising from ionizing radiation. *Official Journal of the European Communities* **39**(L159), 1.

CEU (2014). Council Directive 2013/59/Euratom of 5 December 2013 Laying Down Basic Safety Standards for Protection Aginst the Dangers Arising from Exposure to Ionising Radiation, and Repealing Directives 89/618/Euratom, 90/641/Euratom, 96/29/Euratom, 97/43/Euratom and 2003/122/Euratom. *Official Journal of the European Union* **57**(L13), 1-73.

DSA (2010). *Regulations on the application of the Pollution Control Act to radioactive pollution and radioactive waste.* [Online] Available at https://www.dsa.no/dav/c385577da4.pdf [accessed]

EC (1993). *Principles and Methods for Establishing Concentrations and Quantities (Exemption values) Below which Reporting is not Required in the European Directive.* European Commission, Luxembourg, Radiation Protection 65.

EC (2000). *Practical use of the concepts of clearance and exemption - Part I: Guidance on general clearance levels for practices.* European Commission, Luxembourg, Radiation Protection 122.

EC (2002). *Practical use of the concepts of clearance and exemption - Part II: Application of the concepts of exemption and clearance to natural radiation sources.* European Commission, Luxembourg, Radiation Protection 122.

EC (2003). *Effluent and Dose control from European Union NORM industries. Assessment of current situation and proposal for harmonised Community approach.* European Commission, Luxembourg, Radiation Protection 135.

EP and CEU (2008). Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives Text with EEA relevance. *Official Journal of the European Union* **51**(L312), 3-30.

Ewers LW and Mobbs SF (2010). *Derivation of Liquid Exclusion or Exemption Levels to Support the RSA93 Exemption Order Review.* Health Protection Agency, Chilton, UK, HPA-CRCE-005.

HPA (2009). Application of the 2007 Recommendations of the ICRP to the UK. Advice from the Health Protection Agency. *Documents of the Health Protection Agency* **RCE-12**.

IAEA (1996). *International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources.* International Atomic Energy Agency, Vienna, Safety Series No. 115.

IAEA (1998). *Clearance of materials resulting from the use of radionuclides in medicine, industry and research.* International Atomic Energy Agency, Vienna, IAEA-TECDOC-1000.

IAEA (2004). *Application of the Concepts of Exclusion, Exemption and Clearance.* International Atomic Energy Agency, Vienna, RS-G-1.7.

IAEA (2005). *Derivation of activity concentration values for exclusion, exemption and clearance.* International Atomic Energy Agency, Vienna, Safety Reports Series No 44.

IAEA (2011). *Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards. Interim Edition.* International Atomic Energy Agency, Vienna, General Safety Requirements Part 3 - GSR Part 3 (Interim).

IAEA (2014). *Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards.* International Atomic Energy Agency, Vienna, General Safety Requirements Part 3 (GSR Part 3).

ISO (2010). ISO/IEC 11929:2010. *Determination of the characteristic limits (decision threshold, detection limit and limits of the confidence interval) for measurements of ionizing radiation -- Fundamentals and application.* Geneva, International Standards Organisation

ISO (2012). ISO/IEC 17020:2012. *Conformity assessment -- Requirements for the operation of various types of bodies performing inspection.* Geneva, International Standards Organisation

ISO (2017). ISO/IEC 17025:2017. *General requirements for the competence of testing and calibration laboratories.* Geneva, International Standards Organisation

Mobbs SF and Harvey MP (1999). *Exempt Concentrations and Quantities for Radionuclides not Included in the European Basic Safety Standards.* National Radiological Protaction Board, Chilton, NRPB-R306.

US EPA, US DOD, US DOE, US DHS, US NRC, US FDA, USGS and US NIST (2004). *Multi-agency Radiological Laboratory Analytical Protocols Manual (MARLAP).* US Nuclear Regulatory Commission, NUREG-1576.

Appendix C Questionnaire

This Appendix gives the wording of the questionnaire that was sent to elicit information from other countries. An example response from the United Kingdom was provided (given in italics) to assist responders.

C.1 Background

The UK is currently reviewing its approach to regulating liquid discharges, particularly those containing very low levels of radionuclides. The purpose of this review will be to identify and propose improvements to the current UK framework. Part of the review is to find out how other countries deal with these liquids so that we may learn from their approaches and experiences.

We would be very grateful if you could spend a few minutes completing as many questions in this questionnaire that you are able to. To give some guidance we have included an example of a questionnaire completed from the perspective of the UK.

We are sending this questionnaire to people that we believe are able to answer these questions, principally regulatory authorities and government departments but we welcome responses from any person who is able to answer these questions. If you are not able to answer these questions but you know someone who can we would be grateful if you could pass this questionnaire onto them.

The information from this process will be compiled to produce a publicly available report. All information collated will be attributed by country rather than who responded. We will share the report with respondents and other interested parties such as the IAEA. It is hoped that this information could usefully inform future guidance on this topic.

Question 1
Does your country have exclusion, exemption or clearance provisions for liquids containing very low levels of radionuclides containing artificial radionuclides? If there are specific values, if possible, please provide any information you have on how they were derived. Are any specific industry sectors exempted? Are there any conditions related to possible disposal routes?

In the UK, any aqueous liquid containing artificial radionuclides is considered to be radioactive unless it is falls within a specific exclusion. There are 3 relevant exclusions:

1. *Short half-life (less than 100 seconds)*
2. *Concentrations are at background levels (for example, from general circulation of the climate that derive from weapons testing and accidents)*
3. *The radionuclides are as a result of authorised disposals*

Unlike solids, there are no general exemption or clearance concentration or total activity values for liquids which contain radioactivity. Question 4 has a specific question the distinction between liquids with different properties.

There are various conditional exemptions that allow liquids to be disposed of without an authorisation. For example, small quantities of aqueous effluent (patient excreta, wastes up to 100 Bq/ml (this is general to all radionuclides ie does not apply to just artificial ones) to be discharged to a sewer (capacity > 100m3 of effluent / day at the sewerage plant) or to a person (by tanker) who is permitted to receive such waste. There is an exemption for larger quantities of low concentration aqueous radioactive waste to sewer, river or sea. The waste disposal route can be to (only one of) a sewer or a watercourse and the values are derived in HPA-CRCE-005.

The exclusions and exemptions are all explained in more detail in the government
guidance.

Question 2

Does your country have exclusion, exemption or clearance provisions for liquids containing very low levels of radionuclides containing naturally occurring radionuclides? If there are specific values, if possible, please provide any information you have on how they were derived. Are there any conditions related to possible disposal routes? Are any specific industry sectors exempted?

Liquids containing NORM are excluded unless they arise from a specified NORM industrial activity. Liquids are unconditionally exempted if the concentrations are below the values given in legislation (table reproduced below). For solids or 'relevant liquids'10 the value of 1 Bq/g for the natural decay chains is taken from IAEA RS-G-1.7 with the values for the some of the decay chain segments being taken from EC RP122 Part 211. For liquids other than 'relevant liquids' the derivation of the values is documented in HPA-CRCE-00512 and gaseous concentrations advised in HPA letter to DECC dated 27 August 2010.

[10] Relevant liquid means a liquid which is (a) non-aqueous or (b) classified (or would be so classified in the absence of its radioactivity) under Council Regulation No. 1272/2008 as having any of the following hazard classes and hazard categories (as defined in that Regulation)- (i) acute toxicity: categories 1, 2 or 3; (ii) skin corrosion/irritation: category 1 corrosive, sub-categories: 1A, 1B or 1C; or (iii) hazardous to the aquatic environment: acute category 1 or chronic categories 1 or 2.

[11] EC (2002). Practical use of the concepts of clearance and exemption - Part II: Application of the concepts of exemption and clearance to natural radiation sources. European Commission, Luxembourg, Radiation Protection 122

[12] HPA (2010). Derivation of liquid exclusion or exemption levels to support RSA93 Exemption Order Review. HPA, Chilton, HPA-CRCE-005.

There are a few conditional exemptions that allow NORM liquids to be disposed of without an authorisation. For example, small quantities of aqueous effluent (uranium/thorium aqueous liquid, wastes up to 100 Bq/ml) to be discharged to a sewer (capacity > 100m3 of effluent / day at the sewerage plant) or to a person (by tanker) who is permitted to receive such waste.

Activity Concentration of Radionuclides: NORM industrial activities

Radionuclide	*Solid or 'relevant liquid' activity concentration (Bq/g)*	*Any other liquid activity concentration (Bq/l)*	*Gaseous activity concentration (Bq/m^3)*
U-238sec	*1*	*0.1*	*0.001*
U-238+	*5*	*10*	*0.01*
U-234	*5*	*10*	*0.01*
Th-230	*10*	*10*	*0.001*
Ra-226+	*1*	*1*	*0.01*
Pb-210+	*5*	*0.1*	*0.01*
Po-210	*5*	*0.1*	*0.01*
U-235sec	*1*	*0.1*	*0.0001*
U-235+	*5*	*10*	*0.01*
Pa-231	*5*	*1*	*0.001*
Ac-227+	*1*	*0.1*	*0.001*
Th-232sec	*1*	*0.1*	*0.001*
Th-232	*5*	*10*	*0.001*
Ra-228+	*1*	*0.1*	*0.01*
Th-228+	*1*	*1*	*0.001*

Question 3

How is the discharge of radioactive liquids (from non-exempt practices) regulated in your country? For example, are discharges assessed and approved on a case-by-case basis or do you use general release values, for example, values given in IAEA Tec Doc 1000[13]?

If no exemptions are applicable an authorisation to discharge will be required. Any request for an authorisation will be assessed on a case by cases basis and the authorisation will include discharge limits.

Question 4

Does your country make any distinction between liquids with different properties, for example, aqueous and non-aqueous or those which are hazardous, and so on? If so how does your country categorise the liquids?

In the UK, non-aqueous liquids (e.g mercury and oils) are only considered to be radioactive if they exceed the IAEA RSG-1.7 values. These values also apply to certain aqueous liquids that have hazardous properties. Specifically

(a) is classified (or would be so classified in the absence of its radioactivity) under Regulation (EC) No 1272/2008 of the European Parliament and of the Council on classification, labelling and packaging of substances and mixtures, amending and repealing Directives 67/548/EEC and 1999/45/EC, and amending Regulation (EC) No 1907/2006 as having any of the following hazard classes and hazard categories (as defined in that Regulation)—

(i) acute toxicity: categories 1, 2 or 3;

(ii) skin corrosion/irritation: category 1 corrosive, sub-categories: 1A, 1B or 1C; or

(iii) hazardous to the aquatic environment: acute category 1 or chronic categories 1 or 2;

[13] IAEA (1998) Clearance of Materials resulting from the Use of Radionuclides in Medicine, Industry and Research, IAEA Tec Doc 1000

Question 5

From a practical point of view, do you have any requirements or guidance in relation to when an undertaking should carry out measurement to determine if a liquid is classed as radioactive? Do you have any agreed measurement methods or limits of detection that should be used for this purpose?

> *We expect that any person who knows or who has reason to believe that a substance may be radioactive to understand the characteristics of that substance and to carry out monitoring if necessary. We do not prescribe any monitoring techniques or limits of detection but we do expect best available technique (BAT) to be used.*

Annex 1 IAEA Safety Glossary Definitions

Exclusion: The deliberate exclusion of a particular category of exposure from the scope of an instrument of regulatory control on the grounds that it is not considered amenable to control through the regulatory instrument in question. It is commonly applied to naturally occurring radioactive material (NORM).

Exemption: The determination by a regulatory body that a source or practice need not be subject to some or all aspects of regulatory control on the basis that the exposure (including potential exposure) due to the source or practice is too small to warrant the application of those aspects or that this is the optimum option for protection irrespective of the actual level of the doses or risks.

Clearance: Removal of radioactive material or radioactive objects within authorized practices from any further regulatory control by the regulatory body.

Appendix D Responses received

This appendix provides the verbatim responses from all countries. Where there were more than one response, each respondent's replies have been listed separately.

D.1.1 Argentina

Question 1
In Argentina standards there are no specific exemption or clearance concentration values or total activity values for liquids containing very low levels of artificial radionuclides.

In certain cases, Exemption values from GSR part 3 are used for the exemption of very low volumes of liquid.

Question 2
In Argentina standards there are no specific exemption or clearance concentration values or total activity values for liquids containing very low levels of natural radionuclides.

In certain cases, Exemption values from GSR part 3 are used for the exemption of very low volumes of liquid.

Question 3
Discharges are assessed on a case by case basis. When it´s possible the IAEA Tec Doc 1000 is taken as reference to decide if a radioactive liquid waste can be cleared. Other document used as reference to clear liquids is the "practical guide for clearance of radioactive waste from small facilities" from the FORO (Iberoamerican Forum of nuclear regulators)

Question 4
Yes, the classification is done by the responsible of the facility, but in general the hazardous wastes and the non aqueous wastes can´t be discharged in the sewing. The must be managed according to their characteristics

Question 5
Not yet. The ARN is currently developing guidance for nuclear medicine facilities and it is foreseen to include these issues.

D.1.2 Australia

Question 1
In Australia, there are provisions for exemption for liquids containing very low levels of radionuclides containing artificial radionuclides.

Exclusions apply only to natural radionuclides.

There are no provisions in Australia for clearance at this time, however clearance levels based on IAEA GSR Part 3 are expected to be published by mid-2019.

Exemption Levels:
The National Directory for Radiation Protection (NDRP) (2017) lists the criteria to exempt radioactive material or practices from notification, registration and licensing as follows:

1. The radioactive material has an activity concentration less than that prescribed in Schedule 4 or consists of or contains less than the activity prescribed in Schedule 4, or;
2. The radioactive material has an activity concentration greater than that prescribed in Schedule 4 and consists of or contains greater than the activity prescribed in Schedule 4, but causes an annual effective dose to an individual member of the public of less than 10 μSv, and a collective effective dose to the critical group committed by one year of performance of the practice, as determined by the Authority, of less than 1 person Sv, or;
3. In the case of a mixture of radioactive materials, where each of the radioactive materials present does not exceed the individual activity or activity concentration, the mixture is defined as exempt if the sum of the fractions obtained by dividing the activity of each material present by the appropriate activity value from Schedule 4, or the sum of the fractions obtained by dividing the activity concentration of each material present by the appropriate activity concentration value from Schedule 4, does not exceed 1.

