draeth Cynulliad Cymru Llywo
a Assembly Government Welsh

**Issued: 7 December 2010**

**Respond by: 8 March 2011**

## How to respond:

**By post or email**

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## How to respond

a. When responding, please state whether you are responding as an individual or representing the views of an organisation. If you are responding on behalf of an organisation, please make it clear who the organisation represents and, where applicable, how you assembled the views of members.

b. When responses to this consultation have been analysed, the Government will issue a response.

c. This consultation began on 07 December 2010 and will close on 8 March 2011.

### Responding by post or email

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## Confidentiality and data protection

d. Responses to this consultation, including names, will be made public unless respondents specifically request confidentiality.

e. Respondents who wish for their responses to remain confidential should clearly mark the document/s to that effect and explain the reasons for confidentiality. Any confidentiality disclaimer that may be generated by your organisation's IT system will be taken to apply only to information in your response for which confidentiality has specifically been requested.

f. Respondents should be aware that confidentiality cannot always be guaranteed. For example, responses, including personal information, may be subject to publication or release in accordance with the access to information regimes (primarily the Freedom of Information Act 2000, the Data Protection Act 1998 and the Environmental Information Regulations 2004).

## Additional Copies

g. You may make copies of these documents without seeking permission. Welsh copies of the consultation document are available on request.

## Help with queries

h. Questions about the policy issues raised in this consultation can be addressed to:

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## Consultation conduct

i. If you have comments or complaints about the way in which this consultation has been conducted, these should be sent to:

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# Executive Summary

This document represents the first phase in the development of a draft Strategy for the Management of Solid Low Level Radioactive Waste (LLW) from the Non-Nuclear Industry in the United Kingdom. It is primarily aimed at:

- non-nuclear industry radioactive waste managers;,
- the environmental regulators;
- waste planning bodies.

It will also be relevant to operators of all waste disposal facilities.

In this document the non-nuclear industry means those organisations producing radioactive waste but which are not part of the nuclear industry. It includes hospitals, the pharmaceutical sector, research and education establishments, all of which depend on the use of radioactive materials to conduct their business. The non-nuclear industry also includes those businesses that produce radioactive waste as a by-product of processing material containing natural radioactivity (principally, the oil and gas industries).

In March 2007 the UK Government, Scottish Government, Welsh Assembly Government and Department of the Environment, Northern Ireland (collectively referred to in this document as 'Government') published the 'Policy for the Long Term management of Solid Low Level Radioactive Waste in the United Kingdom' (The LLW Policy). In it Government recognised that there was a need for a UK-wide strategy for radioactive wastes arising from the non-nuclear industry.

This draft strategy fulfils the first part of Government's commitment to produce a UK-wide strategy. It covers the majority of sectors making up the non-nuclear industry and will include general information applicable to the whole of the non-nuclear industry. A second phase of consultation will focus on the specific needs of those organisations which produce wastes containing naturally occurring radioactive materials (NORM). The nature of NORM wastes are very different to those of the rest of the non-nuclear industry hence Government is considering these separately.

The majority of solid LLW produced by the non-nuclear industry is similar in its physical and chemical nature to the wide variety of other municipal, commercial and industrial wastes.  It is distinguished from these directive wastes in that it contains radioactivity that is additional to that which is present naturally and unmodified in the earth's raw materials (and therefore also in all types of waste).  Most LLW produced by the non-nuclear industry contains only very small quantities of this additional radioactivity.  Although UK wide estimates of non-nuclear industry waste are uncertain, the quantities are very unlikely to exceed 0.1% by volume of the quantities of non-radioactive directive waste.  The very small volumes of solid LLW produced by the non-nuclear industry are largely insufficient to drive the provision of bespoke management and disposal facilities via the market.

The estimated radiation doses to workers involved in handling and disposing of solid LLW and to the public are extremely low, typically less than 1% of the dose received from natural background radiation. Because of these low risks and the very small quantities produced, disposal of these wastes has, for many decades, mostly been via facilities that are used for other, non-radioactive, wastes; predominantly, incineration and landfill. However, despite the low risks associated with non-nuclear industry waste disposals, the fact that the wastes are defined as radioactive can give rise to public concern which can be a deterrent for waste facility operators to provide a disposal service.

During the development of the LLW Policy between 2005 and 2007, the non-nuclear industry reported a reduction in the availability of facilities to take their wastes. There was concern about the continued availability of these facilities as well as the need to transport waste over long distances and the increased costs associated with this. A commitment was therefore made in the LLW Policy to prepare a UK-wide strategy for the management of solid non-nuclear industry VLLW and LLW. This policy document (Ref. 1) set out the view that;

> "*it is appropriate that local communities should take greater responsibility for how they deal with non-nuclear industry arisings*", and that there should be
>
> "*provision of sufficient opportunities within national, regional and local planning strategies, as appropriate, to meet the non-nuclear industry disposal needs as set out in the UK-wide strategy*".

Preparation of this strategy included the collection of up-to-date information on the extent and geographical distribution of solid radioactive waste arisings from the non-nuclear industry. Participation in this survey was less than anticipated and therefore the quantification of waste arisings from the non-nuclear industry across the whole of the UK remains very uncertain. Nonetheless the study has provided useful indicative data on the types of waste, disposal practices and transport issues and the main findings are summarised in this strategy.

Organisations which produce NORM wastes will be dealt with separately from the rest of the non-nuclear industry, because their LLW and VLLW are often contaminated with organic material (including hydrocarbons) and contain certain very long half-life radionuclides whose management needs to be considered carefully. Some of these industries face imminent difficulties with disposals of radioactive waste containing naturally occurring radioactivity; therefore a further data collection and options assessment to identify feasible management options, including disposal, will be completed and incorporated in the final strategy to promote optimum disposal routes for these wastes.

Government does not believe it is appropriate to require operators of commercial waste facilities to take particular wastes. However, via this waste strategy, Government intends to reduce the fragility of disposal arrangements for the non-nuclear industry. It believes that providing information on who the non-nuclear industry is, why it creates radioactive waste, the characteristics of the waste, how wastes are managed and the risks associated with their disposal will provide greater clarity over the importance of adequate disposal arrangements. Much of this his information is provided in a series of annexes to this strategy. Collectively this will demonstrate the need for the continued availability of existing radioactive waste disposal facilities and creation of new facilities.

A variety of organisations have roles to play in helping to conserve and improve a UK-wide disposal network for the non-nuclear industry solid LLW, and in this waste strategy, Government summarises its expectations of these bodies as follows:

- Waste producers should continue to ensure appropriate application of the waste management hierarchy and optimum use of the network of facilities that is available for disposals of their waste. This aspect of the strategy is of particular relevance to the use of existing disposal facilities, and the regulators will be expected to play an important role in its implementation.
- Waste planning authorities should take account of non-nuclear industry radioactive waste disposal capacities and requirements, both in their role as consultees to the environmental regulators, and when they prepare and review Local Development Frameworks covering waste. This aspect of the strategy is of particular relevance to new applications from disposal facility operators who wish to take radioactive waste, and to new disposal facilities.

This strategy is expected to increase the potential supply of disposal facilities available to accept non-nuclear industry waste.

# 1. Background and Scope

## Introduction

1.1. This document is the Strategy for the Management of Solid Low Level Radioactive Waste from the Non-Nuclear Industry in the United Kingdom[1]. This strategy has been prepared by Government in response to the 'Policy for the Long Term Management of Solid Low Level Radioactive Waste in the United Kingdom, March 2007' (Ref. 1). Application of the waste management hierarchy is a fundamental part of Government policy but it is recognised there are limited opportunities to employ it on low level radioactive waste generated within the Non-Nuclear Industry; therefore a large component of the strategy is focussed on disposal.

1.2. This strategy is primarily aimed at:

- non-nuclear industry waste managers,
- the environmental regulators, and
- the waste planning bodies.

1.3. This strategy will also be relevant to operators of all waste disposal facilities and to other stakeholders who may be affected by low level waste (LLW) management, for example communities where this waste is generated and disposed.

## Background

1.4. In March 2007 the UK Government and devolved administrations for Scotland, Wales and Northern Ireland published a policy for the long term management of solid low level radioactive waste in the UK, hereafter referred to as the '2007 LLW policy' (Ref. 1).

1.5. This LLW policy requires a strategy to be developed for the management of solid LLW from the non-nuclear industry. This strategy has been developed within the framework of principles set out in the policy:

- Use of a risk-informed approach to ensure safety and protection of the environment.
- Minimisation of waste arisings (both activity and mass).
- Forecasting of future waste arisings, based upon fit for purpose characterisation of wastes and materials that may become waste.
- Consideration of all practicable options for the management of LLW.
- A presumption towards early solutions to waste management.
- Appropriate consideration of the proximity principle and waste transport issues

[1] Radioactive discharges to the environment as liquids or gases are covered by other strategies.