The NDRP does not specify what physical form the above material takes and so these levels can apply to liquids. Additionally:

- the Authority may exempt material or practices that are not exempt under the clauses above, subject to conditions that may be determined by the Authority, where an assessment for the optimisation of protection shows that exemption is the optimum option
- the Authority may declare material or practices otherwise exempt to be subject to the legislation if an assessment of the magnitude of individual doses, the number of people exposed and the likelihood that potential exposures will actually occur justify the practice being subject to the legislation

The table of values in the NDRP is taken from the IAEA's International Basic Safety Standards for Protection Against Ionizing Radiation and for the Safety of Radiation Sources, Safety Series 115 [IAEA 1996], and is supplemented from NRPB Report R306, Exempt Concentrations and Quantities for Radionuclides not Included in the European Basic Safety Standards Directive [NRPB 1999].

Note that the NDRP is currently under review. In the next edition, expected to be published by mid-2019, exemption levels will be updated and clearance levels will be added. Exemption and clearance levels will be those listed in Schedule I (Exemption and Clearance) of the IAEA General Safety Requirement (GSR) Part 3: Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards, including Tables I.1, I.2 and I.3.

For the Commonwealth:
Exempt dealings can be found in Schedule 2 of the ARPANS Regulations but these only apply to Commonwealth entities. This includes a list of dealings that are exempt (some of which apply to liquids) and a list of activity concentration values and activity values for nuclides. The regulations do not specify what physical form the material takes, so these values can apply to liquids.

Question 2
In Australia, there are provisions for exclusion and exemption for liquids containing very low level of radionuclides containing naturally occurring radionuclides.
There are no provisions for clearance in Australia at this time, however clearance levels based on IAEA GSR Part 3 are expected to be published by mid-2019.

Exclusion:
Exclusion is generally applied to exposures that are not amenable to control.
Undisturbed mineral deposits are generally excluded from regulatory control.
The NDRP includes the provisions below for exclusion:
The following exposures whose magnitude or likelihood is essentially not amenable to control through legislation are excluded from regulation*:

1. K-40 in the body
2. Cosmic radiation at the surface of the earth, and
3. Unmodified concentrations of radionuclides in most raw materials, unless otherwise specifically identified in this National Directory for Radiation Protection (NDRP)

*For normal exposure situations, the concept of exclusion usually applies to exposures from materials containing radionuclides of natural origin, where the concentration of each radionuclide is below 1 Bq/g. Typically, 'most raw materials' would include raw materials, except for uranium, which is mined to recover radionuclides; mineral sands, which have radionuclide content high enough to warrant a regulatory approach; and other materials specifically identified in of the National Directory.

Additional guidance on exclusion for naturally occurring radionuclides is provided in ARPANSA RPS-15, Safety Guide: Management of Naturally Occurring Radioactive Material:

For existing exposure situations, it is usually unnecessary to regulate materials with radionuclides of natural origin below 1 Bq g^{-1}. Under these conditions, it can be anticipated that doses to members of the public are unlikely to exceed about 1 mSv g^{-1} (IAEA Safety Standards Series: Safety Guide No. RS-G-1.7, 2004. Application of the Concepts of Exclusion, Exemption and Clearance).

Exposure to a mineral deposit or other natural material may be excluded from the scope of regulatory instruments even if its state has been altered by human activities, when such exposure is deemed to be unamenable to control. However, it is appropriate for the regulatory body to take such exposure into consideration if the individual radionuclide concentration in the material exceeds about 1 Bq g^{-1}. Depending on the outcome of a screening assessment negotiated between the operator and the Authority, the activity concerned may be exempted or be subject to regulatory control.

Exemption:
The details on exemption provided in response to question 1 are also applicable to this question.

In addition, the following guidance on exemption for materials containing naturally occurring radionuclides is provided in the ARPANSA RPS-15, Safety Guide: Management of Naturally Occurring Radioactive Material:

Application of the exemption criterion of approximately 1 mSv to some situations (such as the use of some building materials containing natural radionuclides), will necessitate consideration by the Authority. It may be necessary in such cases to consider some form of regulatory control over exposures from materials due to radionuclides with activity concentrations below those given in Schedule 4 of the National Directory for Radiation Protection and Schedule 2, Part 2 (Activity concentration values and activity values for nuclides) of the ARPANSA Regulations.

Question 3
Schedule 14 of the NDRP specifies conditions and activity (or activity concentration) levels for a variety of radionuclides below which no authorisation is required from the regulatory authority to dispose of liquid radioactive materials via sewer. It should be noted that separate levels apply for each radionuclide in the table depending on the disposal pathway chosen. If these conditions are not met, authorisation by the relevant regulatory authority is required.

Note that Schedule 14 will not be included in the 2nd edition of the NDRP due to be published in 2019. Instead, a new national code, *Code for the Disposal of Radioactive Waste by the User*, will be published that will include revised conditions and activity (or

activity concentration) levels for discharge to sewer. The code will also include an annex that explains the derivation of these values, which are based on calculation of the annual activity of radioactive material that could result in a dose of 100 µSv in a year to the most exposed individual and a concentration that would result in an exposure rate of less than 10 µGy h^{-1} to the most exposed organism.

For the Commonwealth:
If the activity of a radioactive liquid is above the level stated in Schedule 2 Part 2 of the ARPANS Regulations for the given radionuclide, then it is deemed a controlled material and can only be discharged by assessment on a case-by-case basis as approved by the regulatory authority.

Question 4
One of the conditions listed in Schedule 14 of the NDRP to dispose of radioactive material to sewer without authorisation is that the material is aqueous. If this condition is not met, authorisation is required from the relevant regulatory authority.

A material intended for disposal that has multiple hazardous properties, including radioactivity, will be required to comply with radiation legislation (for the radioactive component of the material) and environmental protection legislation (for the non-radioactive hazardous component(s) of the material). Either property of the material for disposal may limit the disposal options available.

Question 5
Under Australian law it is an obligation on the person in possession of any substance to know if that substance is radioactive to a level above the exemption limits.

Measurement methods and limits of detection for determining whether the exemption limit for a given radionuclide is exceeded should be commensurate with the type and properties of the radiation emanating from the material.

D.1.3 Austria

Question 1
The Austrian General Radiation Protection Ordinance ("Allgemeine Strahlenschutzverordnung", AllgStrSchV) contains in its Annex 1, Table 1, column 6 unconditional clearance values for fluids.

These values are derived from an exposition of 10 µSv/a for members of the public (AllgStrSchV, § 79).

For the disposal route of discharges, § 74 of the AllgStrSchV regulates airborne and liquid discharges. Such discharges from licensed facilities must be limited in a way, that 0.3 mSv/a for members of the public are not exceeded. If the values of activity concentrations in Annex 12 of the AllgStrSchV are not exceeded, it can be assumed that

the limit of 0.3 mSv/a will be not exceeded as well. These values are calculated in a very conservative way.

Supplemental query to Question 1: Is there a reference document that explains the methodology used in these calculations? If so, please could you briefly explain the methodology (for example, is it based on RP 65) or send us a link or pdf?
Thank you for your interest into our regulation, these values are identical with the regulation in Germany and derive from different documents describing the calculation of the values for clearance and exempted discharges.

However, there is a useful summary available by the link
https://doris.bfs.de/jspui/handle/urn:nbn:de:0221-2018050314821; and
https://doris.bfs.de/jspui/bitstream/urn:nbn:de:0221-2018050314821/6/BfS_2018_3614R03520_SB.pdf;
more details on liquids are on the same page downloadable by using the link
https://doris.bfs.de/jspui/bitstream/urn:nbn:de:0221-2018050314821/9/BfS_2018_3614R03520_AP3.pdf

According to these documents, the modelling for discharges of radionuclides with wastewater was performed according to TECDOC 1000 of the IAEA and the derived values follow the 10 µSv-concept.

Question 2
In Austria, the regulations for NORM are laid down in the Austrian Ordinance on Natural Radiation Sources ("Natürliche Stahlenquellen-Verordnung", NatStrV) in combination with the Austrian Radiation Protection Act ("Strahlenschutzgesetz", StrSchG). § 26 of the NatStrV addresses discharges: The activity concentration of alpha- and beta-emitters in liquid discharges is limited to 1.5 Bq per litre in the receiving water or in the sewer system. If this limit is exceeded, a license is necessary. Further, the obligated party has to notify the competent authority before discharging the fluid. This notification has to contain the results of the assessment by a radiation protection expert. For a license, the 1.5 Bq per litre can be exceeded, but the dose limit of 0.3 mSv/a must be not exceeded.

Question 3
In Austria, a license is required when the guidance values for liquid or airborne discharges are exceeded. If the guidance values are likely to be exceeded, discharges of radioactive substances have then to be assessed on a case-by-case basis
.
Question 4
In Austria, the reference values for activity concentrations of liquid discharges are only for aqueous solutions.

In § 76 of the AllgStrSchV radioactive wastes are differentiated into following categories:

- liquid – combustible
- liquid – non-combustible
- solid – combustible
- solid – non-combustible
- gaseous
- biogen wastes
- sealed materials, which are radioactive waste
- bulky wastes
- composed radioactive wastes
- hazardous wastes, especially infectious materials, pyrophoric materials, explosive materials, highly reactive materials, materials, which evolve corrosive gases during storage or combustion and materials, which evolve radionuclides into the gas phase during storage.

Question 5
For natural radioactivity, the Austrian Standard ÖNORM S5252 addresses the estimation of effective dose for individual persons of the population by natural radionuclides in case of discharge and landfilling of residues. Liquid discharges are addressed there as well, for example, by spreading of the activity in water, by different exposition paths and the resulting exposure for members of the public.

Artificial radionuclides have to be assessed on a case-by-case basis by best available technology. State of the art includes nuclide-specific assessments, a probe in the stream of the discharge (inline detection system), retrospective samplings, and so on.

D.1.4 Belgium, respondent #1

Question 1
The **exemption** values for liquids (and solids) containing artificial radionuclides are defined in annex IA of the Royal Decree of July 20, 2001 (GRR-2001 or "General Radiation Protection Regulation"). The values are listed in total activity and in activity concentration and are based on BSS/96/29/Euratom.

In the current version of the GRR-2001 there are **no generic clearance values** for liquids. The clearance of all liquids is subject to a specific clearance license to be given in accordance with article 18 of the GRR-2001.

In a future update of the GRR-2001 (new Royal Decree implementing the 2013/59/euratom directive (EU BSS)), **clearance levels will be defined for non-aqueous waste** (f.e. oils or other chemicals) which cannot be discharged in sewers or surface waters due to their chemical contents:

- for smaller quantities (< 1 ton/year) : the generic clearance levels for solids of annex IB of GRR-2001 can be used
- for larger quantities (> 1 ton/year) or for concentration levels > annex IB : a specific FANC clearance license is still required in accordance with article 18 of the GRR-2001

Question 2

Currently, the maximum concentrations in liquid discharges from Table H1 of the Royal Decree of July 20, 2001 are not directly applicable to "work activities involving natural radiation sources". In practice however, they are used as reference levels in the assessment of the declarations from theses work activities.

In the project of new Royal Decree implementing the 2013/59/euratom directive (EU BSS), the values from Table H1 will be used as exemption values for liquids containing naturally occurring nuclides. Operations involving non exempted liquids will be submitted to notification to FANC.

In the Royal Decree of July 20, 2001, notification is only compulsory for NORM industries belonging to the "positive list" given in article 4 of the Decree. The concept of positive list will disappear in the new version of the Royal Decree: all activities handling or processing materials with an activity concentration above exemption levels will be submitted to notification. Specific conditions related to disposal or discharge will be imposed through the registration (resp. licensing) process.

Question 3

Discharges of radioactive liquids with artificial radionuclides

For liquid discharges of artificial radionuclides, article 34 of the GRR-2001 is applicable:

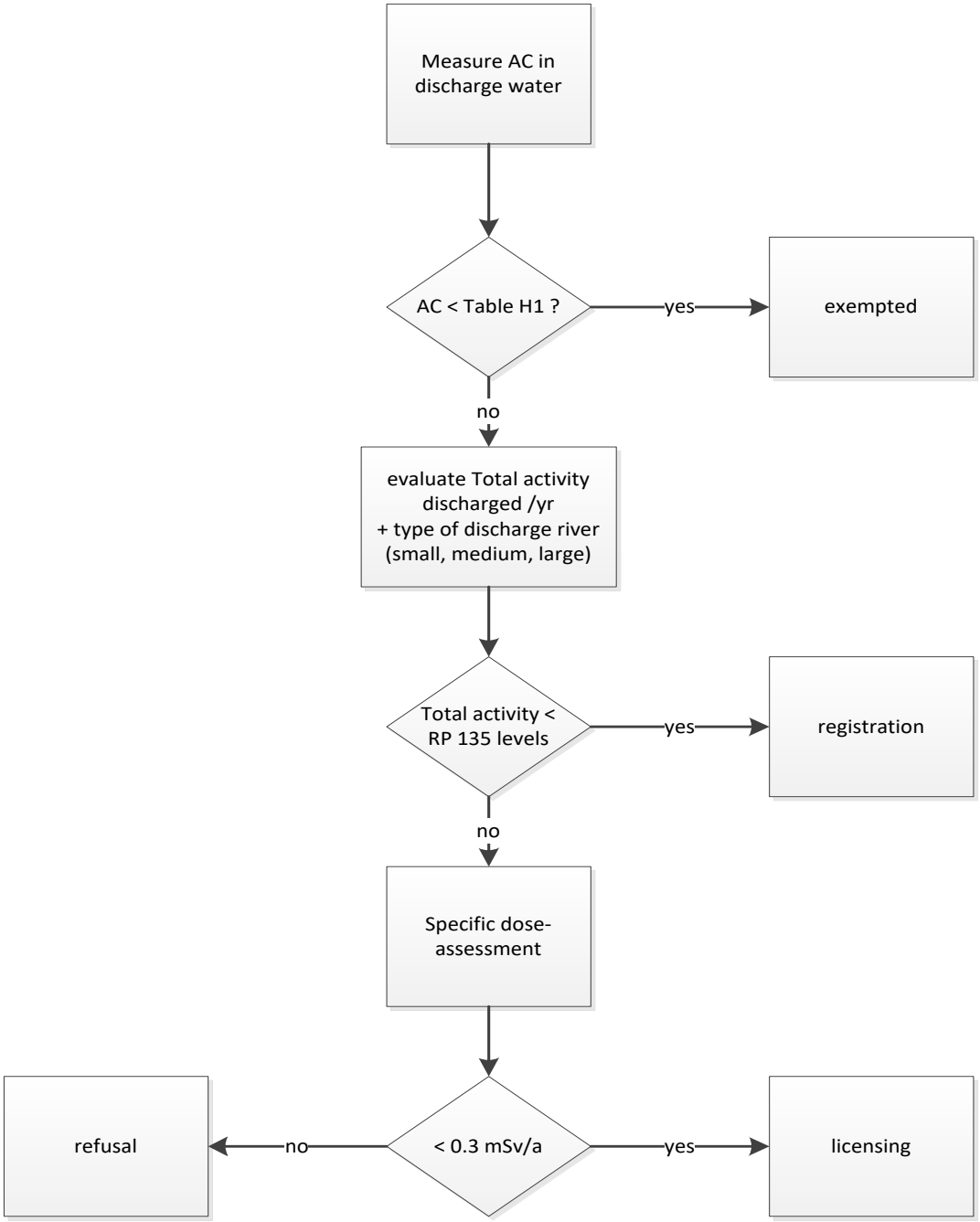
1. Liquid radioactive waste shall not be discharged into surface water or sewage systems if its radionuclide concentration, expressed in Bq/l, exceeds one thousandth of the annual limit for ingestion of an adult member of the public, calculated in accordance with the provisions of Annex III, point D. The values are given in Table H1 of the GRR-2001.
2. Licences issued to Class I and II facilities in accordance with the provisions of this regulation may deviate from this prohibition. In this case, they shall specify either the maximum permissible concentrations at any one time and the average maximum

permissible concentrations of radioactive nuclides liable to be contained in the waste, or the total activity which may be discharged over a defined period of time, or both simultaneously. For these discharge licenses, a case by case basis is used for their assessment.