- In the case of long term storage or disposal facilities, consideration of the potential effects of future climate changes.

1.6. Through the development of this strategy, specific waste management requirements for different organisations within the non-nuclear industry have been identified, by undertaking several data collections. A summary of the main findings of these data collections are given in this strategy in sections 6 and 7, along with other sources of information about radioactive waste arisings.

1.7. The non-nuclear industry generates relatively small volumes of radioactive waste from organisations including hospitals, the pharmaceutical sector, and research and education establishments, all of which use radioactive materials which ultimately leads to the generation of radioactive waste. LLW may also be created as a by-product of the processing of material which contains natural radioactivity, principally the oil and gas industry. This is commonly referred to as 'NORM' (Naturally Occurring Radioactive Materials) wastes.

**Box 1: Categories of radioactive waste**

**Categories of Radioactive Waste**

Solid radioactive waste is divided into three categories according to its radioactivity content and the heat it produces. These categories are:

- **High level waste** (HLW) is waste in which the temperature may rise significantly as a result of its radioactivity, so this factor has to be taken into account in the design of storage or disposal facilities.
- **Intermediate level waste** (ILW) has lower levels of radioactivity than HLW and does not generate sufficient heat for this to be taken into account in the design of storage or disposal facilities.
- **Low level waste** (LLW) is radioactive waste having a radioactive content not exceeding 4 GBq/te (gigabecquerels per tonne) of alpha or 12 GBq/te of beta/gamma activity. LLW makes up more than 90% of the UK's radioactive waste legacy by volume but contains less than 0.1% of the total radioactivity.

## Scope

1.8. For the purposes of this strategy, the non-nuclear industry is defined as '*those organisations which produce radioactive waste and are not part of the nuclear industry*'[2]. Most non-nuclear industry organisations use radioactive materials as a vital part of their day-to-day operations; for example medical, pharmaceutical, research and educational establishments. Other organisations process material which contains natural radioactivity, principally oil and gas sectors and mineral sands industry. Common to all of these

[2] The nuclear industry includes those sites which hold a nuclear site licence under the Nuclear Installations Act 1965.

organisations is that they generate waste containing low levels of radioactivity which requires management and which may be subject to regulation. The regulatory framework which applies to the management and disposal of these wastes is described in section 4.

1.9. Solid radioactive waste produced by the non-nuclear industry is similar in its physical and chemical nature to the wide variety of other municipal, industrial and commercial wastes, for example, plastic, paper, glass and metal, as well as sludges and scales (the latter two are specifically generated by the oil and gas industries). However, radioactive waste is distinguished from these wastes in that it contains radioactivity that is additional to that which is present naturally and unmodified in all the earth's raw materials. Section 3 provides an explanation of radioactivity.

1.10. The majority of radioactive waste produced by the non-nuclear industry falls into the category of low level radioactive waste or its sub-category very low level radioactive waste (VLLW) and may contain radioactivity of artificial or natural origin. These categories are defined by maximum levels of radioactivity that are set down in Government policy (Ref. 1) and are defined in the boxes below.

**Box 2: Definition of Low Level Waste**

**Definition of Low Level Waste**

**Low Level Waste** (LLW) is defined as 'radioactive waste having a radioactive content not exceeding 4 GBq/te of alpha or 12 GBq/te of beta/ gamma activity'.

Radioactivity within LLW may be alpha activity, or beta/ gamma activity.

**Box 3: Definitions of Very Low Level Waste**

**Definition of Very Low Level Waste**

**Very low level waste** (VLLW) is a sub-category of LLW and is defined as either low volume VLLW or high volume VLLW. The principal difference between the two definitions is the need for controls on the total volumes of high volume VLLW being deposited at any one particular landfill.

**Low volume VLLW (dustbin loads):**
Radioactive waste which can be safely disposed of to an unspecified destination with municipal, commercial or industrial waste ("dustbin" disposal), each $0.1m^3$ of waste containing less than 400 kBq (kilobecquerels) of total activity or single items containing less than 40 kBq of total activity.

For wastes containing carbon-14 or hydrogen-3 (tritium):

- In each $0.1m^3$, the activity limit is 4,000 kBq for carbon-14 and tritium taken together;

**Definition of Very Low Level Waste**

and
- For any single item, the activity limit is 400 kBq for carbon-14 and tritium taken together."

**High volume VLLW (bulk disposals):**
Radioactive waste with maximum concentrations of 4 MBq/te (megabecquerels per tonne) of total activity which can be disposed of to specified landfill sites. For waste containing tritium, the concentration limit for tritium is 40 MBq/te. Controls on disposal of this material after removal from the premises where the wastes arose, will be necessary in a manner specified by the environmental regulators.

1.11. This strategy refers to other types of waste that are disposed of via similar routes to non-nuclear industry radioactive waste for example municipal or household, commercial, industrial, controlled, clinical and hazardous wastes.

- Directive waste (defined in the Environmental Protection Act 1990) 'waste arising from household, industrial and commercial premises and ultimate disposal is via landfill and incineration'.
- Clinical and hazardous wastes are special types of Directive wastes that must be disposed of to certain types of facility, usually incinerators in the case of clinical wastes, and special landfills in the case of hazardous wastes.

## Development of the Strategy

1.12. This strategy has been developed in response to the 2007 LLW Policy. This policy recommended that this strategy be developed by following three steps;

- firstly, the estimation of the extent and geographical distribution of LLW arisings from this sector. This will be undertaken by Government working in conjunction with the NDA;
- secondly, a process to develop a UK-wide strategy and identification of future arrangements for its delivery, again undertaken by Government working in conjunction with the NDA. The strategy should emphasise the importance of the waste management hierarchy, particularly waste avoidance. The involvement of the NDA will ensure that there is appropriate integration of the nuclear and non-nuclear industry strategies. There will be appropriate public and stakeholder engagement as the strategy is developed;
- thirdly, ensuring the provision of sufficient opportunities within national and local planning strategies, as appropriate, to meet the non-nuclear industry disposal needs as set out in the UK-wide strategy.

1.13. The development of this strategy has involved data collections and engagement with a number of key stakeholders including non-nuclear industry LLW producers, representatives from Government (including the Devolved Administrations), regulators, and planning authorities. This work has identified the benefits of producing this strategy in two parts based on the different radioactive waste management needs of the NORM waste producers. The strategy will be therefore be consulted on in two phases;

- The first part of the strategy to be consulted on concerns information which is applicable generally to the whole of the non-nuclear industry including requirements on different organisations involved in implementing the strategy, disposal routes and information explaining the nature of waste and low risk associated with its disposal.
- The second phase of consultation will focus on the management of radioactive wastes from those organisations which produce naturally occurring radioactive materials (NORM) wastes. This will more specifically consider disposal options for this waste given that some existing waste routes for NORM are due to close.

1.14. Work will continue to be undertaken to support the development of the NORM section of the strategy. A final strategy, including both parts is expected to be published in spring 2011.

1.15. Government will use information gathered by the waste planning authorities and environmental regulators as the basis to inform the review of this strategy in years to come. Based on the studies undertaken to inform this strategy, it would appear that for the majority of non-nuclear industry LLW adequate treatment and disposal capacity is available. However, this capacity will be subject to Government review, to determine whether further strategic measures are required.

1.16. The UK Government determined that this non-nuclear industry waste strategy did not fall under the requirements of the Strategic Environmental Assessment (SEA) Directive (Ref. 2). Nonetheless, the related process of Sustainability Appraisal (SA) was applied to the strategy on the basis that it should ensure that environmental, economic and social perspectives would be covered in a systematic fashion. Therefore, a consultation on the scoping report for sustainability appraisal of the strategy was held in early 2009. The responses to this consultation have been analysed and are reported elsewhere (Ref. 3a).

# 2. Strategy for the Management of Solid Low Level Radioactive Waste from the Non-Nuclear Industry in the United Kingdom

## Introduction

2.1. The volumes of solid LLW produced by the non-nuclear industry are relatively small compared with the total volume of municipal, construction and industrial wastes. When considered on their own, these wastes are largely insufficient to drive the provision of management and disposal facilities via the market. Therefore this industry will nearly always have to rely on waste management and disposal networks provided for other large volume wastes.