Non-exempt practices involving natural radiation sources:

For discharges of naturally occurring nuclides , in case the concentration in the liquid discharges exceeds the exemption value, a second tier of assessment will be made using the screening values derived in the EC report RP 135 "Effluent and dose control from European Union NORM industries" (with a dose criteria of 0.3 mSv y^{-1}).

This tiered assessment is summarised in following flowchart:



Question 4

For liquids containing naturally occurring nuclides, FANC does not regulate other hazardous properties than radioactivity. Next to FANC requirements, the disposal , processing or discharge of non-exempted liquids need to comply with the requirement of the non-radioactive waste regulators (regional authorities in Belgium).
For liquids containing artificial nuclides, the same answer applies.

Question 5

For artificial nuclides:
There are no generic requirements on the measurement methods.

For NORM:
Requirements on the frequency and nature of the measurement (for example, which nuclides need to be measured) are imposed on a case-by-case basis depending on the data from the notification and on expert judgment. There are no generic requirements on the measurement methods except for the fact that the detection limit of the method should at least be lower than the exemption levels.

D.1.5 Belgium, respondent #2

Question 1

In Belgium, the following regulations[14] (Art. 34) applies with respect to the collection, treatment and disposal of liquid waste:

1. Art. 34.1 : Liquid radioactive waste may not be discharged into the ground.
2. Art 34.2 : Liquid radioactive waste shall not be discharged into surface water or sewage systems if its radionuclide concentration, expressed in Bq/l, exceeds one thousandth of the annual limit for ingestion of an adult member of the public. Licences issued to facilities in accordance with the provisions of this regulation may deviate from this prohibition (See also question 3). In this case, they shall specify either the maximum permissible concentrations at any one time and the average maximum permissible concentrations of radioactive nuclides liable to be contained in the waste, or the total activity which may be discharged over a defined period of time, or both simultaneously.
3. Art 34.3 : Liquid waste with a radioactive nuclide concentration exceeding the limits defined in article 34.2 or the conditions stipulated in the issued licences and which thus cannot be discharged, shall be stored in leak tight receptacles which guarantee adequate protection with a view to treatment or possible disposal once the activity has been reduced to the limits specified in article 34.2 after decay or dilution; the latter process shall only be used if the licence explicitly allows this. In all cases,

[14] Royal Decree of 20 July 2001 laying down the General Regulation for the Protection of the Public, Workers and the Environment against the hazards of ionizing radiation.

receptacles containing liquid radioactive waste shall be stored in a system which is capable of collecting possible leaks.

4. Art 35.2 : The total activity of the discharged liquid radioactive waste shall be maintained at a level which is as low as reasonably achievable. The FANC[15] may impose, by issuing a general directive published in the Official Journal, limits for the total activity of liquid radioactive waste which may be discharged by a facility over a defined period of time.

Question 2

Work activities involving naturally occurring radionuclides need to be declared to the FANC. This declaration also needs to include the measures related to the characterisation, processing, storage and disposal of the waste produced. If the dose limits for members of the public or occupationally exposed individuals are, or could be, exceeded, the FANC may impose corrective measures. If, despite these corrective measures, the dose limits defined for members of the public or occupationally exposed individuals are still, or could still be, exceeded, the FANC shall impose that all or some of the regulatory requirements applicable to the practices in accordance with this regulation apply for the facility in question (and hence the become a licensed facility). With respect to liquid discharges, the general regulation applies.

Question 3

The Belgian regulation (the same royal decree as mentioned in question 1, Art. 18) foresees that licenses can be issued for the disposal of liquid radioactive waste:

- art 18.1: Without prejudice to the provisions of article 34, the disposal, the removal in view of recycling or re-use of liquid radioactive waste originating from a class I, II or III facility specified in article 3 are subject to a license issued by the FANC
- the disposal, the removal in view of recycling and re-use of radioactive waste originating from work activities involving NORM, are also subject to a licence issued by the FANC
- art 18.2: the request for license shall include the following:
    - a description of the history of the radioactive waste
    - an impact assessment showing compliance with the radiological protection criteria for the different appropriate scenarios
    - an investigation into the possible benefits of storage for decay purposes
    - an investigation into the possibilities of re-using waste in another practice covered by the classified facilities policy in accordance with the present regulation
    - a document demonstrating that options in which the authorities can keep track of products which have been disposed of, recycled or re-used have been considered and prioritised

[15] FANC – Federal Agency for Nuclear Control is the Belgian nuclear regulatory body dealing with the safety and security aspects for all activities involving ionising radiation.

  - a description of the measurement procedures and techniques with a view to checking compliance with the requested concentration levels for disposal, recycling or re-use
  - a description of the means intended to guarantee the destination of the substances and materials for which disposal in landfill or by incineration, recycling or re-use has been planned
- art. 18.3
  - The concentration levels set in licences issued by the FANC shall also be as low as reasonably achievable and may not exceed the exemption levels specified in this regulation in the case of radioactive waste originating from Class I, II or III facilities. These levels shall ensure compliance with the radiological protection criteria. They shall be set in consideration of available international recommendations, European recommendations in particular.

Question 4
With respect to the radiological aspects, no distinction is made between liquids with different properties. For the treatment and the conditioning of the radioactive waste, a distinction is made with respect to the properties of the waste in regards of the future way of disposal of the waste. This is under the competence of the National Institute for Radioactive Waste and Spent Fuel (NIRAS) and not the FANC.

Question 5
The Belgian regulations foresee that appropriate measurement needs to be performed by the licensee before discharging (possible) radioactive waste, but no specific methods or procedure are imposed by the FANC.

D.1.6 Bulgaria

Question 1
In Bulgaria, we have exemption/clearance values in accordance with Annex 7 of Directive 2013/59/Euratom.

Exemption and clearance values are given in Annex 3 of Radiation Protection Regulation.

Any specific industry sectors are not exempted.

Question 2
We have exemption/clearance values in accordance with Annex 7 of Directive 2013/59/Euratom. These values are given in Annex 3 of Radiation Protection Regulation.

For surface and groundwater (excluding drinking water) of former uranium mining and milling sites, we use the values from Annex 5 of Regulation No 1 of 1999 on norms for

the radiation protection and safety in the elimination of the effects of the uranium industry in the Republic of Bulgaria:

№	Object of control	Activity concentration (Bq/m3)
1.	Natural uranium	7500
2.	Radium-226	500
3.	Lead-210	400
4.	Total α-activity	500
5.	Total β-activity	2000

Supplemental query to Questions 1 and 2: [In Annex 3 of your Radiation Protection Regulation] you group all radionuclides (both artificial radionuclides and NORM) by radiotoxicity. Please could you advise us how you specified the grouping, for example, is it based on Annex VII of Directive 2013/59/Euratom, and if so, on which Table and column is it based?

It depends on total activity values for exemption for unsealed sources (column 3, Table B, Annex VII of Directive 2013/59/Euratom):

- group 1: Radionuclides with very high radiotoxicity – activity 10^3 Bq
- group 2: Radionuclides with high radiotoxicity – activity 10^4 and 10^5 Bq
- group 3: Radionuclides with medium radiotoxicity – activity 10^6 and 10^7 Bq
- group 4: Radionuclides with low radiotoxicity – activity 10^8 Bq and more

Question 3
Yes, we use values from IAEA-TECDOC-1000 "Clearance of materials resulting from the use of radionuclides in medicine, industry and research" (1998).

Question 4
We do not make any distinction between liquids.

Question 5
We require the laboratory to be accredited according EN ISO/IEC 17020 or 17025.

D.1.7 Canada

Question 1
The' Nuclear Substances and Radiation Devices Regulations' have provisions for the exemption and clearance of radionuclides generally, but do not have exemption or clearance provisions applicable to liquids specifically. Generally, for amounts of materials of 1 ton or less, the exemption levels are the same as those in Table I.1 from the BSS (GSR Part 3), and for amounts greater than 1 ton, they are the same as those in Table I.2 of the BSS. Values for radionuclides of natural origin are not provided separately as they are in the BSS, but rather are included with artificial radionuclides.

In terms of discharge limits for liquids, Nuclear Substances licenses (for example, for medical facilities), have conditions that stipulate limits for releasing water soluble liquids to sewer systems. The release limits are from IAEA TECDOC-1000, and are stipulated separately for various radionuclides, and apply on an annual basis (per building per year). When more than one radionuclide is released, the sum of the quotients obtained by dividing the quantity of each radionuclide by its corresponding limit shall not exceed one.

The 'General Nuclear Safety and Control Regulations' stipulate that "12 (1) Every licensee shall … (f) take all reasonable precautions to control the release of radioactive nuclear substances or hazardous substances within the site of the licensed activity and into the environment as a result of the licensed activity". Consequently, every licensee that discharges radionuclides to the environment has release limits regulated through their licence. Hence, no industry sector is exempted from having release limits. In terms of disposal routes, the licence conditions stipulate the permitted disposal route. For Nuclear Substances licences, the licence condition specifies the release limits for liquids apply to releases of water soluble liquids to sewer systems.

Question 2

Nuclear Substances licence conditions establish limits for releasing radionuclides in water soluble liquids to sewer systems. Limits for natural uranium and other naturally occurring radionuclides are provided, for example, Pb-210, and were derived from the methodology in IAEA-TECDOC-1000. The 'General Nuclear Safety and Control Regulations' stipulates that:

10. Naturally occurring nuclear substances, other than those that are or have been associated with the development, production or use of nuclear energy, are exempt from the application of all provisions of the Act and the regulations made under the Act except the following:

(a) the provisions that govern the transport of nuclear substances;
(b) in the case of a nuclear substance listed in the schedule to the Nuclear Non-proliferation Import and Export Control Regulations, the provisions that govern the import and export of nuclear substances.

Release limits for naturally occurring radionuclides apply; therefore, only to those radionuclides that are regulated under a licence from the CNSC.

Question 3

Discharges are assessed and approved on a case-by-case basis. Most facilities have a Derived Release Limit (DRL) that limits the release of radionuclides to the environment such that the most exposed members of the public will not receive a dose of more than 1 mSv as a result of the release. For smaller facilities where the releases would be orders of magnitude less than their DRL, their release limits are adopted from IAEA-TECDOC-1000 or derived using site-specific data and a dose criterion of 10 μSv y^{-1}.

Question 4
The licence condition discussed in the answer to question 1 applies only to water soluble liquids. Any request from a licencee to release non-aqueous liquids would need to be submitted and reviewed on a case-by-case basis. Such release limits would need to comply with the criteria for conditional clearance, as set out in the *Nuclear Substances and Radiation Devices Regulations*, namely "**conditional clearance level** means an activity concentration that does not result in an effective dose (a) greater than 1 mSv in a year due to a low probability event referred to in the IAEA Safety Standard RSG-1.7; or (b) greater than 10 μSv in a year (niveau de liberation conditionnelle)."

Other hazardous substances are regulated through other agencies. CNSC licensees must comply with all those applicable regulatory requirements.

Question 5
The CNSC requires licensees with direct interactions with the environment to demonstrate that they have made all adequate provisions for the protection of the environment. This information is captured in an environmental risk assessment (ERA). The requirement for an effluent monitoring program will be identified as a result of the ERA. The CNSC's environmental protection requirements are illustrated in a regulatory document entitled: "REGDOC-2.9.1: Environmental Protection: Environmental Principles, Assessments and Protection Measures."

The Canadian Standards Association standard, "CSA N292.0: General principles for the management of radioactive waste and irradiated fuel", Annex A, provides information on radioactive waste classification, exemption, clearance, and storage for decay.
The CNSC expects licensees to implement best available technologies and/or techniques when deciding which measurement methods or limits of detection should be used.

D.1.8 Czech Republic

Question 1
[Not answered]

Question 2
The clearance levels for discharge of waste water into surface water are:

- the average total alpha activity volume concentration in all substances 0.5 Bq/l
- the average total beta activity volume concentration after the deduction of the contribution of ^{40}K in all substances 1 Bq/l

These clearance levels are not regarded as exceeded if the average alpha activity volume concentration or the average beta activity volume concentration after the deduction of the contribution of ^{40}K is not greater than the value of the clearance level.

The clearance levels for discharge of waste water into the waste water disposal system for public need are:

- the average total alpha activity volume concentration in all substances 50 Bq/l
- the average total beta activity volume concentration after the deduction of the contribution of ^{40}K in all substances 100 Bq/l

These clearance levels are not regarded as exceeded if the average alpha activity volume concentration or the average beta activity volume concentration after the deduction of the contribution of ^{40}K is not greater than the value of the clearance level. The average values apply to the quantity of materials subject to clearance in which it is possible to regard the activity weight concentration or the activity volume concentration as homogeneous.

If none of the clearance level is exceeded, the residues can be handled and discharged of as if they are not radioactive.

These clearance levels were derived from clearance levels for liquids containing artificial radionuclides and should ensure then effective dose 1 mSv/y, will not be exceed in case of consumption of surface water.

The clearance levels are binding for operators of NORM sectors listed in the "positive list".

Question 3

1. Radioactive liguids may be discharged from a workplace without a licence of the SONS [State Office for Nuclear Safety, Czech abbreviation SÚJB] if clearance levels are not exceeded.
2. Radioactive substance may be discharged from a NORM workplace without a license of the SONS also if the effective dose of each member of the public during a calendar year caused by a discharge is lower than 0.3 resp. 0,1 mSv. Operator who discharges radioactive substances from a NORM workplace shall inform the office at least 60 days in advance about:
    - type of discharged radioactive substances
    - activity of radionuclides in discharged radioactive substances
    - place, time and method of discharging
    - assessment of exposure to a member of the public

Radioactive substance may be discharged from a workplace NORM without a license of the SONS also if the discharged radioactive substances are used for manufacturing of building materials. Operator who discharges radioactive substances from a workplace with purpose to use it for manufacturing of building materials shall inform the SONS at least 60 days in advance about:

- type of discharged radioactive substances
- activity of radionuclides in discharged radioactive substances
- time and scope of discharging of radioactive substances
- identification data of building materials manufacturer. ubstance may be discharged from a workplace without a licence of the SONS if clearance levels are not exceeded.

Radioactive substance may be discharged from a NORM workplace without a license of the SONS also if the effective dose of each member of the public during a calendar year caused by a discharge is lower than 0.3 mSv. Operator who discharges radioactive substances from a NORM workplace shall inform the office at least 60 days in advance about:

- type of discharged radioactive substances
- activity of radionuclides in discharged radioactive substances
- place, time and method of discharging
- assessment of exposure to a member of the public

Radioactive substance may be discharged from a workplace NORM without a license of the SONS also if the discharged radioactive substances are used for manufacturing of building materials. Operator who discharges radioactive substances from a workplace with purpose to use it for manufacturing of building materials shall inform the SONS at least 60 days in advance about:

- type of discharged radioactive substances;
- activity of radionuclides in discharged radioactive substances;
- time and scope of discharging of radioactive substances and
- identification data of building materials manufacturer.

Question 4
no

Question 5
Yes doporučení [recommendation]

D.1.1 France

Question 1
The management of the radioactive effluents in France is made according to the period of the radionuclide.

<u>Management of the liquid effluents of lower period in 100 days</u>
After radioactive decay, the contents of barrels/demijohns or if necessary tanks can be rejected in the sewer system. In case effluents are managed towards a system of tanks, the capacity of tanks must be sufficient to store the quantity of effluents produced during

the duration necessary for their radioactive decay before their discharge in the sewer system.

Before realizing a discharge, the holder of the authorization to possess or use radioactive sources delivered by ASN verify the respect for the requirements which are fixed to it in terms of activity.

The decision n°2008-DC-0095 of the ASN of January 29th, 2008 plans that the contents of tanks or containers of storing of contaminated liquid effluents can be rejected in the sewer system only having made sure that the volume activity is lower than a limit of 10 Bq / L.

Any discharge of waste water other than domestic in the public sewer system must be beforehand authorized by the mayor or the president of the competent public institution regarding collection at the place of the pouring if the police powers of the mayors of the member municipalities were transferred to him, after opinion delivered by the public person in charge of the transport and in charge of the discharge of waste water as well as treatment of muds downstream, if this community is different.
Management of the liquid effluents of superior period in 100 days
Generally speaking, the installations must be conceived and exploited so as to limit the discharges of radionuclides of superior radioactive time in 100 days. The contents of barrels / demijohns susceptible to contain radionuclides of superior period in 100 days are considered as a liquid waste and it is managed in sectors authorized for the management of radioactive waste. It does not join the sewer system.

Question 2
Same answer as for the question 1.

Question 3
The discharge of radioactive liquids is approved on a case-by-case basis and the authorisation will include discharge limits.

Question 4
A distinction is made between liquid types (aqueous or non-aqueous; radioactive or non-radioactive) in medical laboratories. Radioactive liquids are recovered in cans and decayed if the radioactive period is lower than 100 days or taken over by ANDRA if the radioactive period is greater than 100 days. These volumes are generally very small.

In nuclear medicine departments in hospitals, patients treated by 131 iodine (> 800 MBq) are placed in radioprotected rooms. The urine of these patients treated by 131 iodine (> 800 MBq) is recovered in vats and decanted for 10 periods (approximately 3-4 months) before rejection in sewer system if the limit is under 100 Bq/l. Other tanks collect liquids from toilets and washbasins of nuclear medicine departments with radionuclides with a period <100 days (99mTC, 111In, 18F ...). Theses liquids can be rejected if the measure of global radioactivity is under 10 Bq/l.

Question 5
Authorities do not prescribe any monitoring techniques or limits of detection but they do expect best available technique (BAT) to be used.
There is no limits of detection in France for the liquid effluents of superior period in 100 days. These effluents are considered as radioactive whatever the activity.
For the liquid effluent of inferior period in 100 days, they can be rejected in the sewer system only having made sure that the volume activity is lower than a limit of 10 Bq / L.

D.1.1 Germany, respondent #1

Preliminary remark for Germany:

Germany is currently transposing the EU BSS (Council Directive 2013/59/Euratom of 5 December 2013 laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation …) into national legislation. This has the following effects on exclusion, exemption and clearance:

1. Exclusion: none, as this is out of the scope of the legislation anyhow.
2. Exemption: the mass-related exemption values for "moderate quantities" (cf. Annex VII Table B Col. 2 of EU-BSS 2013) will no longer be contained in the German Radiation Protection Ordinance; only the (much smaller) mass-related values of Annex VII Table A1 of EU-BSS 2013 and the values for total activity of Annex VII Table B Col. 3 of EU-BSS 2013 will be numerical exemption criteria.
3. Clearance: There are several clearance options in Germany, as discussed below. Clearance levels for unconditional clearance, which includes certain liquids, will be changed to the values of Annex VII Table A1 of EU-BSS 2013. The other clearance options are not affected by the transposition of the EU-BSS.
4. The new German Radiation Protection Act has entered into force in 2017, the new German Radiation Protection Ordinance (RPO) will enter into force presumably on 31 Dec. 2018. Until then, the Radiation Protection Ordinance as of 2001 (as amended) will remain valid. The following answers therefore cover the current and the future situation.

Question 1
Exclusion is not treated on the basis of quantities, but on a qualitative basis.

Exemption of the use of radioactive substances with artificial radionuclides in liquid form is possible. This is governed by Section 7 ("Handling of Radioactive Substances Requiring a Licence") and Section 8 ("Handling not Requiring a Licence; Possession of Nuclear Fuels not Requiring a Licence") of the RPO. Current exemption values for solid or liquid substances are those of Annex I Table A of EU-BSS 1996, which are identical to those of Annex VII Table B of EU-BSS 2013. In future, similar regulations for handling not requiring a licence will apply, only the exemption values will change to those of

Annex VII Table A1 of EU-BSS 2013 for the mass-specific values (the values for total activity remaining those of Annex VII Table B Col. 3 of EU-BSS 2013).

Clearance of liquids with artificial radionuclides is currently governed by Sect. 29 ("Clearance"). Unconditional clearance of such liquids is governed by Sect. 29 para. 2 No. 1 Letter a RPO, clearance of liquids for disposal by incineration in a conventional waste incineration plant is governed by Sect. 29 para. 2 No. 2 Letter b RPO. Clearance levels (CL) are listed in Annex III Table 1 RPO. The CL in column 5 for unconditional clearance apply to oils, oil containing liquids, organic solvents and coolants (non-aqueous liquids that cannot be concentrated after clearance). The CL in columns 9b or 9d for clearance for disposal by incineration apply to any liquids.

The reason for distinction between aqueous and non-aqueous liquids is dealt with in the answer to question 4. The basis for the derivation of the CL is given by detailed studies based on radiological models. These studies are cited below. Upon request, they can be made available as PDF documents in German only.

Deckert, A.; Thierfeldt, S.: Berechnung massenspezifischer Freigabewerte für schwach radioaktive Reststoffe; BMU 1998-520, Schriftenreihe Reaktorsicherheit und Strahlenschutz des BMU, ISSN 0724 3316, Brenk Systemplanung, Aachen, 1998
Strahlenschutzkommission: Freigabe von Materialien, Gebäuden und Bodenflächen mit geringfügiger Radioaktivität aus anzeige- und genehmigungspflichtigem Umgang; Empfehlung der Strahlenschutzkommission, verabschiedet auf der 151. Sitzung im Februar 1998, Berichte der Strahlenschutzkommission (SSK) des Bundesministeriums für Umwelt, Naturschutz und Reaktorsicherheit, Heft 16, Gustav Fischer Verlag, 1998

Question 2
Regulations on NORM are contained in Sections 97 to 102 of the current RPO. A list of residues from NORM operations is given in Annex XII Part A RPO, all of them solid materials (or semi-solid like sludges, but no liquids). Numerical values for mass-specific activity defining surveillance limits for these residues in also given in Annex XII Part B RPO. There are no regulations for liquids from NORM industry or from other work activities involving NORM.

The new RPO will not change this situation. The surveillance limits will probably remain the same.

Question 3
There are 2 ways of regulating discharges:

1. Discharges from "large installations" during construction, operation, decommissioning, safe enclosure and dismantling, that is, nuclear power plants, research reactors, fuel cycle installations, and so on. The limitations for discharges are regulated in Section 47 RPO, with 0.3 mSv effective dose per calendar year (additional limits for organs apply) for liquid discharges and 0.3 mSv effective dose

per calendar year for gaseous discharges. The effective dose remaining to the dose limit 1 mSv per calendar year may be apportioned to external irradiation. A technical guideline how to perform the modelling and dose calculations for liquid and gaseous discharges including parameter values is laid down in a General Administrative Procedure (Bundesministerium für Umwelt, Naturschutz, Bauen und Reaktorsicherheit: Allgemeine Verwaltungsvorschrift zu § 47 der Strahlenschutzverordnung (Ermittlung der Strahlenexposition durch die Ableitung radioaktiver Stoffe aus Anlagen oder Einrichtungen), vom 28. August 2012; Federal Gazette AT 05.09.2012 B1, 5 September 2012). – There is no contradiction that the dose limit 1 mSv/a is seemingly apportioned to the exposure from just one installation, as it is necessary to take into account all contributions from surrounding installations (for example, from the 2nd block of a NPP station, from the discharges of NPPs and research reactors upstream, and so on), including very conservative assumptions on the diet and habits of the reference person. There is therefore no possibility to bust the dose limit 1 mSv/a by exposure from various sources.

2. Discharges from "small installations", that is, from medical, industrial or technical use of radioactive substances, may be treated in a simpler way. Generic discharge limits are given in Appendix VII Part D Table 4 RPO in terms of Bq per m³ air for gaseous and Bq per m³ water for liquid discharges. They have been derived on a conservative basis with a partial model as the one mentioned in the first point. Application of these values is limited to certain quantities of air and water discharged per hour, making these values inapplicable, for example, for NPPs or large installations.

The General Administrative Procedure is under review currently. A new edition is planned for mid-2019, supplementing the new RPO. This will contain some less conservative assumptions and parameters. Apart from rivers as in the current version, liquid discharges to lakes will also be included. In addition, the new concept in the EU BSS 2013 of limiting exposure from multiple sources to 1 mSv/a will be taken into account.

IAEA guidance like TECDOC 1000 or SR 19 is not used. However, the concept for small installations described in the second point above is very similar to the concept of IAEA TECDOC 1000.

Question 4

The Radiation Protection Ordinance distinguishes liquids with different properties, in particular aqueous and non-aqueous, with respect to clearance. In principle, all types of liquids (aqueous, non-aqueous, oils, lubricants, and so on) are eligible for clearance. However, the application of existing CL is limited to certain cases:

1. CL for unconditional clearance (Annex III Table 1 Col. 5 RPO) are only valid for oils, oil-containing liquids, organic solvents and coolants, as these will not be concentrated after clearance (unlike, for example, acids or bases, which may be concentrated after clearance to the desired strength). The derivation of the CL does

not encompass scenarios for increase of activity concentration in liquids due to concentration, only for substances with the unchanged activity concentration or for reduction of activity concentration due to mixing because of technical reasons.

2. If aqueous liquids are to be cleared for reuse or recycling, this clearance needs a case-by-case approach. In many cases, it may suffice to report to the authorities the purpose for clearance, explaining that no concentration is intended, and then the same CL may be used.

3. CL for clearance for disposal by incineration (Annex III Table 1 Col. 9b/d RPO) does not require a similar caveat, as the liquids are destroyed in the incineration process and this has been taken into account when deriving these CL. If a liquid cannot be incinerated, it cannot be cleared by this pathway.

Legislation pertaining to water use and water protection (as well as to conventional waste) applies to discharges of liquids and to use of liquids after clearance. This legislation needs to be taken into account already in the application for discharges and the application for clearance, and the authorities would not allow discharge or clearance of a certain liquid if this was not permissible. These regulations set limits on the content of hazardous substances or proscribe the use, recycling or disposal of certain types of liquids. More details cannot be provided in this questionnaire.

Question 5
Activity measurements are required whenever:

- it is determined whether a liquid shall be used as part of a practice and it needs to be determined if a license is required (below or above exemption values)
- discharges are assessed (see answer to Question 3), that is, prior to releasing (discharging) water from a nuclear installation or facility using radioactive substances into a river or canal
- clearance of liquids (transformer oils, lubricants, coolants, and so on) shall take place

Practical guidance on measurements of liquids for clearance is to a small extent contained in DIN 25457. Assessment of liquid discharges from nuclear installations is regulated by KTA 1504 ("Überwachung der Ableitung radioaktiver Stoffe mit Wasser" – "Surveillance or discharges of radioactive substances with water"). Requirements on detection limits are given in both documents. The calculation of these detection limits is governed by ISO 11929.

D.1.11 Germany, respondent #2

Question 1
In Germany, exemption and clearance are regulated by the Federal Radiation Protection Ordinance (RPO; officially: Strahlenschutzverordnung (StrlSchV)). The RPO contains

radionuclide-specific exemption levels, generic radionuclide-specific clearance levels and further requirements for clearance.

As exemption levels, the generic values of RP 65 of the European Commission are used in the RPO. They also apply to liquids.

For clearance, Germany distinguishes between 2 classes of liquids, (i) oil and organic coolants or organic solvents, and (ii) other liquids, for example, aqueous liquids, including water.

For oil and organic coolants or organic solvents, unconditional clearance may be applied. In this case, the use of the liquid is not subject to further regulatory control. Generic radionuclide-specific clearance levels for this option are listed in the RPO. Another option is restricted clearance for incineration, for which another set of generic clearance levels applies.

For other liquids, clearance proceeds according to a case-by-case review. In particular, compliance with the dose criterion (effective dose of 10 micro Sievert per year for individuals of the public) must be proved.