**Box 4. The Regulation of Low Level Waste**

**The Regulation of Low Level Waste**

The environment agencies regulate disposals of radioactive waste on or from premises in the UK. In Scotland and Northern Ireland, regulation is under the Radioactive Substances Act 1993 (RSA 93). From April 2010, regulation in England and Wales is under the Environmental Permitting Regulations 2010 (EPR 2010). The different legislation used in different parts of the UK does not change the environmental standards for radioactive substances

To simplify the description of the different legislation in Scotland and Northern Ireland to England and Wales, throughout this strategy RSA 93 and EPR 2010 will collectively be referred to as the 'radioactive waste regulations'. Furthermore, references to an "environmental permit" mean a permit to dispose of radioactive waste under EPR 2010 for England and Wales, and/or authorisation to dispose of radioactive waste in Scotland or Northern Ireland.

The environment agencies responsible for the regulation of radioactive substances are the Environment Agency in England and Wales; the Scottish Environment Protection Agency (SEPA) in Scotland; and the Department of the Environment's Northern Ireland Environment Agency (NIEA).

For a full description of the regulation of LLW, please refer to section 3.

2.2. Despite the low risks associated with the disposal of non-nuclear industry LLW (as explained in section 7), the fact that the wastes are defined as radioactive can give rise to public concern which can be a deterrent for waste facility operators to provide a disposal service. Government does not believe it is appropriate to require waste facility operators to take particular wastes[3]. However, via this waste strategy, Government:

- intends to reduce the fragility of disposal arrangements for the non-nuclear industry,
- wishes to see existing disposal routes conserved and other appropriate routes to be established or expanded as necessary to meet the waste disposal requirements for solid LLW arising from the non-nuclear industry,
- wishes to ensure that adequate radioactive waste management arrangements are in place to provide the continued security of supply of hydrocarbons from the United Kingdom continental shelf.

2.3. In order to address the challenges associated with managing radioactive wastes from the non nuclear industries, Government has included explanatory information on the non-nuclear industry, so as to promote greater understanding of:

- why these wastes are created,
- what these wastes comprise,
- how these wastes are managed and
- the risks associated with the disposal of these waste.

2.4. This information is provided in the ‘supplementary information’ (section 3 onwards) as set out below.

- Radioactivity and Radiation Dose – section 3
- The Regulatory Framework – section 4
- Societal dependence on the non-nuclear industry – section 5
- Waste arisings from the non-nuclear industry – section 6
- Assessment of risk from disposals of non-nuclear industry LLW and VLLW – section 7
- Risks from radiation – section 8

[3] There are some exceptions to this statement: a) Section 18 of EPR 2010/ RSA 93 places a duty on local authorities to accept waste if the appropriate agency authorises waste to be disposed of at a facility “provided by a local authority for the deposit of refuse”. The Government may direct the environment agencies to grant authorisations for such facilities to take radioactive waste. However, as very few waste disposal facilities are now operated by local authorities, this is a largely historical provision; b) Section 29 of EPR 2010/ RSA 93 also gives Government the power to provide facilities for the disposal or accumulation of radioactive waste. However, non-nuclear industry wastes are mostly disposed of to commercially run disposal facilities, where this power does not apply.

## Roles of the Organisations involved in implementing this Strategy – a summary

2.5. A number of different organisations have roles to play in helping to maintain a UK-wide disposal network for managing radioactive wastes from the non-nuclear industry, and Government summarises its expectations of these organisations as follows:

- **Waste producers should continue to ensure appropriate application of the waste hierarchy and optimum use of the network of facilities that are available for managing their waste.** This aspect of the strategy is of particular relevance to the use of existing disposal facilities, and the environmental regulators will be expected to play an important role in its implementation.
- **Planning bodies and waste planning authorities should take account of non-nuclear industry radioactive waste disposal requirements, both in their roles as consultees to the environmental regulators, and when they prepare and review their Local Development Frameworks covering waste.** This aspect of the strategy is of particular relevance to new applications from disposal facility operators who wish to take radioactive waste, and to new disposal facilities.
- **The UK Strategy for the Management of Solid Low Level Radioactive Waste from the Nuclear Industry is expected to influence the potential supply of disposal facilities available to accept non-nuclear industry waste.** This aspect of the strategy is of relevance to both existing and new disposal facilities.

Each of the expectations outlined above is discussed in further detail below.

## The Role of Waste Producers and the Environmental Regulators

### Existing UK Policy Requirements of Low Level Waste Management Plans

2.6. The existing UK LLW policy (Ref. 1) stated that plans for the management of all radioactive waste must be developed by waste managers. Key requirements of waste management plans are included in paragraph 1.5.

2.7. Regarding the non-nuclear industry, the LLW policy stated that waste management plans should be proportionate to the scale of waste production and holdings, as agreed with the regulator, and that regulators would clarify their requirements of the non-nuclear industry in light of the general principles in the policy statement. Effectively, it is a matter for regulators to consider what emphasis should be placed on each of the key policy requirements by individual waste producers. The Environment Agency has issued guidance and briefing notes on the 2007 LLW policy definitions of LLW and VLLW, and on the regulatory requirements for disposal of these wastes in England and Wales (Ref. 10). This guidance is welcomed by Government, and will go some way to addressing certain issues that have arisen during the data collections conducted on VLLW by SNIFFER4 and the Atkins project[5] (both described in detail in section 6). However, this non-nuclear industry strategy focuses on other areas which warrant further attention by both waste producers and regulators.

## Minimisation of Waste Arisings

2.8. Application of the waste hierarchy is already embodied in the 2007LLW policy and is implemented by the environmental regulators through use of 'best practicable means' (BPM) and 'best available techniques' (BAT) assessments. For example, environmental permits contain conditions such as;

*'The [environmental permit] holder shall use best practicable means to ensure that no unnecessary radioactive waste is generated', and*

*'The [permit] holder shall use best practicable means to minimise the volume of, and the total radioactivity in, all of the radioactive waste that will require disposal'.*

2.9. Hence, the requirements imposed by the regulators are for the producers of radioactive waste to ensure:

- radioactive waste is not generated unnecessarily,
- minimise radioactivity in all disposals, and
- minimise effects of disposals on environment and members of the public.

2.10. It falls to the waste producers to demonstrate BPM/BAT to the regulators. However, it is incumbent on the regulators to help waste producers fully understand their permits, and make best use of existing disposal options. The EA has recently issued guidance on BAT to support EPR and SEPA guidance on BPM is included on the SEPA website; both documents help satisfy this onus on regulators.

## Data Collections in Support of this Strategy

2.11. A number of data collections and surveys were undertaken during the development of this strategy and are presented in section 6. Feedback from the Atkins project follow-up survey suggests that some changes in the permits issued to waste producers would further help waste minimisation. Some examples are set out below:

i) It was suggested that it should be possible to categorise waste at the time of transfer/disposal (rather than when it is first produced). One respondent put this as:

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[4] For example, the SNIFFER report (Ref. 13) included the comment *"A significant degree of confusion and uncertainty over the interpretation and use of VLLW disposal routes was apparent across the full set of 230 questionnaire responses received, and this argues for a simplification of the VLLW disposal regime or, at the very least, clearer guidance on its use".*

[5] For example, one response to the Atkins survey stated *"The lack of alpha VLLW routes means that low levels of contaminated wastes need to be sent as LLW which is both very costly and results in the needless filling in of a valuable resource (i.e. LLWR at Drigg)".* [The new definition of VLLW now allows alpha activity to be included within the total radioactivity limit, and this is restated by the EA guidance.]

*“you may have started with some LLW that you have put down for a period of decay storage. After this time when it comes to disposing of the waste, it may be VLLW or even SOLA (i.e. exempt)”.*

ii) It was also suggested that there could be greater use of decay storage by waste producers if this was allowed by the environmental permit. Amongst the responses to the question “how did you select your waste routes? What were the main drivers?” were the following:

*“Decay storage is a very useful management technique for short-lived isotopes. Provided storage areas are adequate and secure, there should be consideration of longer authorised periods prior to disposal as VLLW”, and*

*“The maximum length of time allowed storing waste on site to allow us to dispose of waste as non-radioactive waste”.*

2.12. Government recognises that decay storage is a useful technique that can be used to minimise the amount of radioactivity that requires disposal. Government wishes to encourage use of decay storage where it is appropriate to do so, and as part of the ongoing exemption order review, is working with regulators and other interested parties to remove perceived and actual barriers that prevent decay storage being utilised further.