Clearance regulations in Germany are very complex. This is due to the long history of developing clearance levels with a generic scope. For unconditional clearance, the corresponding clearance levels together with the underlying exposure scenarios were published by the German Commission on Radiological Protection (Strahlenschutzkommission, SSK) in 1998. An English summary of this report is available at 'Clearance of Materials, Buildings and Sites with Negligible Radioactivity from Practices subject to Reporting or Authorisation, Recommendation of the Commission on Radiological Protection'). Unconditional clearance levels are based on 3 enveloping scenarios for external irradiation, inhalation and ingestion. They were developed mainly for solids. In a follow-up study, it was shown that the applicability of these clearance levels could be extended to oil and organic liquids. For example, possible scenarios for used oil were studied. The scenarios include a worker, who is exposed to external irradiation from filter residues such as oil sludge stored in a tank. The scenarios are described in detail in a recent BfS report on unconditional clearance of liquids ('Überarbeitung der Strahlenschutzverordnung bzgl. der Regelungen zur Freigabe künstlicher radioaktiver Stoffe zur Umsetzung der neuen Euratom-Grundnormen in deutsches Recht – Konzept zur Umsetzung', AP 3, BfS Bundesamt für Strahlenschutz, 2018). This report is available only in German.

In Germany, according to paragraph 29 of the RPO, clearance is mandatory for all industry sectors that have a licence to work with radioactive substances (see also Question 2).

Question 2

In case of discharges from NORM industries, there are no specific regulations and restrictions to liquids containing naturally occurring radionuclides.

In transposing the Euratom-BSS into national law, Art. 23 required Germany, inter alia, to identify classes or types of practice involving naturally-occurring material (commonly known as NORM industries) that may lead to exposures of members of the public that cannot be disregarded from a radiation protection point of view. Discharges are part of the practice and had to be assessed whether they should become a subject to regulatory control or not. Therefore, water discharged from NORM industries were investigated as a part of a research project. The investigation included the 16 sectors of NORM industries listed in Annex VI of the BSS, and additional sectors that have been known in Germany for potentially being of radiological concern. In total, 26 industrial sectors had been analyzed. In result of this project, only discharges of mine effluents from closed hard coal mines (as part of the perpetual mine management obligations) were identified to potentially lead to effective doses for members of the public exceeding 100 µSv/a. The main reason for the absent of relevant expositions to the public was the high level of environmental standards for discharges in general. In the case of mine effluents, long-lasting sedimentations can lead to a significant dose for the public, at least in rare and almost unpredictable situations.

Related to the disposal of NORM residues: In Germany, it is forbidden to landfill or dispose liquid wastes or liquid residues from any sources, independent of the NORM-content. After solidification (via evaporation, in geopolymer, or other techniques) of possible liquid residues, the regulations for solid NORM residues are used.

Question 3

In Germany, a licence is required for the discharge of radioactive substances with water and it must be proven that the limit values in §47 of the RPO for the protection of the population and the environment are observed. For this verification it shall be calculated how high the radiation exposure by the discharged radioactive substances may be at the most unfavourable location for a reference person. Assumptions for the calculation of the radiation exposure of the reference persons (including dispersion models, exposure pathways to be taken into account, habits such as food intake rates) shall be used which are laid down in Annex VII of the RPO and in the "Allgemeine Verwaltungsvorschrift zu § 47 Strahlenschutzverordnung: Ermittlung der Strahlenexposition durch die Ableitung radioaktiver Stoffe aus Anlagen oder Einrichtungen (General Administrative Regulation according to § 47 of the Radiation Protection Ordinance: Determination of the radiation exposure by the discharging of radioactive substances from installations or facilities). The maximum discharges and activity concentrations shall be set by the licensing authority taking into account the calculations carried out.

In distinction to this, radiochemical laboratories or medical facilities, that is, institutions or facilities that do not require a nuclear licensing, are classified as so-called small emitters. They require an approval according to the RPO. The RPO specifies the

maximum activity concentrations (in Bq per cubic metre) of radioactive substances in wastewater from radiation protection areas. They have been calculated using generic model assumptions and are not based on IAEA Tec Doc 1000, where the total activities (Bq per year) are given. The German RPO does not set a limit value for the total quantity of discharged water from a plant licensed in accordance with the RPO. Taking into account the specific local conditions, the approval of the licensing authority may contain more restrictive limit values.

Question 4

According to the German clearance legislation, liquid material can be divided into 2 groups, (i) oil and organic coolants or solvents, and (ii) other liquids, including water, often termed as aqueous liquids. A rough subdivision of liquids according to Appendix X of the RPO is as follows:

- inorganic radioactive liquids, including chemical effluents, laboratory effluents, effluents from decontamination, acids and bases, sludge and suspensions, biological and medical sewage, sewage from the pharmaceutical industry
- organic radioactive liquids, including oil, lubrication oil, hydraulic oil, transformer oil, organic solvents, scintillation liquids, fuel, emulsions

For details see the recent BfS report on unconditional clearance of liquids ('Überarbeitung der Strahlenschutzverordnung bzgl. der Regelungen zur Freigabe künstlicher radioaktiver Stoffe zur Umsetzung der neuen Euratom-Grundnormen in deutsches Recht – Konzept zur Umsetzung', AP 3, BfS Bundesamt für Strahlenschutz, 2018). This report is available only in German.

This categorization of liquids is the basis for the clearance procedure according to the German RPO (see Question 1).

Question 5

In Germany, specialized (fit-for-purpose) measuring techniques have to be used in order to prove compliance with the clearance levels. In the clearance procedure of a liquid, the level of radioactivity of the liquid has to be determined by radiation measurements and, if necessary, by radiochemical analyses. The clearance levels as specified in the RPO are valid all over Germany. The clearance procedure itself is within the area of responsibility of the German federal states (Bundesländer). Companies that apply for clearance of radioactive liquids must have the ability to carry out the measurements needed for clearance.

For clearance, it is not sufficient that the activity levels of the liquid comply with the clearance levels. In addition, all clearance-specific requirements of the RPO have to be met prior to clearance.

D.1.12 Germany, respondent #3

Question 1
The German Radiation Protection Ordinance will be novelled. The final version will be available in end 2018.

In Germany, any aqueous liquid containing artificial radionuclides is considered to be radioactive unless it is falls within a specific exclusion. In general, if concentrations are at background levels (for example, from general circulation of the climate that derive from weapons testing and accidents).

Threshold values for distinct radionuclides are listed within Table 1: Exemption levels, clearance values for various clearance procedures, levels of surface contamination of the German Radiation Protection Ordinance. Radionuclides with half-life < 1 h are included.

Insofar as no exemption levels have been specified for radionuclides, these shall be calculated for the individual case.

Otherwise, the following levels for exemption levels can be used as a basis:

a) for alpha emitters or radionuclides that deteriorate through spontaneous fission: 103 Bq and 1 Bq/g,
b) for beta and gamma emitters insofar as they are not specified in (c): 105 Bq and 102 Bq/g,
c) for electron caption emitters and beta emitters with a maximum beta limit energy of 0.2 MeV: 108 Bq and 105 Bq/g

Unlike solids, there are no general exemption or clearance concentration or total activity values for liquids which contain radioactivity.

Threshold value for Uranium, according to German drinking water ordinance: 0,010 mg/L / 10 µg Unat (1 µg Unat = 25,1 mBq)

Total directing dose (drinking water ordinance (Uranium and Radium): 0,1 Millisievert (mSv)/a

Question 2

Question 3

Question 4

Question 5

Measurements will be carried out on the base of Industrial Board Guidelines. These Guidelines have legal status for the Industry.

D.1.13 Germany, respondent #4

Question 1

1. In accordance with the Council Directive 96/29/Euratom, the current German Radiation Protection Ordinance (RPO) regulates the following:

   a) Clearance of artificial radioactive substances, which accumulate during operational activities. This is regulated by § 29, annex III and IV of the RPO.
   b) Clearance values for an unrestricted clearance apply also for solids and burnable liquids like oils and organic solvents and cooling liquids (see annex IV section B RPO).
   c) Clearance values for incineration also apply to all burnable liquids.
   d) There are no exemptions for a specific branch of industry, but the proceedings and clearance values do not apply to contamination caused by a nuclear and radiation accident.

2. Based on the Council Directive 2013/59/Euratom, the German Radiation Protection Ordinance is currently revised. The draft stipulates, that:

   a) Clearance of artificial radioactive substances, which accumulate during operational activities in planned exposure situations, is still regulated in the German RPO.
   b) Clearance of aqueous solutions will only be possible on a case-by-case assessment, because the clearance values for an unrestricted clearance in the Council Directive 2013/59/Euratom annex VII table A section 1 solely apply for solid substances.
   c) Clearance values for incineration will also apply to all burnable liquids.
   d) There still exist no exemptions for a specific branch of industry, but the proceedings and clearance values do not apply to contamination caused by a nuclear and radiation accident.

Question 2

1. The current German RPO in accordance to the Council Directive 96/29/Euratom regulates the following:
   a) There are no special regulations for liquids containing naturally occurring radionuclides.

2. Based on the Council Directive 2013/59/Euratom, the German RPO is currently revised:
   b) It is not intended to include special regulations for liquids containing naturally occurring radionuclides into the draft of the new Radiation Protection Ordinance.

Question 3

The monitoring of the discharge of radioactive substances with water ensures compliance with the requirements of §§ 6, 47 and 48 RPO. Therefore, it must be ensured that:

a) any radiation exposure or contamination of man and environment, even if below the respective limit, by taking into consideration the state of the art and by taking into account all circumstances of individual cases shall be minimized (§ 6 (2) RPO),
b) the following limits of the radiation exposure of individual members of the general public shall apply (§47 (1) RPO):
    1. Effective dose 0.3 mSv/a
    2. Organ absorbed dose for gonads, uterus, bone marrow (red) 0.3 mSv/a
    3. Organ absorbed dose for colon, lungs, stomach, bladder, breast, Liver, gullet, thyroid gland, other organs or tissues as specified in Appendix VI, Part C 0.9 mSv/a
    4. Organ absorbed dose for bone surface, skin 1.8 mSv/a,
c) radioactive substances are not discharged uncontrolled into the environment (§ 47 (1) RPO) and
d) the discharges are monitored and reported to the competent authority at least once a year, specifying its kind and activity (§ 48 (1) RPO). The monitoring equipment must fulfill the requirements of § 67 RPO.

The specific limits for discharging radioactive substances with water are stipulated by the competent nuclear regulatory authority on a case-by-case basis, with the aim of minimizing the limits specified in §47 (1) RPO.

Question 4

There are no distinctions made in the radiation protection law; however the law pertaining to water or, for example, to recycling lists substances-based requirements and duties which need to be considered for clearing or discharging purposes.

Note:

Classification, labeling and packaging of non-radioactive substances (for example, liquids) is based on Regulation EC 1272/2008 (EC). Registration, evaluation, authorization and restriction of chemicals (REACH) is based on the amending Regulation (EC) 1907/2006. Additionally, the Technical Regulations for Hazardous Substances (TRGS) reflect the state of the art, occupational medicine and work-hygiene as well as other reliable findings from science for activities involving hazardous substances, including their classification (for example, TRGS 201 "Classification and labeling of waste for disposal during handling").

In the case of liquid wastes containing radioactive substances, the State Collecting Facility shall accept this waste in accordance with § 76 (4) RPO or by order of the competent authority in accordance with § 76 (5) RPO.

Annex X RPO (§§ 72 – 79) regulates the description, record keeping and transport declaration for radioactive wastes. The description of radioactive waste occurs in accordance with encoded information on processing condition, designation and treatment (Annex X, Part A, tables 1 – 3).

The State Collecting Facility usually define types of wastes:

- type 1: solid/non-flammable
- type 2: solid/flammable
- type 3: special wastes
- type 4: liquid/non-flammable
- type 5: liquid/flammable
- type 6: digestible and fermentable
- type 7: scintillator waste

Question 5

1. The current German RPO in accordance to the Council Directive 96/29/Euratom regulates the following:
    a) If a radioactive substance accumulates during an operational activity, which requires approval, it must be, independent of the level of activity, cleared before it may be reused, reprocessed or disposed of. The requirements of the measurements are determined in the permit or in technical standards, especially DIN standards.
2. Hereof are no changes planned; therefore, the described above will apply in the future.

D.1.14 Germany, respondent #5

Question 1

Exclusion: cannot say.
Exemption and clearance: See Appendix III, Table 1 to the current Radiation Protection Ordinance (attached). Note that this will change with the introduction of the new Radiation Protection Ordinance (currently in draft status) as part of the new legislative framework of the Radiation Protection Act (2017), implementing Directive 2013/59/Euratom.

Question 2

K-40 is generally excluded.

No exemption for liquids, to my knowledge.

Clearance is granted if detailed dose estimates demonstrate that members of the public incur less than 1 mSv/a from all sources (including natural and artificial). This is a new approach of the Radiation Protection Act (2017), implementing Directive

201/59/Euratom. How this will be implemented in practice remains to be seen. The new Radiation Protection Ordinance is currently in the making and will be adopted and promulgated by the end of 2018.

Question 3
Artificial nuclides: See Appendix III, Table 1 to the current Radiation Protection Ordinance (attached).

Natural radionuclides: Not currently regulated. However, in future a case-by-case assessment may be necessary in principle. On the other hand, the background documents to the new Radiation Protection Act state that it is unlikely that liquid discharge with natural radionuclides will be subject to any concern and assessment, because the doses are too low.

Question 4
Radioactive properties are regulated separately from non-radioactive properties. Separate sets of regulations (including concentration/mass limits, approval procedures, and so on) apply. Only if all authorities ("conventional" water regulators, radiation protection authorities) agree, a practice involving discharges is permitted. Often, the very strict regulations on non-radioactive discharges are a constraint to what can be discharged into the environment (and thus automatically limit the radioactive discharges). For example, the concentration of total suspended solids (TSS) is limited for discharges in most industries. As radionuclides are often bound to suspended solids, a constraint on TSS means automatically a constraint on the radioactive load that is discharged.

Question 5
Guidance on classing a liquid as radioactive: Not to my knowledge, apart from the exemption levels for artificial radionuclides mentioned above.
Guidance on sampling and determination methods exist, usually issued by BfS (Federal Office for Radiation Protection).

D.1.15 Hungary

Question 1
In Hungary, any liquid containing artificial radionuclides is considered to be radioactive if its total activity or activity-concentration exceed the relevant exemption levels, or it has been arisen in a practice licensed as management of radioactive materials.

There are only one relevant exclusion, if the effluents containing radionuclides are as a result of authorised discharges.

Clearance for liquids can be applied in case of:

1. Small quantities (a few ml of ampoule) if the total activity decayed below the exemption level
2. Very low activity liquids, which are not allowed to be discharged into the sewer or surface water, and needs special treatment as hazardous waste, if the activity-concentration decayed below the exemption level or the dose consequence due to the management of waste would be less than 30 μSv y^{-1} for the members of the public.

Supplemental query to Question 1: What are the values of [the relevant exemption levels] and what is the source of those levels?