2.13. It has been suggested that permits should allow disposal by any approved route, and not require details of individual routes, which reduces flexibility. In responses to the Atkins project, this was stated as:

*“..allow disposal by any approved route without specifying particular organisations in the authorisation”,* and

*“There are a limited number of disposal options which is further complicated by the requirement to have each disposal route specified on the authorisation”*

2.14. Government agrees that allowing disposal to any person authorised to accept such waste would be sensible step forward and increase flexibility for waste producers and reduce administrative burden. Provided waste producers are required to state where wastes have been sent to at the time they leave their premises, such a change should not result in loss of information on waste disposal practices, compared to present arrangements. Government therefore urges the environmental regulators to consider making such changes to the environmental permits it issues to the non-nuclear industry for example in accordance with the new Environmental Permitting Regulations in England and Wales.

## The Proximity Principle and Waste Transport Issues

2.15. It is recognised that waste planning by waste producers involves balancing regulatory and policy requirements with what appropriate disposal routes are actually available. In the case of most low volume VLLW from the non-nuclear industry, its fate is purely dependent on that of the conventional waste with which it is mixed at the point of production i.e. waste producers have no influence on choice of disposal facility (other than whether incineration or landfill routes are used). However, in the case of deciding on disposal routes for LLW, Government wishes to see appropriate explicit consideration of the proximity principle when deciding upon an appropriate disposal route. This principle should not dominate the waste plan developed by producers, but should be given appropriate consideration by both the environmental regulators and non-nuclear industry waste producers. To this end, Government expects that as a minimum, it should be feasible for the environmental regulators to be able to provide to waste producers (or other interested parties), up-to-date, timely and centrally available, lists of all waste disposal facilities authorised under the radioactive waste regulations to accept and dispose of radioactive waste.

2.16. Responses to the Atkins project also suggested that more could be done to promote understanding of wastes by those operating disposal facilities, which in turn could help widen the current disposal network. For example, regarding difficulties in finding disposal routes, one respondent stated there was:

"*Reluctance on the part of landfill sites to accept radiological waste even though they can be disposed of under a relevant exemption order or VLLW authorisation*".

2.17. Whilst it is anticipated that the Environment Agency's new guidance and briefing notes on LLW and VLLW (Ref. 10) will help rectify these difficulties, Government also intends that by providing explanatory information in this waste strategy that it will have gone some considerable way to improving general understanding of the nature of radioactive wastes arising from the non-nuclear industry, and associated risks to workers and members of the public.

## Databases on Radioactive Waste Arisings from the Non-Nuclear Industry

2.18. The databases held by the environmental regulators on non-nuclear industry holders of environmental permits were used by Atkins to obtain contact details for their project. These databases could be improved and updated. Via this waste strategy, Government encourages dialogue between waste producers and the regulators to consider how these databases could be improved without imposing undue burden on either waste producers or the regulators. It is recognised that the very low risks associated with the majority of waste disposals from the non-nuclear industry do not warrant very detailed additional record-keeping. However, work in support of developing this strategy has highlighted that it would be very useful for radioactive waste quantities to be calculated on an equivalent footing to conventional waste quantities (i.e. volumes and or masses, with approximate waste densities to allow conversion between physical units).

## Public consultations by the environmental regulators

2.19. When the environmental regulators receive applications for permits under the radioactive waste regulations, they send copies to relevant local authorities. When they receive applications from waste disposal facility operators to accept radioactive waste (either as high volume VLLW or as LLW), they should consult relevant local authorities. When they liaise with, or consult, local authorities on matters to do with radioactive waste regulations waste disposal applications, they should ensure direct contact with the most appropriate bodies within local authorities, i.e. the waste planning authorities, as well as those currently contacted.

## Non-Nuclear Industry Liaison Groups

2.20. The environmental regulators co-ordinate meetings of the non-nuclear industry. In England and Wales, the Small Users' Liaison Group is run by the EA which includes representation from the Northern Ireland Environment Agency, and in Scotland, SEPA runs the Scottish Non-Nuclear Industries' Liaison Group. These are fora for effective liaison, communication and consultation between non-nuclear users of radioactive substances and the regulators.

Concerns expressed at these fora have formed part of the impetus to develop this waste strategy. Government therefore expects these meetings will continue to provide the opportunity for the non-nuclear industry to provide feedback to the regulators, and hence to Government, of any impacts of the present strategy on their operations.

### Environmental permitting for conventional waste facilities

2.21. The majority of radioactive waste arising from the non-nuclear industry falls into the category of low volume VLLW. Low volume VLLW may be disposed of with conventional wastes at facilities that do not themselves require environmental permits for example landfill and incinerators. In issuing environmental permits to such facilities, the environmental regulators should ensure this co-disposal of conventional and radioactive wastes falling within the definition of low volume VLLW is not inadvertently excluded because of the way in which waste is described in the permits.

## Coverage of the Non-Nuclear Industry within Spatial Planning

### National waste planning policy

2.22. The Coalition agreement sets out this Government's ambitions on delivering a radical decentralisation of power. The proposed Localism Bill will be introduced to provide greater powers to council and neighbourhoods, and give local communities far more ability to determine the shape of the places where they live and more control over planning decisions. It will also help set the foundations for the Big Society by radically transforming the relationships between central government, local government, communities and individuals.

2.23. The Coalition Government are committed to giving a greater say to people, communities and councils through a faster and more democratically accountable planning system. As part of this, the Government has ambitious plans to reform planning policy and publish a simple and consolidated framework covering all forms of development. This framework will include national, economic, environmental and social priorities and will be presented to Parliament.

2.24. The 2007 LLW policy (Ref. 1) summarised the role of planning authorities in the management of LLW as follows:

"*Decisions on planning applications for facilities for the management of radioactive and other forms of waste, including LLW, are a matter for the planning authority concerned. Decisions on planning applications are taken within a framework provided by national, regional and local planning policy. This framework differs across the UK but there is a common expectation for local level plans to identify suitable sites for waste management...*"

2.25. The connection between national planning policies and waste management policies is currently via planning policy statements, which are country-specific. Current planning policy on sustainable waste management in England is set out in PPS10. In the Coalition Agreement the Government stated that it will publish and present to Parliament a simple and consolidated National Planning Framework covering all forms of development. PPSs will continue to apply until they are replaced by the National Planning Framework. Planning Policy Statement 10 (PPS10 – Ref. 37) applies to England and forms part of the national waste plan for the UK. In Wales, the relevant planning policy statement is TAN21 and in Scotland, NPPG 10 'Planning and Waste Management'.

2.26. PPS10 establishes the Government's national policies on land-use planning for sustainable waste management. By implementing national policy in PPS10, waste planning authorities should address and plan for all relevant waste streams, including LLW, and are expected to provide a framework in which communities take more responsibility for their own waste. The following paragraphs, extracted from PPS10, are relevant.

i) PPS10 states that policies contained within it

*"..should be taken into account by waste planning authorities in discharging their responsibilities; …..in general, by local planning authorities in the preparation of local development documents. They may also be material to decisions on individual planning applications….."*

2.27. Paragraphs 16-21 of PPS10 set out what waste planning authorities should do at the local level through local development frameworks. This includes considering the opportunities for on-site management of waste where it arises (para. 20).

## The role of waste planning authorities in the NNI LLW Strategy

2.28. Organisations in the non-nuclear industry are distributed across the UK, although they tend to be concentrated in urban areas. What these industries do and why they need to produce radioactive waste is explained in section 6. All of them perform an important role for society, particularly in the case of the medical and research sectors. The oil and gas industries clearly also are vital parts of the UK economy, and there is a need to accommodate both operational and decommissioning arisings of NORM waste.

2.29. The remit of waste planning authorities through planning legislation[6] is to ensure that land proposed for a particular waste management activity is suitable for that activity. These planning decisions will be taken in the context of the development plan for the area concerned (i.e. the Local Development Frameworks covering waste). In formulating these plans, waste planning authorities take account of total waste arisings, and therefore have an interest in the waste streams that may be consigned to particular waste facilities in their area. When granting planning permission it is possible to impose a condition which broadly specifies what waste can be taken to a particular site - this may include restrictions e.g. 'household & commercial waste only', and this would effectively exclude certain other waste streams such as radioactive waste. (If this type of condition is imposed It is important to note that planning permission to vary or delete it may be required before a site can take radioactive waste).

2.30. Waste planning authorities should actively consider conditions which allow radioactive waste from these sources in landfill. It is the legal responsibility of the environment agencies, through the environmental permitting system to decide in detail which waste types can be taken to a particular site[7]. In the case of facilities requiring environmental permits under radioactive waste regulations (i.e. those wishing to take high volume VLLW

[6] Town and Country Planning Acts are different for England/Wales, Scotland and Northern Ireland – see table 1.
[7] For environmental legislation regarding radioactive wastes - see table 1.

and LLW), local authorities should be consulted on these applications by the environment agencies, who themselves will comment on the adequacy of risk assessments supporting the applications.

2.31. Although the legal separation of the powers of waste planning authorities and the environment agencies is clear, the two regimes are complementary. The environment agencies are consultees in the planning system, both in terms of the preparation of plans (e.g. Local Development Frameworks) and on individual planning applications for waste facilities. A waste facility cannot be built or operated without first obtaining both planning permission and an environmental permit (and any other relevant consents).

2.32. The waste that is the subject of this non-nuclear industry waste strategy is defined as radioactive waste under the radioactive waste regulations, and does not fall within the EU Waste Framework Directive of directive waste[8]. However, this report has shown that most non-nuclear industry radioactive waste is physically similar to directive waste and because it contains only very low quantities of radioactivity, it is largely disposed of via facilities that are also used for conventional waste. This practice is in accordance with Government policy for the management of LLW and VLLW (Ref. 1), but only if authorised by the environment agencies under the radioactive waste regulations. Despite this practice of co-disposal of radioactive and conventional wastes, planning authorities do not routinely consider the non-nuclear industry and its disposal needs in their local development documents. The data have shown that the majority of non-nuclear industry wastes are of very small volume in comparison to the annual volumes of municipal waste (very unlikely to exceed 0.1% by volume, and there is some evidence from the Atkins project that it will reduce).

## Low Volume Very Low Level Waste

2.33. In the case of low volume VLLW which comprises the bulk of VLLW produced by the non-nuclear industry), it has been explained that disposals to landfill or via incineration, are made with other conventional wastes, with the mixing of VLLW and these other wastes taking place before the material leaves the point of production. This document sets out the levels of risk associated with low volume VLLW disposal to landfill or via incinerators in section 8 and it is because risks to the public and workers are so low that these disposal routes are permitted. In summary, provided a site produces less than 50 $m^3$ of VLLW per year, this is classed as low volume VLLW.

2.34. The permit to use these disposal routes under the radioactive waste regulations is held by the waste producer, and not the operator of the receiving disposal facility. Under these arrangements, any landfill or incinerator in the UK that is also used for municipal, commercial or industrial wastes may be accepting low volume VLLW mixed in with the other directive wastes. It is existing policy that any such facility which has the appropriate permits from the environment agencies to accept conventional wastes, can continue to accept low volume VLLW until it is closed. A new facility may also accept low volume VLLW, again with the proviso that its operator has the appropriate permits to accept conventional wastes from the environment agencies. In their waste disposal records which are provided to the environment agencies under the terms of their environmental permits, waste producers of low volume VLLW do not have to identify which landfill site,

[8] Directive 2006/12/EC of the European Parliament and of the Council of 5 April 2006 on waste

or incinerator, is used for disposal of this material. For these reasons, it must be assumed that any landfill or incinerator receiving conventional wastes could also be receiving low volume VLLW from the non-nuclear industry. To this extent, and bearing in mind that conventional waste disposal will largely be to facilities that are closest to their point of arising, it is concluded that the present arrangements for low volume VLLW satisfy Government policy.

## High volume Very Low Level Waste

2.35. The differences between low and high volume VLLW are explained in Box 3. The exceptions to this in England and Wales[9] are incinerators licensed under EPR 2010 where all VLLW (i.e. incinerator residues) is currently classed as low volume VLLW (Ref. 10).

2.36. The majority of the non-nuclear industry does not produce high volume VLLW, but the exception will possibly be the oil and gas sectors, particularly when they undertake decommissioning work. Disposal of high volume VLLW requires permits under radioactive waste regulations by both the waste producer and the operator of a disposal facility. Sites accepting high volume VLLW will therefore be identified during the radioactive waste regulations application process and associated consultation of waste planning authorities by the environment agencies.

2.37. Where operators of existing disposal sites wish to take high volume VLLW, the environment agencies will consult waste planning authorities on the radioactive waste regulations applications. In the absence of detailed information within this strategy on non-nuclear high volume VLLW that might arise in the future (e.g. from the oil and gas sectors), it will be for the environment agencies to explain to the relevant waste planning authorities the exact nature of the waste and the risks associated with its disposal. However, the Environment Agency's recent guidance (Ref. 10) provides generic information on how LLW and VLLW disposal is regulated, including the new practice of high volume VLLW.

2.38. It is also to be expected that occasional applications will be made for new sites to take high volume VLLW, and such situations will clearly directly involve both the environment agencies and relevant waste planning authorities. To the extent that it is possible without having detailed information on likely arisings of high volume VLLW, and on site-specific applications for planning permission, waste planning authorities should make note in their Local Development Frameworks that disposal requirements for such wastes may arise from time-to-time.

## Low Level Waste

2.39. All LLW disposals require an environmental permit under the radioactive waste regulations to be held by both the waste producer and the operator of the disposal facility that receives it. LLW has to go either to an incinerator licensed under radioactive waste regulations, or to a landfill as a "controlled burial", or the LLWR near Drigg. It has been explained that LLW from the non-nuclear industry, except that from the oil and gas

[9] SEPA does not preclude any waste producer from making use of low volume VLLW disposal routes. Nor has SEPA classed incinerator ash as low volume VLLW. It is anticipated that these differences in regulators' approaches to low volume VLLW will be resolved by the outcome of the Exemption Order Review.

industry, is commonly disposed of via incineration. Currently, LLW disposals from the non-nuclear sector as "controlled burials" in landfills appear to be minimal, and use of the LLWR near Drigg is usually only for particular types of LLW. Disposal facilities accepting LLW will therefore be identified during the radioactive waste regulations application process and associated consultation by the environment agencies.

2.40. LLW disposal, except for that to the LLWR near Drigg, takes place at facilities that are used for other directive wastes. It must therefore be assumed that an operator of any landfill or incinerator receiving directive wastes could also apply to the environment agencies to take LLW under radioactive waste regulations. Unlike the network of disposal facilities available to take low volume VLLW, there are considerably fewer facilities across the UK that currently take LLW, a fact reflected in findings of the Atkins data collection project of the relative transportation of LLW for incineration compared to landfill. Nonetheless, operators of existing and new facilities may wish to apply to take LLW at any time, from either the nuclear or non-nuclear industries.

2.41. Government considers that there are two situations regarding LLW where waste planning authorities should be aware of LLW that arises within their communities from the non-nuclear industry, and that these wastes require disposal routes along with other conventional wastes generated by those communities. These situations are:

- In the case of existing facilities that accept conventional waste (incinerators and landfills) whose operators may wish to apply to the environment agencies to take non-nuclear LLW under an environmental permit; and
- in the case of new disposal facilities that are primarily intended for directive waste, but whose operators may also wish to apply to the environment agencies to take non-nuclear LLW under an environmental permit.

2.42. Government intends that the information in this strategy will increase transparency as to the nature of LLW and VLLW from the non-nuclear industry and the risks associated with their disposal, and that it will be of immediate value to waste planning authorities.

## The Role of the NDA in the Non-Nuclear Industry Waste Strategy

### UK Nuclear Industry LLW Strategy

2.43. The NDA is responsible for the decommissioning of public-sector civil nuclear sites in the UK. It has produced waste strategies for all its anticipated waste streams, and completed consultation on the UK Strategy for the Management of Solid Low Level Radioactive Waste from the Nuclear Industry (hereafter referred to as the UK Nuclear Industry LLW Strategy) in November 2009. The strategy was published in August 2010.

2.44. Decommissioning the UK's public-sector civil nuclear sites will create large amounts of LLW and VLLW, likely to be well in excess of the current capacity at existing nuclear disposal facilities. The draft UK Nuclear Industry LLW Strategy identifies how it will ensure availability of management and disposal routes for VLLW and LLW by applying the waste management hierarchy, developing new routes for the management and disposal of LLW and optimising the use of existing facilities. This includes seeking flexible, risk based, disposal routes for lower activity wastes based on robust information and transparent decision making processes. The strategy sets out how application of the waste management hierarchy presents significant opportunities for effective management of LLW, including due consideration for safety, environmental responsibility, and cost-effectiveness. Additional alternative waste treatment and disposal routes are being pursued.

2.45. The UK Nuclear Industry LLW Strategy recognises the importance of continued availability of the use of the LLWR near Drigg to ensure that only those wastes requiring engineered multi-barrier containment and disposal in are consigned to the site.

2.46. In summary, the UK Nuclear Industry LLW Strategy sets out how the nuclear industry, with supply chain support, can ensure continued capability and capacity through applying flexibility in the determination of treatment and disposal routes and giving proper consideration to all viable options. These options include in-situ disposal; development of new facilities on or adjacent to sites for management of waste from those sites; or extended facilities to manage wastes from a number of sites; or the development of new facilities away from nuclear sites.