The Governmental Decree 487/2015 (XII.30) on protection against ionization radiation contains the exemption levels for each of radionuclide expressed in Bq/g.

The exemption levels based on IAEA GSR Part 3 and EU BSS. According those there are exemption levels for "any amount and any type of solid" materials and exemption levels for "moderate amounts of any type of material."

For moderate amounts (less than 1 ton) of any type of materials the exemption levels equal the values laid down in IAEA GSR Part 3 / EU BSS.

For bulk amount of solid materials the exemption levels equal the values laid down in IAEA GSR Part 3 / EU BSS.

However, in Hungarian regulation the exemption levels for bulk amount of materials could be interpreted for liquid and solid materials both.

Question 2

In Hungary there are no special arrangements for the exclusion, exemption or clearance of liquids containing very low levels of radionuclides containing naturally occurring radionuclides.

Regarding the exemption levels and clearance criteria relevant for materials containing naturally occurring radionuclides the EU BSS (Council Directive 2013/59/Euratom) rules are fully implemented into the Hungarian legislation system.

Question 3

The discharge of radioactive liquids is regulated by a ministerial decree issued by the Minister responsible for environmental affairs. Regarding the regulation of the discharges there are 2 categories of the practices:

1. In case of "special facilities" – such as a nuclear facility, a uranium mine, a radioactive waste management facility or a Level A laboratory – in the first step the

dose restriction for the critical group of public living around the facility should be approved by the competent radiation safety authority. The experts should derive the discharge limits from the dose restriction taking into account all possible discharge routes. The discharge limit should calculate by radionuclides. The annual limits are approved by the competent environmental protection authority case-by case. However the annual operational plans for the discharges should not exceed the 30 % of the discharge limits.

2. In case of medical, industrial and research institutions other than "special facilities", there are general annual limits for the radionuclides for airborne and liquid discharges both. In case of general liquid discharge limit, the 5-fold amount of the discharge limit results 30 µSv annual dose to the reference group of population living 500m from the place of inflow into the surface water. The discharge limits listed are valid for discharges through the wastewater channel to surface water with a minimal water flow lower than 10 m3 /s. The discharge limits shall be multiplied by 5 for surface water with a minimal water flow between 10 m3 /s and 100 m3 /s, furthermore by 30 for surface water with a minimal water flow higher than 100 m3 /s.

Question 4

In Hungary, the regulatory body does not make any distinction between liquids with different properties regarding the exemption, clearance or discharges in the viewpoint of radiation safety at the level of regulation.

However the properties of liquids need to take into account in the safety assessments developed for the operation of the facilities and for the clearance and discharges of liquids. Additionally the relevant regulations for chemical hazards, hazardous waste management and environmental protection must be considered.

If the liquid radioactive waste is also classified as hazardous waste, the requirements for hazardous waste must also be considered. Moreover when designing liquid radioactive waste processing systems, must be taken into account of the composition and properties of the liquid. Different types of liquid radioactive waste must be appropriately separated and the most effective processing method should be used.

Question 5

In Hungary there is ministerial decree "on the rules of accountancy for and control of radioactive materials, and on the corresponding data provisions". It prescribes to the undertaking to record the actual stock of sealed sources, unsealed sources and radioactive waste (including liquids). Ignoring the reporting system of sealed sources, the undertaking should report annually the amount of received, handed over, used up and actual stock of unsealed sources and of radioactive waste.

In the regulation system we do not prescribe any monitoring techniques or limits of detection but we do expect best available technique to be used. However in the

application for the operational licence the applicant should detail the procedures for the characterisation of waste and for the records keeping system of radioactive materials.

The undertaking must report the amount of authorised discharges to the competent authority.

In case of application for clearance, the undertaking must verify by measurements the characteristics of the liquid waste to be cleared.

D.1.16 Ireland

Question 1
Irish law provides both for exemption on the basis of compliance with specific and total activity values and for the exemption of specified practices. Exemption with respect to the specific and total activity is based on the relevant schedules of the Euratom Basic Safety Standards (BSS) Directive. General criteria are set out in law for the exemption of practices from the requirements for notification or authorisation. Practices may be exempt if they involve handling of amounts of radioactivity below the exemption values or if it can be shown that workers should not be classified as exposed workers and that dose criteria for the exposure of members of the public are met in all feasible circumstances.

While earlier Irish legislation did not specifically address the concept of clearance, the legislation transposing EU Council Directive 96/29 now sets out specific and total activity levels for both exemption and clearance.

Question 2
Hazards from ionising radiation due to natural sources of radiation are covered by Ireland's Ionising Radiation Regulations. Essentially, these state that the use or disposal of naturally occurring radioactive materials (NORM) in Irish workplaces are subject to regulation if they are liable to give rise to a radiation dose of greater than 1 mSv y^{-1}. The EPA has carried out an extensive survey of such industries and the materials they handle and dispose of, including those involving discrete sources (for example, thoriated products) and diffuse sources (mainly those arising from extractive industries, especially oil and gas but also peat burning and bauxite and cement production). Because of the wide range of processes involved, the EPA has found it necessary to adopt a sector-specific approach to the risk assessment methodologies it has adopted.

The assessments carried out to date indicate that no worker is likely to receive a dose in excess of 1 mSv and that doses likely to be received by members of the public are considerably lower than those received by workers and are well within limits set in national legislation. Currently, therefore, no NORM industries are subject to regulation.

Question 3
The practice of liquid radioactive waste disposal relates mainly to the medical sector in Ireland. Disposal of liquid radioactive waste can only be conducted under a licence issued by the EPA.

In Ireland, except in the case of excreta from patients, waste containing unsealed radioactive substances shall not be disposed of unless:

1. for the total quantity to be disposed of per day, the sum of the ratios between either the total activity or the total activity concentration of each of the radioactive substances being disposed of and the corresponding limits listed in legislation are each less than or equal to 1; and
2. the method of disposal of the waste does not result in the further concentration of the radioactivity contained therein to values greater than those specified in legislation; and
3. in the case of liquid waste, the waste is soluble/miscible in water and is discharged of directly to the sewers.

Question 4
In Ireland there is no distinction made in the regulatory framework between liquids with different properties, for example, aqueous and non-aqueous or those which are hazardous, and so on.

Question 5
An EPA licence is required for radioactive liquids above exemption levels and it is the responsibility of the undertaking to undertake an assessment to determine if a liquid is classed as radioactive and carry out monitoring if required. It is a legal requirement for licensees to consult with an EPA approved Radiation Protection Adviser who can assist with this assessment if requested. The EPA does not prescribe any measurement methods or limits of detection.

D.1.17 Italy

Question 1
Liquid effluents from practices are unconditionally exempted whether radionuclides with half-life shorter than 75 days and concentration lower than 1 Bq/g are involved.

Question 2
Liquids containing NORM are excluded unless they come from one of the NORM industrial activities present in the specific positive list of the Italian regulation. Actually, for those specified NORM industrial activities, an action level of 300 microSv/y effective dose is fixed regards member of the public, including liquid discharge pathway. It is recommended in National Guidelines to refer, for this purpose, to Radiation Protection 135 screening levels, where applicable

Supplemental query to Question 2: Is the positive list of NORM industrial practices in Italian regulation the same as those in Annex VI of 2013/59/EURATOM?

The positive list in the current Italian law, based on the introduction of NORM activities in the Directive 96/29/EURATOM, is shorter than the list in Annex VI of 2013/59/EURATOM. Indeed, it includes:

1. Industry using phosphate minerals and deposits for the fertilizer wholesale;
2. Processing of minerals in the extraction of tin, ferro-niobium from pyrocloro and aluminum from bauxite;
3. Processing of zircon sands and production of refractory materials;
4. Processing of rare earths;
5. Processing and use of thorium compounds, with regard to welding electrodes with thorium, production of lenses or optical glasses and gas mantles for lamps;
6. Production of titanium dioxide pigment;
7. Extraction and refining of oil and gas extraction, concerning the presence and removal of sludges and scales in pipes and containers.

Question 3
For non exempt practices with materials containing artificial radionuclides (or naturally ones, but used for the reason of the radioactive properties of the materials – not NORM work activities), liquid discharge may be authorized whether the compliance with 10 microSv/y effective dose to members of the public is demonstrated. This is done on a case-by case basis

Question 4
In Italy, 2 separate laws rule radioactive effluents (D.Lgs 230/95 s.m.i.) and conventional pollutant contaminated ones (D.Lgs 152/2006 s.m.i.). Owners of property discharging liquids have to fulfil provisions of both legislations

Question 5
As U.K.

D.1.18 Latvia

Question 1
There are no special provisions for liquids in Latvia. Any aqueous liquid containing artificial radionuclides is considered to be radioactive.

Cabinet Regulation on Licencing sets exclusion only for the activities with sources of ionising radiation if it is not possible to influence such activities by human actions or the potential dose of ionising radiation and the adverse effects of the irradiation are so small that it need not be taken into account from the viewpoint of radiation safety.

There are no general exemption or clearance concentration or total activity values for liquids which contain radioactivity. Activities with liquids are under the same Licencing Regulations with Annex setting exemption levels for specific or total activity values for radionuclides.

In Latvia there are 6 nuclear medicine facilities using liquid radioactive substances and few laboratories using liquid control sources.

Supplemental query to Question 1: What is the source of the values in the Annex, for example, are they from Table B of Annex VII of the BSSD (Council Directive 2013/59/Euratom)?

Yes, our exemption levels are the same as in the Table B of Annex VII of the BSSD (Council Directive 2013/59/Euratom). These exemption levels were put in our regulations already about 10 or 15 years before Council Directive 2013/59/Euratom.

Question 2

There are no special provisions for liquids containing NORM in Latvia, as there are not any places that could cause liquids to contain very low levels of radionuclides containing naturally occurring radionuclides.

Nevertheless Licencing Regulation sets exclusion for natural radioactive material, the specific radioactivity of which exceeds the exemption values specified in Annex of this Regulation, if such material is not specially treated in order to increase its specific radioactivity and, during performance of activities with such materials, the total dose of ionising radiation received by a person does not exceed 1 mSv per year. For radioactive material the value of 1 Bq/g is set for the natural decay chains.

Question 3

We use general release values given in Latvian legislation where allowed discharge levels of 54 radionuclides are given (level is given in activity per year). Conditions related to possible disposal routes are set in Regulations for Protection against Ionising Radiation which specifies the permissible amounts of radionuclides that may be annually emitted in the environment from the operator controlled area. Permissible amount for liquids into sewerage and waste dumps are expressed in Bq/per year.

Operator shall give report once per year to national regulator about amount of discharged radioactive liquids.

Supplemental query to Question 3: Where do the values [in the legislation] come from, for example, are they from IAEA RS-G-1.7?

Discharges into the environment, sewage and waste sites in activity permitted per year was implemented about 20 years ago taking into account experience from other regulators. As I was not involved in preparing these regulations I can not say from which

countries was taken information. All people involved in creation of regulation now are retired, nobody to ask. This question about discharges was never revised. Possible in our regulation we could return to this question, if we will see your review and could learn from it.

Question 4
No special description in legislation.

Question 5
No special requirements.

Nevertheless Regulations for Protection against Ionising Radiation sets requirement for operators working with unsealed sources (if total radioactivity exceeds exemption level more than 1000 times) to carry out monitoring of environmental radiation in a supervised area. Operator shall ensure the development of an environmental radiation monitoring programme. Programme (including methods of measurements) shall be submitted for co-ordination with the Regulator. Operator at least once a year submit report to the Regulator For example, operator of I-131 therapy facility ensure temporary storage of hospital sewage liquids into tanks for decay few months and monitor dose rate. The sample is taken from each tank before release of liquid into sewerage system. Radioactivity concentration of samples are measured in the accredited laboratory.

D.1.19 Lithuania

Question 1
In Lithuania, we do not have special legislation for exemption or clearance of liquids containing very low levels of artificial radionuclides.

Liquid discharges from authorized practises at NPP are regulated due by public exposure (dose constrain) and total dose due to liquid and gaseous discharges for public is 0.2 mSv y^{-1}. For that Order No 22.3-89 of Head of State Atomic Energy Safety Inspectorate of 27 September 27 2011 (amendment of 31 October 2017 version 22.3-198) Nuclear safety requirements BSR-1.9.1-2017 The norms for release of radioactive materials from a nuclear facility and requirements for the Plan is valid.

Liquid discharges from authorized practises at non-nuclear industry, hospitals, and scientific institutions are regulated by Order of the Minister of Health No. V-900 of 13 October 2011 "On the Description of Procedure for Issuing Permissions for Radionuclide Discharges to the Environment from Medical, Industrial, Except Nuclear Energy Facilities, and Agricultural and Research Entities". For the liquids (and gaseous discharges), limits are set. If the activity does not exceed the limit value, no permission for discharges is needed. The values are as in IAEA Tec Doc 1000 (1998) as follow:

Table B 1. Summary of documents on which exemption/clearance values and discharge limits are based.

No.	Radionuclide	Gaseous discharge, Bq per year	Discharge to water, Bq per year
1.	^{3}H	$1*10^{11}$	$1*10^{12}$
2.	^{14}C	$1*10^{10}$	$1*10^{10}$
3.	^{32}P	$1*10^{8}$	$1*10^{6}$
4.	^{35}S	$1*10^{8}$	$1*10^{9}$
5.	^{36}Cl	$1*10^{7}$	$1*10^{10}$
6.	^{42}K	$1*10^{10}$	$1*10^{9}$
7.	^{45}Ca	$1*10^{8}$	$1*10^{10}$
8.	^{47}Ca	$1*10^{9}$	$1*10^{8}$
9.	^{51}Cr	$1*10^{9}$	$1*10^{8}$
10.	^{59}Fe	$1*10^{8}$	$1*10^{6}$
11.	^{57}Co	$1*10^{9}$	$1*10^{9}$
12.	^{58}Co	$1*10^{9}$	$1*10^{8}$
13.	^{67}Ga	$1*10^{10}$	$1*10^{8}$
14.	^{75}Se	$1*10^{8}$	$1*10^{6}$
15.	^{85}Sr	$1*10^{8}$	$1*10^{6}$
16.	^{89}Sr	$1*10^{8}$	$1*10^{9}$
17.	^{90}Y	$1*10^{10}$	$1*10^{10}$
18.	^{99}Mo	$1*10^{9}$	$1*10^{8}$
19.	^{99}Tc	$1*10^{7}$	$1*10^{10}$
20.	^{99m}Tc	$1*10^{11}$	$1*10^{9}$
21.	^{111}In	$1*10^{9}$	$1*10^{8}$
22.	^{123}I	$1*10^{10}$	$1*10^{9}$
23.	^{125}I	$1*10^{8}$	$1*10^{8}$
24.	^{131}I	$1*10^{8}$	$1*10^{7}$
25.	^{127}Xe	$1*10^{11}$	–
26.	^{133}Xe	$1*10^{12}$	–
27.	^{147}Pm	$1*10^{10}$	$1*10^{10}$
28.	^{169}Er	$1*10^{10}$	$1*10^{10}$
29.	^{198}Au	$1*10^{9}$	$1*10^{8}$
30.	^{197}Hg	$1*10^{10}$	$1*10^{9}$

No.	Radionuclide	Gaseous discharge, Bq per year	Discharge to water, Bq per year
31.	^{203}Hg	$1*10^{8}$	$1*10^{7}$
32.	^{201}Tl	$1*10^{10}$	$1*10^{8}$
33.	^{226}Ra	$1*10^{6}$	$1*10^{6}$
34.	^{232}Th	$1*10^{5}$	$1*10^{6}$

Question 2

In fact, NORM related industry and problems with discharges containing natural radioactivity not exist in Lithuania, so we do not have special legislation for exemption or clearance of liquids containing very low levels of natural radionuclides.

Liquid discharges from authorized practises at non-nuclear industry, hospitals, and scientific institutions are regulated by Order of the Minister of Health No. V-900 of 13 October 2011 "On the Description of Procedure for Issuing Permissions for Radionuclide Discharges to the Environment from Medical, Industrial, Except Nuclear Energy Facilities, and Agricultural and Research Entities". For the liquids (and gaseous discharges), limits are set. If the activity does not exceed the limit value, no permission for discharges is needed (see for Question 1).

Liquid discharges from authorized practises at that type institutions (non-nuclear sector) are regulated due by dose constrain as well and total dose due to liquid and gaseous discharges for public is 0.2 mSv y^{-1}.

Question 3

See Aswers to Questions 1 and 2.
Discharges are assessed for each of authorized practises.
Exempted values are the same as in IAEA Tec Doc 1000:1998.

Question 4

No.

Question 5

No.
Authorised limits for discharges shall be calculated according dose constrain to public and radiation protection regulatory body shall approve Plan for discharges.
Activity of discharges are controlled by means of activity used and discharged (Except NPP, where monitoring of emissions is performed).

D.1.20 The Netherlands

Question 1

For materials of any type (that is, including liquids) containing very low levels of artificial radioactivity, clearance levels are set for 64 nuclides. These levels are set as the total yearly activity, and are, except for a summation requirement, without further conditions. The reason to include this in legislation was the recycling and reuse of equipment and materials where the release of very small radioactive amounts of liquids and gases is inevitable (in the research, hospital and production sectors). Since table A in Annex VII of the directive Euratom/2013/59 only applies to solid materials such materials can not be cleared. Basis for these clearance levels is a very conservative calculation, based on dose limits of 1 µSv per year (inhalation and ingestion), 10 µSv per year (external exposure), and 10 µSv per year for the dose to the skin. These clearance levels are included in the ANVS-Regulation on Basic Safety Standards for Radiation Protection(2018). A poster presented at IRPA-2018 (enclosed) provides more details on the methodology and results.

In the Netherlands, moderate amounts of materials of any type (that is, including liquids) containing radionuclides of artificial origin can be exempted without further conditions on the basis of the exemption levels in Table B of directive 2013/59/Euratom and the extension of this table in NRPB 306. These exemption levels are based on the scenarios and dose criteria described in Radiation Protection 65, and are laid down in the Dutch Decree on Basic Safety Standards for Radiation Protection and the underlying Regulation on Basic Safety Standards for Radiation Protection.

Any quantity of any type of material (including liquids) containing radionuclides of artificial origin can be cleared under the condition that these materials are incinerated and on the basis of the clearance levels in Annex VII Table A part 1 of directive 2013/59/Euratom, and the extension of this table in BRENK-report "Berechnung von Freigrenzen und Freigabewerten für Nuklide, für die keine Werte in den IAEA-BSS vorliegen (2012)", and laid down in the Dutch Decree on Basic Safety Standards for Radiation Protection and the underlying Regulation on Basic Safety Standards for Radiation Protection.

All other situations are dealt with on case by case basis. The entrepreneur needs to send a clearance request at the ANVS showing a.o. compliance to the general clearance and exemption criteria of the directive 2013/59/Euratom (Annex VII).

Question 2

Specific clearance of wet sludge containing radionuclides of natural origin from the oil- and gas industry and geothermal industry, on the condition that residues are disposed on a specified landfill, is possible on the basis of the clearance levels in Radiation Protection 122, part II, second column. These clearance levels are laid down in the Dutch ANVS-Regulation on Basic Safety Standards for Radiation Protection.

Question 3

Discharge of radioactivity (including liquids) to soil is not allowed , if the discharged radioactivity exceeds 10^{-6} radiotoxicity equivalent-ingestion[16] per year.

Discharge of radioactivity of artificial origin (including liquids) to water is subject to licensing, if the discharged radioactivity exceeds 0.1 radiotoxicity equivalent-ingestion per year (water) or 10 radiotoxicity equivalent-ingestion per year (sewer). These discharge screening levels are laid down in the Dutch Decree on Basic Safety Standards for Radiation Protection, and are based on a dose criterion of 0.1 µSv per year for a member of the public.

Discharge of radioactivity of natural origin (including liquids) to water is subject to licensing, if the discharged radioactivity exceeds the discharge screening levels, as laid down in the Dutch Decree on Basic Safety Standards for Radiation Protection. The discharge screening levels are based on a dose criterion of 10 µSv per year for a member of the public and 1 mansievert per year for the population.

The discharge screening levels are reproduced in the table here below:

Nuclide	Discharge screening level for discharge of natural radioactivity to water(GBq/year)
Pb-210+	10
Po-210	10
Rn-222+	-
Ra-223+	1.000
Ra-224+	1.000
Ra-226+	10
Ra-228+	100
Ac-227+	100
Th-227	1.000
Th-228+	1.000
Th-230	100
Th-232sec	100
Th-234+	10.000
Pa-231	10.000
U-234	1.000
U-235+	1.000
U-238sec	1.000

[16] The radiotoxicity equivalent-ingestion (Re) of a radionuclide is the activity that results in an effective dose of 1 sievert, assuming complete ingestion

Any request for a license will be assessed on a case by cases basis and the license will include discharge limits.

Question 4
In the Dutch radiation protection legislation there is no difference between aqueous and non-aqueous liquids.

Question 5
We expect that any person who knows or who has reason to believe that a substance may be radioactive to understand the characteristics of that substance and to carry out monitoring if necessary. We do not prescribe any monitoring techniques or limits of detection but we do expect best available technique (BAT) to be used.
Additional requirements on measurements can be set in the licence.

D.1.21 Norway

Question 1
In Norway, any radioactive discharges above given activity constraints are only legal if the responsible party obtain a discharge permit from the Norwegian Radiation Protection Authority. The given activity constrains are given in our "Regulations on the application of the Pollution Control Act to radioactive pollution and radioactive waste" appendix II. The activity constraints are given both in total activity discharged per year, or specific activity. If any discharge is equal or higher than any of the 2 given activity constraints, the responsible party must apply for a discharge permit. If the discharge consist of a mixture of several radionuclides, the ratio between the discharge and limits of the specific activity must be added (as shown by the formula at the start of appendix II) and if the result of the summary is 1 or higher, the responsible party must apply for a permit.

If needed, we can provide you with the rationale behind setting the limits in appendix II in late august/September.

No sectors are exempted from these limits.

The discharge permits contain several conditions, and they may vary based on where the discharge is located. All discharge permits have a upper limit of what is acceptable for yearly discharge. Discharges from hospitals and universities are usually to public sewage, and the discharge must not cause exposure to workers in the sewage systems above the legal constraints for exposure of the public. In addition, the discharges must not influence the quality of the by-products of sewage treatment, which can be used for soil conditioning purposes. The discharges can not cause harm to biota. NORM-facilities including NORM-waste and infrastructure build in NORM-areas can have direct discharges to salt- or fresh water. Usually for land-based NORM-facilities, these discharges has to be collected and put through a water treatment facility in order to reduce discharges.

In general, the responsible party has to reduce or avoid discharges if possible.

Question 2

The same regulations are valid for discharges of VLL of NORM. NORM can be both uranium or thorium in equilibrium with it's decay products (U-nat and Th-nat in the regulations appendixes), or if not in equilibrium, as U-238, U-234 and so on, and Th-232 and so on.

The same regulations and conditions apply for NORM discharges as mentioned as an answer for question 1. No sectors are exempted.

Question 3

The responsible party for a discharge above the limits in the regulations appendix II has to apply to the NRPA for a discharge limit (after § 11 in the Pollution Control Act, which is also valid for radioactive waste and pollution. NRPA assess the discharge application on a case-by-case basis, but treats similar enterprises with similar risks and complexity and environmental impact on a similar basis and give similar conditions for the permit. The responsible party need to give NRPA information about their enterprise, their discharges, the receptor and possible environmental impacts and so on. NRPA may ask for public feedback on the case, and based on the evaluation of the application, eventual comments, and our own assessment, may give a permit to discharge. The permit has several conditions, such as the responsible party needs to provide NRPA with a yearly report regarding their discharges, inform us of accidental discharges and having an emergency preparedness regarding accidental discharges and wrongful handling of radioactive waste, having an EIA, water treatment facilities, environmental surveillance with regards to radioactive substances, and as mentioned earlier, a set upper discharge limit which can not be exceeded.

Question 4

NRPA is an environmental protection authority with regards to radioactivity only. However, as radioactive waste and pollution is regulated by the same laws and regulations as non-radioactive pollution and waste, radioactive pollution which has other hazardous effects or are non-aqueous will be regulated by both the NRPA and the Norwegian environmental protection authority (EPA). NRPA and EPA are in close contact in these cases and as a free and unhindered communication and flow of information in order to have a holistic regulation on all discharges which falls under the pollution control act. In general, radioactive and non-radioactive mixes of pollution and wastes has to be regulated both as radioactive and non-radioactive pollutants and wastes.

Question 5

The owner of any enterprise must know what substances they discharge. For some industries, it is obvious that the enterprise has discharges, such as hospitals and research facilities that uses open sources. These kind of facilities are knowledgeable and understand that they have discharges and needs discharge permits.

The largest challenge has been to inform industry which utilises large volume of natural substances such as rock, water or wood that they may, in fact, have radioactive discharges which needs a permit. NRPA has looked to IAEAs list over potential NORM-industries in order to identify which industries might have radioactive discharges and must measure or in other ways assess their discharges.

In such cases, information has been given to representative organisations, which provide the information to their members, and in some cases directly to the organisations themselves. In addition, NRPA has presentations in forums where the industries are represented in order to try to inform as many as possible. We also have information on our website.

For some of these facilities, direct measurement of the discharges is not applicable, due to the very large volume of waste waters which may run through the facility. In such cases, NRPA accept calculations in order to establish discharges rather than measurements.

D.1.22 Romania

Question 1
In the new legal framework which implements Council Directive 2013/59/EURATOM only exemption and clearance concepts does exist. In the new legal framework the exemption and clearance levels are those from Council Directive 2013/59/EURATOM. There are not specific levels for liquid.

Question 2
The uranium mining and milling is under regulatory control as part of nuclear fuel cycle. The following requirements are applicable; the radioactive effluents may be released in the public sewerage only if all the following conditions are fulfilled:

a) the liquid radioactive effluents are neutral solutions, totally mixable with water
b) they do not contain solid radioactive suspensions
c) the total activities and the activity levels are under the liquid radioactive effluents derivated limits for releasing in public sewerage
d) the releasing is stated case by case and it is mentioned by the licence issued by the Authority

If the releasing conditions mentioned above are not fulfilled by the liquid effluents the licensee shall ensure their temporary storage or treatment.

NORM activities are regulated as well. The exemption level is 1 Bq/g for U-238 and Th-232 and 10 Bq/g for K-40. There are no special criteria for liquid.

Question 3

Except for uranium mining and milling and medicine, during normal operation, the releases of liquid and gaseous effluents from a practice are based on annual derived emission limits respectively for the liquid and gaseous radioactive effluents that ensure the observance of the annual effective dose constraints.

In view of triggering investigations in the case of increased releases of radioactive effluents, so ensuring the observance of the annual derived emission limits, and in order to prevent the possibility of significant increase of the doses due to increased emissions of radioactive effluents in weak dispersion conditions in the environment, derived daily/per release, weekly, monthly and quarterly emission limits should be established. In order to establish the annual derived emission limits, the licensee shall evaluate the annual doses corresponding to intended discharges for all discharged radionuclides, by every discharge route, determining the relative weight of doses corresponding to each radionuclide on each discharge route.

Based on relative weights, for each radionuclide for each discharge route, annual derived emission limits are established, so that the annual effective dose constraint are totally satisfied, according to the formula:

$$\sum_i \sum_k (f_{ik})_{\mathrm{mod}\,el} \cdot Q_{ik}^{*} \le \frac{E_{constr}}{\Gamma}$$

where:

$(f_{ik})_{model}$ is the conversion factor of annual effective dose, expressed in Sv/Bq, due to incorporation by a critical group member of radionuclide i (group of radionuclides i, established according to the provisions of par. (3)), on the discharge route k; Q_{ik}^{*} is the annual derived emission limit, expressed in Bq/year, for the radionuclide i (group of radionuclides i, established according to the provisions of par. (3)), on the discharge route k; the respective dose is calculated using a model recognised by CNCAN; E_{constr} is the annual effective dose constraint, expressed in Sv y^{-1} for critical group members referring to radiation exposure due to radioactive effluents; Γ is a safety factor taking into account the uncertainties associated with the model used for dose estimation and its value is to be approved by CNCAN together with the annual derived emission limits.

CNCAN may accept also the establishing of annual derived emission limits for groups of radionuclides (such as noble gases, halogens, or groups of radionuclides less relevant for the dose), in which case for establishing the annual derived emission limit for the respective group are to be used conservative assumptions, such as, for example, the consideration of the most restrictive radionuclide from the group.

If the annual effective dose constraint is established by CNCAN separately for different discharge routes, it is necessary to satisfy the respective dose constraint, for each discharge route k, according to the formula:

$$\sum_i (f_{ik})_{\mathrm{mod}\,el} \cdot Q_{ik}^{*} \le \frac{E_{constr,k}}{\Gamma}$$

where $E_{constr,k}$ represents the annual effective dose constraints for the critical group on the exposure parthway k, in mSv/an.

From nuclear medicine practices:

- liquid effluents with $t_{1/2}$ less than 100 days can be temporary stored till the activity concentration reach the clearance level
- liquid effluents as well as liquid scintillators and any other liquid effluents can be released

Only if:
a) activity concentration is less than 10 Bq/ml and do not contain alfa emitters;
b) activity concentration is less than 100 100 Bq/ml and contain only C-14 or H-3.