## The Expected Availability of NDA Disposal Routes to the Non-Nuclear Industry

2.47. The demand from the nuclear sector for waste disposal facilities is expected to stimulate new opportunities for waste management operators. The potential widening of the commercial treatment and disposal network is expected to also benefit the non-nuclear industry. As most of the non-nuclear industry only produces very small quantities of LLW and VLLW, it is not anticipated that it will stimulate investment in new facilities, with the possible exception of the oil and gas sector.

2.48. However, this non-nuclear waste strategy is complementary to the UK Nuclear Industry LLW strategy and will seek to utilise any treatment and disposal routes developed to ensure capacity for the management of LLW arising in the UK.

2.49. Where the NDA have facilities that support the NNI strategy, it is recognised that these routes will only be made available where it is appropriate and practicable and doesn't impact on the delivery of the NDA mission and will be under appropriate commercial and regulatory terms.

2.50. Specifically, LLW Repository Ltd will play a central role in supporting waste producers to work collaboratively to take advantage of its comprehensive integrated waste service for the treatment and disposal of LLW from the nuclear and non-nuclear industry.

2.51. Should further treatment or disposal capacity be developed by the supply chain, it will be the responsibility of NNI waste producers to engage with the supply chain to take advantage of these treatment or disposal routes as appropriate, again based on suitable commercial and regulatory terms.

## Storage of spent sealed sources

2.52. In line with Government expectations, and only where necessary, NDA will continue to make facilities available for treatment and storage of redundant radioactive sources.

## Summary

2.53. This document is the UK strategy for the management of solid LLW arising from the non-nuclear industry, and is primarily aimed at non-nuclear industry waste producers, the environment agencies and waste planning bodies. It will also be relevant to the waste disposal facility operators, including the NDA and its site licensed companies. The strategy has been developed by a programme board set up in 2007 by Government following publication of the 2007 LLW policy (Ref. 1).

2.54. Work on the strategy has been influenced by other developments – in particular the development of the UK Nuclear Industry LLW Strategy and recent events affecting the oil and gas industries. Both of the latter are expected to influence the waste disposal market and there are some signs that this is happening already. The review of exemption orders under the radioactive waste regulations is underway and is expected to improve the consistency and transparency of the regulation of radioactive waste produced by both the nuclear and non-nuclear sector.

2.55. The non-nuclear industry includes a range of different organisations all of which perform vital functions for society. Many of these industries depend on the use of radioactive materials, although some, including the oil and gas industries, produce radioactive waste as a by-product of their processing of material which contains natural radioactivity.

2.56. Information held by the environmental regulators on radioactive waste arising from the non-nuclear industry is in the form of levels and type of radioactivity rather than in volume or mass, and does not cover details of all disposal routes. However, the management of radioactive waste from most of the non-nuclear industry, particularly low volume VLLW, is linked with that of directive waste, with which it is largely co-disposed. To inform the development of the strategy, further data on waste arisings and disposal practices were therefore sought from the non-nuclear industry across the UK. All the organisations contacted appeared to be managing to find disposal routes for their solid radioactive wastes. However, as participation in this study was rather less than anticipated, quantification of waste arisings from the non-nuclear industry across the whole of the UK has been uncertain although volumes are unlikely to exceed 0.1% of the annual quantities of conventional waste. It is clear from the data collection project and the sustainability appraisal undertaken in support of the strategy, that the disposal network available to the non-nuclear industry for radioactive waste is fragile, and almost virtually non-existent in some parts of the country. This situation is inevitably leading to excessive transport of wastes from their site of production to ultimate disposal location.

2.57. The difficulties facing the non-nuclear industry are that the volumes of LLW produced are largely insufficient to drive the provision of facilities via the market, and it will nearly always have to rely on disposal networks provided for other large volume wastes. Despite the low risks associated with current non-nuclear industry waste disposals (assessed as a risk of death from cancer of less than one in a million per year), the very fact that the wastes are defined as radioactive can give rise to public concern which can be a further deterrent for waste facility operators to provide a disposal service. Government does not believe it is appropriate to require operators of commercial waste facilities to take particular wastes. However, via this waste strategy, Government intends to reduce the fragility of disposal arrangements for the non-nuclear industry. Government wishes to see that existing disposal routes are conserved and that other appropriate routes can be developed or expanded as necessary.

2.58. Government believes that the waste strategy should contain information on the non-nuclear industry, so as to promote greater understanding of why radioactive wastes are created, what these wastes comprise, how they are managed and the risks associated with their disposal. This information is provided in this document, and forms an important element of the strategy.

2.59. Various organisations have roles to play in helping to conserve and improve the UK-wide disposal network for the non-nuclear industry, and in this waste strategy, Government has set out its expectations of these bodies.

2.60. Waste producers and the environment agencies are encouraged to continue to work together to ensure appropriate application of the waste hierarchy and to consider whether the current network of disposal facilities is being used in an optimum manner. Via this waste strategy, Government urges the environment agencies to consider certain changes to environmental permits for non-nuclear industries which should further help achieve waste minimisation. Recent guidance from the Environment Agency on waste disposal to landfill in England and Wales has been welcomed, and the review of exemption orders under the radioactive waste regulations is also expected to improve clarity and consistency of the regulation of radioactive wastes.

2.61. There is a close inter-relationship between spatial planning and environmental regulation, and Government looks to waste planning authorities to take account of non-nuclear industry radioactive waste disposal requirements, both in their role as consultees to the environment agencies, and when they prepare and review Local Development Frameworks covering waste. This aspect of the strategy is of particular relevance to new applications from existing disposal facility operators who wish to accept radioactive waste, and to new disposal facilities. However, planning bodies and waste planning authorities should also be aware of the current disposal needs and waste management practices of non-nuclear industries that operate throughout the UK.

2.62. The UK NI LLW strategy was consulted on during 2009. Demand from the NDA may result in additional availability of waste disposal facilities for the non-nuclear sector. However, in some cases where the NDA develops its own facilities for nuclear waste, there may be opportunities for them to also accept non-nuclear industry wastes provided that this does not compromise their primary mission in relation to the management of the UK's nuclear legacy wastes. This waste strategy has set out Government expectations on what NDA facilities might potentially be available to the non-nuclear industry.[10]

2.63. The oil and gas sector is a special case within the non-nuclear industry, both because of the physical form of the wastes produced, and their particular radionuclide content. They face imminent difficulties with disposal of certain types of their solid radioactive (NORM) waste.

2.64. Government does not propose to review this waste strategy for at least five years. However, the liaison groups for the non-nuclear industry that are run by the environment agencies

[10] UK Strategy for the Management of Solid Low Level Radioactive Waste from the Nuclear Industry, August 2010. http://www.nda.gov.uk/documents/upload/UK-Strategy-for-the-Management-of-Solid-Low-Level-Radioactive-Waste-from-the-Nuclear-Industry-August-2010.pdf

should be the focus for any feedback from regulators and waste producers, on issues emerging from this strategy and on influences felt by them from events that are external to the strategy.

# Supplementary Information

# 3. Radioactivity and Radiation Dose

## Radioactivity

3.1. Radioactivity is the property of unstable atoms to undergo transformation with the emission of radiation. The unit of radioactivity is the becquerel (Bq), but radioactivity is usually expressed as Bq per unit mass and in the case of solid waste, as Bq per gram, or per tonne. The Bq is equal to one radioactive transformation per second. Multiples of the Bq are commonly used:

- Kilobecquerels (kBq) = one thousand Bq
- Megabecquerels (MBq) = one million Bq
- Gigabecquerels (GBq) = one thousand million Bq.

3.2. Radioactive atoms (called radionuclides or radioisotopes) occur both naturally and artificially. Some, particularly those that are naturally occurring, are part of long decay chains (for example, isotopes of uranium and radium), but all eventually decay to non-radioactive atoms. The rate of decay is unique to each radionuclide and is called the half-life; this is the time required for one half of the atoms of a given amount of a particular radionuclide to disintegrate. Half-lives vary from fractions of a second through to many millions of years. The existence of naturally occurring radionuclides of extremely long half lives, together with decay chains, means that virtually all material on the earth is radioactive to some extent. Natural radioactivity is also created by processes in the upper atmosphere.

3.3. The type of radiation emitted by radionuclides (mainly alpha or beta particles and gamma rays) is called ionising radiation because it removes electrons from atoms, leaving them unstable. Ionising radiation loses energy as it passes through matter, and when it interacts with living tissue, the ionisation it causes may lead to changed or damaged cells.

## Radiation Dose

3.4. A radiation dose is defined as the energy lost by the radiation per unit mass of material through which it passes. The unit of dose is the gray (Gy) but when dose to living tissue is involved, the unit sievert (Sv) is used. The Sv is a very large amount of radiation dose, and so sub-multiples of the Sv are more commonly used, for example;

- millisieverts (mSv) = one thousandth of a sievert, or
- microsieverts (μSv) = one millionth of a sievert.

3.5. People are exposed to radiation simply as a consequence of living in a naturally radioactive world. The average dose from natural sources of radioactivity to members of the public in the UK is 2.2 mSv (i.e. 2,200 μSv) per year. However, the property of radioactivity is also used to diagnose medical conditions (with radioactive tracers) and treat disease (by killing malignant cells). It is also used to carry out research, and these activities usually create wastes containing small quantities of radioactivity that require disposal. Exposures of members of the public to the radioactive wastes arising from medical and other uses of radioactivity by the non-nuclear industry are generally in the range of a few µSv or less per year, i.e. around one thousandth of the natural background radiation dose.

3.6. Investigation into the effects of radiation on humans has been considerable and spans at least 60 years, covering actual exposures of people to natural sources of radiation (e.g. uranium miners) and artificial sources (e.g. the Japanese atomic bomb survivors, people treated with radiation for various medical conditions and more recently, large studies of the health of radiation workers). The long-term effects of these real-life human exposures have been considered alongside a vast number of animal and cell experiments. The bulk of evidence points to a linear relationship between exposure and effect, without a threshold (that is, the greater the exposure, the greater the effect). In the UK, radiation exposure that is imposed upon the public over and above natural background is subject to regulation, based upon European standards and international recommendations on radiological protection.

# 4. Regulatory Framework

## Principles of radiation protection

4.1. The systems of radiation protection used in many countries of the world, including the UK, are based on the recommendations of the International Commission on Radiological Protection (ICRP). ICRP is a non-governmental scientific organisation which publishes recommendations for protection against ionising radiation. ICRP's recommendations have been incorporated into European Law through Council Directive 96/29/Euratom (Ref. 4), laying down basic safety standards for the protection of the health of workers and the general public against the dangers from ionising radiation. ICRP's most recent recommendations (Ref. 5) have yet to be incorporated into EU law, but their basic principles of radiological protection are unchanged, and are:

- **Justification:** any decision that alters the radiation exposure situation should do more good than harm;
- **Optimisation of protection:** 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;
- **Dose limitation:** the total dose to any individual from regulated sources in planned exposure situations other than medical exposure of patients should not exceed the appropriate limits recommended by the Commission.

4.2. It should be noted that the justification principle relates to the practice giving rise to the waste, and not to subsequent waste management. However, both of the other two principles, optimisation of protection and dose limitation, do apply directly to waste management.

## Regulation of Radioactive Waste Disposal

4.3. The disposal of radioactive waste on or from premises in the UK is subject to regulation.

- In England and Wales, this regulation is provided for through the Environmental Permitting Regulations 2010 (EPR 2010).
- In Scotland and Northern Ireland regulation is provided via the Radioactive Substances Act 1993 (RSA 93).

4.4. These regulations provide the framework for controlling the management of radioactive wastes so as to protect the public and the environment. The different legislation used in different parts of the UK does not change the environmental standards for radioactive substances. In order to simplify the description of applicable regulations, throughout this strategy EPR 2010 and RSA 93 will collectively be referred to as the 'radioactive waste regulations'. Furthermore, throughout this strategy, references to an "environmental permit" mean a permit to dispose of radioactive waste under EPR 2010 for England and Wales, and/or authorisation to dispose of radioactive waste under RSA 93 in Scotland or Northern Ireland.

4.5. The environmental regulators responsible for the regulation of radioactive substances are the Environment Agency in England and Wales; the Scottish Environment Protection Agency (SEPA) in Scotland; and the Department of the Environment's Northern Ireland Environment Agency (NIEA). The EA is therefore responsible for enforcement of EPR 2010 and SEPA/ DoENI are responsible for RSA 93 in Scotland and Northern Ireland respectively.

## Exemptions from regulation

4.6. All materials are radioactive to some extent (see section 3). There is some waste which is not required to be subject to specific regulatory control, because the levels of radioactivity contained within it are either not possible to control, or are so low that regulation is not warranted. Such wastes may be disposed of in the same manner as other municipal, commercial and industrial wastes i.e. to landfill and incineration, without environmental permits/ authorisations.

- In the case of certain natural radionuclides in the uranium and thorium decay chains, the levels of radioactivity are specified in Schedule 1 of the radioactive waste regulations, below which the substances are outside the scope of the Act[11].
- In the case of other artificial or man-made radionuclides, levels for exemption are laid down in the current suite of Exemption Orders issued under the radioactive waste regulations, below which controls additional to those specified in the Exemption Order, are not required.

4.7. UK Government is undertaking a review of Schedule 1 of the radioactive waste regulations, and the entire suite of exemption orders. The purpose of the review is to simplify and rationalise the exemptions and to demonstrate clearer compliance with the BSS Directive 96/29/Euratom.

## Application of the Radioactive Waste Regulations

4.8. Nearly all non-nuclear organisations that keep and use radioactive materials produce radioactive waste. Unless all their activities are covered by Schedule 1 and/or an exemptions order, such premises have to be registered under the radioactive waste regulations to keep and use radioactive materials. If the radioactive materials will generate waste or become waste, then an environmental permit will also be required to accumulate and then dispose of this waste.

[11] Substances that are radioactive as a result of natural processes of irradiation are also outside the scope of EPR 2010. Examples are tritium (H-3) and carbon-14, but only at naturally occurring levels.

## Application of the Radioactive Waste Regulations to the Non-nuclear Industry

4.9. Before organisations can keep or use most radioactive materials, they need a Registration under the radioactive waste regulations. If the radioactive materials will generate or become waste then an environmental permit/ authorisation is also required to accumulate and then dispose of this waste. Some radioactive sources and wastes are exempt and do not require an environmental permit and details of these are given in exemption orders.

4.10. Applications to keep and use radioactive materials, or accumulate and dispose of radioactive waste, should be sent to the relevant environment agencies. Details on how to do this, the forms needed and how much it costs, are provided on each of the environment agencies' websites. For some sources an inspection by the relevant environment agency and a Counter Terrorist Security Advisor from the relevant police force may be required before a permit can be issued. The radioactive waste regulations allow the environment agencies up to 4 months to issue a permit.

4.11. It is the applicant's responsibility to identify disposal routes for their waste. The environment agencies do not advise on specific companies that may deal with waste, but will consider the different options that are available when deciding whether to grant authorisation. Applicants are also required to provide a risk assessment when applying for a new environmental permit/ authorisation, or a variation to an existing environmental permit/ authorisation. The level of detail in the application should be proportionate to the potential doses to members of the public and the population as a whole. Guidance is available on the regulator's websites.

4.12. In England and Wales, the Environment Agency consults with the Food Standards Agency prior to issuing environmental permits/ authorisations. Similar arrangements apply in Scotland.

4.13. The relevant environment agency inspects premises where radioactive waste is accumulated or disposed from. The frequency of inspection depends on the environmental and security risk the site poses.

4.14. Each environment agency has an enforcement and prosecution policy which determines what action to take if an authorisation condition is breached. Enforcement action can include: prosecution, formal caution, warning letter or an on-site warning. In addition, to ensure compliance or prevent harm, the environment agencies can serve enforcement and prohibition notices. (In Scotland, the procurator fiscal, and not SEPA, issues cautions and carries out prosecutions).

4.15. Holders of environmental permits/ authorisations must keep records of the waste they produce and dispose of (but see next paragraph regarding VLLW). These records are inspected by environment agencies' officers when they check compliance against conditions. The environment agencies also require all holders of environmental permits/ authorisations for radioactive waste to provide an annual report of the waste they have produced and how it was disposed of.

4.16. Whilst disposal records for VLLW are not required to be sent to the environment agencies, waste producers have to be able to demonstrate compliance with their environmental permit/ authorisation if required, and therefore should keep their own records of such disposals. However, an environmental permit/ authorisation does contain limits on the time that VLLW can be accumulated to ensure that disposal takes place as soon as practicable.

## Current disposal options for radioactive waste from the non-nuclear industry

4.17. Historically, incineration, landfill and use of the Low Level Waste Repository near Drigg (LLWR) have been used by the non-nuclear industry for disposal of its solid low level radioactive waste (Ref. 8,9). The 2007 LLW policy statement on the long term management of solid LLW has confirmed that these disposal options continue to be amongst those that may be considered for the disposal of the wide spectrum of waste types and activity concentrations within LLW in the UK (Ref. 1) (see table 1). All disposal facilities are regulated by the environment agencies, using radioactive waste regulations, depending on whether the sites take LLW or only VLLW. All disposal facilities also require planning permission from relevant local authorities, under the Town and Country Planning Act 1990 (and its equivalents in Scotland and Northern Ireland).