Question 4
Two categories:

- aqueous liquid effluent
- non-aqueous liquid effluents

The following restrictions for the release of liquid radioactive effluents are applying:
a) the liquids for discharge shall be miscible with and readily dispersible in water;
b) if the liquid for discharge contains suspended materials above the legal limits, it shall be filtered prior to discharge;
c) if the liquid for discharge contains, or is suspected to contain radioactive hot spots, it shall be filtered prior to discharge;
d) acid or alkaline liquids shall be neutralized prior to discharge;
e) if the liquids for discharge also contain toxic or other chemicals that could adversely affect the environment or the treatment of sewage, the waste shall be treated prior to discharge in accordance with the specific regulations for protection of health and environment.

Supplemental query to Question 4: How do you define a liquid as aqueous or non-aqueous, and how does this affect disposal of the effluent?

There is not a definition of aqueous or non-aqueous liquid effluents. They are based on the stream where they are produced. The non aqueous are in general liquid scintillates and mineral oils and they are restricted for release by sewage. These non aqueous are

released from regulatory control or in case do not meet criteria for release they are solidified for further disposal, and in this second case they are proper considered in safety assessment for disposal.

Question 5
There are requirements for monitoring technics as well as detection limits but only for solid materials(metals). For liquids there are no any requirements for detection or monitoring.

D.1.23 Spain

Question 1
In Spain, there are not exclusion, exemption or clearance provisions for liquids containing very low levels of radionuclides containing artificial radionuclides.

Question 2
Liquids containing NORM are excluded unless they arise from a NORM industrial activity, as listed in CSN Instruction IS-33 on the radiological criteria for the protection against exposure to natural radiation. There are no generic exemption/clearance values for liquids. Regulatees shall demonstrate that doses arising from discharges are below 0.3 mSv y^{-1}

Question 3
According to Article 51 of the Regulation on Sanitary Protection against Ionizing Radiations, all evacuation of radioactive effluents into the environment needs a specific authorization that includes discharge limits, surveillance requirements and conditions for the releases.

The discharge limit, that applies both during operation and decommissioning of nuclear installations, is set as an effective dose value of 0,1 mSv y^{-1} considering 12 consecutive months. This value, which corresponds to the overall effluents emitted by each of the groups at a site, is the result of an optimization process and represents a proper percentage of the dose constraint (0,3 mSv y^{-1}) and the dose limit for public required in the Spanish legislation (1 mSv y^{-1}).

In the case of the radioactive installations, according to CSN IS-28 on the technical specifications that second- and third-category radioactive facilities must observe, the licensee must be expressly authorised before disposing of radioactive effluents from the facility, in accordance with to that envisaged in Article 51 of the Regulation on Sanitary Protection against Ionising Radiations.

Controlled discharges of liquid radioactive effluents into the public sewer system must fulfil the following requirements:

- the material released shall be in water-soluble form or easily dispersible biological material
- the activity concentration at the end point of discharge into the general sewer system shall not exceed, in each discharge, the concentration levels obtained by dividing the limits of intake by ingestion for the "older than 17 years-old" age group by the yearly water ingestion rate for an adult individual (600 l)
- if more than one radionuclide is discharged, the sum of the fractions obtained by dividing the concentration value of each radionuclide by the corresponding concentration level shall not exceed one
- the total activity of radioactive material discharged into the public sewer system in one year shall not exceed 10 GBq of ^{3}H and 1 GBq of ^{14}C; the sum of the activities of the other radionuclides shall be below 1 GBq

Question 4
Regarding the different properties of the liquids released from the nuclear installations, no considerations are established by the Nuclear Safety Council (CSN).

In the case of the radioactive installations, according to CSN IS-28, the material released shall be in water-soluble form or easily dispersible biological material.

Question 5
In the nuclear installations every liquid considered as potentially radioactive must be monitored. Regarding the limits of detection, Recommendation 2004/2/EURATOM is applied in the nuclear power plants.

D.1.24 Sweden

Question 1
Exemption values for materials (incl. liquids) are the same as EU BSS, Annex VII, tables A and B.

Clearance levels for materials (incl. liquids) are the same as EU BSS, Annex VII, table A.

Sweden also have specific clearance levels for hazardous waste (incl. liquids) that is handed over to conventional incineration or disposal. The levels are 10 times the values of the EC recommendation RP 122 part 1.

Question 2
Exemption values for materials (incl. liquids) are the same as EU BSS, Annex VII, tables A and B.

For practices where radioactive materials are processed for their radioactive, fissile or fertile properties, clearance levels for materials (incl. liquids) are the same as the values of the EC recommendation RP 122 part 1.

Sweden also have specific clearance levels for hazardous waste (incl. liquids) that is handed over to conventional incineration or disposal. The levels are 10 times the values of the EC recommendation RP 122 part 1 for practices where radioactive materials are processed for their radioactive, fissile or fertile properties.

Question 3
For all practices (nuclear and non-nuclear) the discharges shall be measured and the RP shall be optimised taken into account the dose constraint 0,1 mSv a year, effective dose. For NPP the dose constraint 0,1 mSv a year shall be applied for the sum from all NPP:s (and other practices) located at the same site. Compliance with this requirement is demonstrated applying graded approach. Best available techniques shall be applied.

For non-nuclear facilities, limited discharge to the sewer-system is allowed if:

1. the activity released each time is less than the values given in column 3 in Table B, Annex VII, EU BSS.
2. the total amount released at one month is less than 10 times of the values given in column 3 in Table B, Annex VII, EU BSS.

Question 4
See answers to questions 1 and 2 concerning clearance of hazardous waste.
Supplemental query to Question 4: Do you have a legal definition of hazardous waste?
Hazardous waste ("farligt avfall") is defined in section 3 of the Swedish waste ordinance, Avfallsförordning (2011:927).

In Swedish:
Farligt avfall: avfall som i bilaga 4 beskrivs med en avfallskod markerad med en asterisk (*) eller som enligt föreskrifter som har meddelats med stöd av 12 § ska anses vara farligt avfall.

I would translate it as:
Waste that is described by a waste code marked with * in appendix 4 of the ordinance, or that is considered as hazardous waste according to regulations that have been promulgated with support from section 12 of the ordinance.

Information on the Swedish environmental legislation can be found here:

Question 5
We share the same approach as was described by the UK: We expect that any person who knows or who has reason to believe that a substance may be radioactive to understand the characteristics of that substance and to carry out monitoring if

necessary. We do not prescribe any monitoring techniques or limits of detection but we do expect best available technique (BAT) to be used.

D.1.25 Switzerland

Question 1
The exclusion, exemption and clearance values for liquid discharges are the same as for solids (LL as for limite de liberation in Bq/g). Exemption from practices can use higher values if it does not include release to the environment.

The values used are those of IAEA, Safety Requirements: Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards, Revision of IAEA Safety Series N°115, GOV2011/42, 15 August 2011; Tableau I-2. For nuclides for which no value is available in table I-2 values were calculated using the same scenarios by a private company and added to the Radiological Protection Ordinance (RPO). For short-lived nuclides and a few others, alternative values were used to avoid inconsistencies. For details see our Radiological Protection Ordinance (RPO), annex 3).

These values must be respected in all practices using artificial radionuclides and those where a contamination of liquids is possible must verify compliance with the LL. Such liquid waste (under LL) can be, if its other properties allow for it, be disposed of in normal sewage systems.

Question 2
As of 2018, with the coming into force of the revised Radiological Protection Ordinance, NORM practices must be analysed if a material (inclusive liquids) contains more than 1 Bq/g of natural radionuclides (10 Bq/g for K-40) (From EU-BSS). In planned exposure situations immission limit leading to a max of 0.3 mSv y^{-1} in publicly accessible waters must be respected for natural as for artificial radionuclides (limit, for example, for U-238 3 Bq/liter). Further, limits for drinking water must be respected if drinking water is impacted (30 micro-g/litre for uranium, for example).

For existing exposure situations, a reference level of 1 mSv per calendar year applies. The licencing authority may recommend to the Federal Council, in individual cases, reference levels of up to 20 mSv per calendar year but the drinking water limit still applies.

Question 3
Discharges above the LL (see question 1) is possible for authorised practices. First, all authorised practices can discharge up to a maximum of the equivalent of 10kg of a substance containing a specific activity of LL per week (= 10 [kg] x LL [Bq/kg]/week, that is, Bq/week) without a specific discharge authorisation. The respect of the limit must be verified and documented.

Above this value, specific discharge authorisation can be applied for. The regulatory authority fixes the discharge limit based on the immission limit for publicly accessible waters, which assures the respect of a dose criterion of 0.3 mSv y^{-1} for the public (drinking water scenario).

Question 4
Only liquids, which properties (other than radiotoxicity) allow for discharge, can be released to the environment. Other liquids, for example, oils or chemicals must be treated as radioactive waste if the activity concentration is above LL. Which liquids meat this criteria depends on many different regulations (chemicals, waste treatment, drinking water…)

Question 5
For practices concerning radioactive material above the exemption limits, it would be checked before an authorisation is given if the production of liquid radioactive waste is possible. Under these values, but above the exclusion values LL the discharge of liquids above the LL is also subject to authorisation. For NORM, the identification of practices is ongoing.

For any authorised discharges, the used techniques depend on radionuclide and value to be detected. In most cases, scintillation or gamma-spectroscopy are used. For well-known and documented practices, categorisation using models can also be accepted (calculus).

D.1.26 United States of America

Question 1
1. The U.S.A (for example, US NRC) has schedules for Exempt Concentrations for liquids. For example, 10 CFR 30.70 Schedule A, Col. II lists exempt concentrations for radioactive byproduct material in µCi/ml. Currently, there are no provisions in NRC regulations for "Clearance" of liquids. These may be dealt with on a case-by-case basis considering potential impacts to humans and the environment. There are no specific industry sectors that are categorically exempted.

2. Allowed liquid effluent release limits (in µCi/ml) from licensed facilities to water and to sewer for different radionuclides are presented in 10 CFR part 20 Appendix B, Tables 2 and 3 respectively. These limits are enforced based on monitoring, reporting, and inspection. These values were conservatively derived based on the assumption that human continuously drinks 2L/day of such contaminated effluent over the course of a year that would produce a total effective dose equivalent of 0.5 mille Sieverts.

3. Radionuclides released into water or sewer must be dispersible and readily soluble to allow dispersion and prevent concentration or coagulation of radionuclides into the environmental media.

Question 2

Liquids (or solids) containing naturally occurring radionuclides such as U/Th or any combination thereof in any physical form are designated as "source materials." Such materials are regulated under 10 CFR part 40-Domestic Licensing of source material. Specific regulatory exemptions for such materials are provided under 10 CFR 40.13 and 10 CFR 40.14. Para §40.13 stated: (a) Any person is exempt from the regulations in this part and from the requirements for a license set forth in section 62 of the Act to the extent that such person receives, possesses, uses, transfers or delivers source material in any chemical mixture, compound, solution, or alloy in which the source material is by weight less than one-twentieth of 1 percent (0.05 percent) of the mixture, compound, solution or alloy. Para §40.14 (a) stated: "The Commission may, upon application of any interested person or upon its own initiative, grant such exemptions from the requirements of the regulation in this part as it determines are authorized by law and will not endanger life or property or the common defense, and security and are otherwise in the public interest."

There are no specific conditions for such exemptions or specific industry sectors which are excluded. It is noted that source materials already contained in certain products such as glazed ceramics, glassware, or piezoelectric ceramics may contain more than 0.05 percent by weight and may be exempted.

Question 3

The discharge of radioactive liquids from NRC-licensed facilities is regulated under 10 CFR Part 20 Appendix B (See bullet #2 response to Q1). 10 CFR Part 20, Subpart K; Waste Disposal, provides requirements that include disposal of liquid effluents to sanitary sewerage (10 CFR 20.2003) and methods for obtaining approval of proposed disposal procedures (10 CFR 20.2002), which has been used for approving radioactive liquid discharges to the environment as a remediation method. 10 CFR 20.1101; Radiation Protection Programs, also requires licensees to use procedures and engineering controls that are based on sound radiation protection principles to achieve occupational doses and doses to members of the public that are as low as is reasonably achievable (ALARA).

Additionally, disposal of liquid wastes containing radionuclides may also be subject to U.S. Environmental Protection Agency (EPA) regulations as well as state and local regulations. For example, the Clean Water Act requires anyone discharging pollutants into U.S. waters through a point source to obtain a National Pollutant Discharge Elimination System (NPDES) permit from the state or EPA Region. While Federal regulations do not set specific limits on radionuclides in such discharges, States have the authority to establish these limits.

Question 4

Liquids released into water or effluent system must be readily soluble (see response to Q1 bullet #3). Hazardous liquids, or immiscible solutions such as oil, are treated as

mixed waste, and dealt with on a case-by-case basis. Currently, there are no specific categorization of liquids except that liquids containing both hazardous materials and radionuclides may be dealt with as mixed radioactive waste.

Question 5

Currently, there are no specific limits except those mentioned above in response to Q1. For measurements and establishing limits of detection, U.S. Federal agencies adopted MARLAP protocols using the concept of "Data Quality Objectives" considering regulatory limits to be applied for selection of analytical instruments and appropriate analytical methods. NRC staff typically assess inherent uncertainties in measurements associated with methods, instruments, as well as variations due to sampling, inhomogeneity of liquid material, as well as temporal and locality of liquid sampling.

About Public Health England

Public Health England exists to protect and improve the nation's health and wellbeing, and reduce health inequalities. We do this through world-leading science, research, knowledge and intelligence, advocacy, partnerships and the delivery of specialist public health services. We are an executive agency of the Department of Health and Social Care, and a distinct delivery organisation with operational autonomy. We provide government, local government, the NHS, Parliament, industry and the public with evidence-based professional, scientific and delivery expertise and support.

Public Health England
Wellington House
133-155 Waterloo Road
London SE1 8UG
Tel: 020 7654 8000

www.gov.uk/phe
Twitter: @PHE_uk
Facebook: www.facebook.com/PublicHealthEngland

Prepared by: K A Jones, T Anderson and T Cabianca.
This report has been produced by Public Health England's Centre for Radiation, Chemical and Environmental Hazards under contract to Department for Business, Energy and Industrial Strategy (BEIS).
Any enquiries regarding this publication should be sent to Centre for Radiation, Chemical and Environmental Hazards, Public Health England, Chilton, Didcot, Oxfordshire OX11 0RQ E: CRCEDirectorsOffice@phe.gov.uk

Published: January 2021
PHE gateway number: GW-1858

PHE supports the UN Sustainable Development Goals