### Very Low Level Waste – low volume

4.18. Most VLLW produced by the non-nuclear industry falls into the definition of low volume VLLW (see Box 3). Low volume VLLW does not have to go to facilities that are permitted/ authorised under the radioactive waste regulations, and mostly therefore goes to landfill and incineration, under environmental permits/ authorisations that are held by the waste producers for disposal of directive wastes only.

### Very Low Level Waste – high volume

4.19. A new category of VLLW has been defined in the 2007 Government policy on LLW management, that is, high volume VLLW (see Box 3). Most high volume VLLW is expected to arise from the decommissioning of nuclear sites. Its disposal will be permitted to landfill, but will require control on the total volumes that are deposited at any one particular site.

### Low Level Waste

4.20. Some LLW is sent to the LLWR near Drigg, because of the presence of particular radionuclides (principally those that emit alpha particles). Other LLW, particularly clinical waste, must go either to incinerators that hold environmental permits/ authorisations to burn radioactive waste, or to landfill. Historically, environmental permits/ authorisations have been issued to waste producers wishing to use landfill for LLW as ‘controlled burial’ or ‘special precautions burial’. These specified conditions relating to disposal, such as which landfill may be used, radioactivity type and quantity, and burial arrangements (for example, specifying minimum depth, and that the waste should be placed amongst non-radioactive waste). Although the landfills themselves were not permitted/ authorised under radioactive waste regulations to take these wastes, the site operator had to keep records of each disposal, including its location.

4.21. In implementing the 2007 LLW policy, both the Environment Agency and SEPA have decided that any new environmental permits/ authorisations for disposal of LLW and high volume VLLW to landfill will be issued to the landfill site, as well as to the waste producer. In January 2009, the Environment Agency published guidance and briefing notes on the disposal of radioactive waste to landfill in England and Wales (Ref. 10).

### Regulatory guidance on requirements for authorisation

4.22. The developers and operators of near-surface facilities for solid radioactive waste disposal (i.e. low level waste repositories or landfill sites that could take LLW and high volume

VLLW) have to demonstrate to the regulators that the facilities will adequately protect people and the environment. To do this, they will need to show their approach to developing and operating the facilities, and also demonstrate that the location, design, construction, operation and closure of the facilities, will meet a series of principles and requirements12. The environment agencies have published new guidance (called Guidance on Requirements for Authorisation, GRA – Ref. 11) which sets out these principles and requirements, and which indicates how they are likely to be interpreted. The guidance also provides information about the associated framework of legislation, government policy and international obligations.

4.23. The HPA[13] has also recently revised its advice on the land-based disposal of solid radioactive waste (Ref. 12). This advice is intended for the detailed risk assessment of solid radioactive waste disposal facilities at the planning stage. It applies to all types of disposal facilities for solid radioactive waste management, ranging from purpose-built facilities near-surface and deep underground, to existing landfill sites that accept small quantities of low level or very low level radioactive waste. The advice primarily focuses on the situation after a facility has closed rather than the operational period when it is receiving waste for disposal.

## Primary and secondary Very Low Level Waste

4.24. Incinerators that burn LLW must have a permit/ authorisation to do so under the radioactive waste regulations, whilst those that burn VLLW do not. In practice, premises that produce both combustible LLW and VLLW will often send both types of waste to authorised incinerators. The radioactive waste is usually mixed at the incinerator premises with much larger amounts of other wastes (i.e. directive waste, including non-radioactive clinical wastes which must be incinerated).

4.25. Incineration leads to a reduction in waste mass and volume of up to 90% and results in the creation of residual ash and air pollution control residues (APCR). Due to the dilution of radioactive wastes by other wastes in the incineration process, these residues can usually be disposed of as VLLW – and this is termed “secondary VLLW” to distinguish it from “primary VLLW” as produced directly by waste producers that are described later in this strategy (e.g. hospitals, pharmaceutical and biotechnology companies etc.).

## Scotland and Northern Ireland Forum for Environmental Research (SNIFFER) reports on VLLW and LLW

4.26. SNIFFER has commissioned several reports which contain information relevant to this strategy; this information is of relevance to non-nuclear waste producers throughout the UK. One project (Ref. 13) aimed to establish a framework for assessing the suitability of controlled burial of LLW. This report stated that the availability of approved sites for such LLW had declined because those that had closed had not been replaced. At that time (2005), only two landfill sites (with very limited remaining capacity) existed in Scotland that would take LLW; this remains the situation in Scotland. Although the situation in England

[12] In the case of proposals for co-disposal of solid radioactive wastes with conventional waste, the guidance applies if simplified approaches to calculate radiological capacity and public/ population dose provide insufficient assurance that people and the environment are adequately protected so that more detailed assessment is required.

[13] The Health Protection Agency (HPA) had a department that specialises in radiation protection, the Radiation Protection Division (RPD, previously the National Radiological Protection Board). HPA-RPD has a statutory function of providing radiological protection advice in the UK (but it is not a regulator)

and Wales was not as extreme, the SNIFFER report further stated that without new sites and further capacity, the current situation was not sustainable, and for the non-nuclear industry, the scattered distribution of approved sites was resulting in unnecessary transport and handling of the wastes.

4.27. A further project was undertaken for the specific purpose of assessing risk from VLLW disposals (Ref. 14). This work identified the types of VLLW being produced, and estimated the amounts of VLLW arising from the non-nuclear industry in 2005 (but excluded oil and gas sectors), examined trends in waste management, and included an assessment of the potential impacts of exposure to VLLW during waste management and disposal. Data on risk assessments from this SNIFFER study are reproduced in this present document. The project resulted in the collection of data on VLLW arisings from about one third of environmental permit holders in the UK. The authors then used these data to estimate national annual arisings of VLLW, these being 3,600 tonnes of ‘primary’ VLLW and 20,000 tonnes of ‘secondary’ VLLW (i.e. residues arising from incinerators licensed to take LLW under EPR 2010). These SNIFFER projects provide useful guidance that non-nuclear industry waste producers can use as the basis for their submissions to the environment agencies about the disposal of solid waste.

## Government consultation on management of solid low level radioactive waste

4.28. In 2005, Government started a process of stakeholder engagement on policy for the long term management of solid low level radioactive waste in the UK. This led to a public consultation in 2006 (ref 15). Throughout these processes, the non-nuclear industry stated that there was a growing trend towards fewer facilities to take their radioactive wastes (Ref. 16) and this was giving rise to concern about future disposals.

4.29. In the case of historic incineration capacity, clinical waste from the medical sector had largely been disposed of via on-site incinerators that were authorised to take radioactive waste. However, regulations relating to the incineration of hazardous waste were tightened up considerably in the 1990s, and because of the cost of upgrading incinerators to meet the new requirements, few hospitals continued to have incinerators that could be used for the disposal of clinical waste (Ref. 17).

### Galson Sciences Ltd pilot study

4.30. Recognising that data would be needed to verify the urgency of what was being reported, Government commissioned a pilot study in 2006, which was to assess the feasibility of gathering various data on radioactive waste arisings (VLLW and LLW), and their disposal, from the non-nuclear industry (ref 18). The study was limited to the south-east of England, and gathered data from around a third of organisations in that area holding environmental permits/ authorisations. Based on this sample, annual arisings from the south-east of England were estimated at 170 tonnes of primary VLLW (60% by mass sent for incineration and 40% for landfill) and 250 tonnes of LLW (58% by mass sent for incineration, 24% sent to the LLWR near Drigg, 14% sent for storage or other treatment, and 4% sent for controlled burial at landfill). Secondary VLLW (incinerator residues) for the study area was estimated at 4,200 tonnes per year.

**Table 1: LLW and VLLW disposal options and associated environmental and planning legislation[14]**

| | | UK Legislation | |
|---|---|---|---|
| **Type of Waste** | **Disposal Option** | Radioactive Waste legislation (RSA 93 and EPR 2010; other environmental regulations are different throughout the UK) | Legislation under which planning permission is required |
| **LLW** | Low Level Waste Repository (currently, the only LLWR is near Drigg in Cumbria) | RSA 93 / EPR 2010 | Town and Country Planning Act 1990 in England and Wales; Planning and Compulsory Purchase Act 2004;<br><br>Town and Country Planning Act (Scotland) 1997 as modified by the Planning etc (Scotland) Act 2006;<br><br>Planning (Northern Ireland) Order 1991 as amended by the Planning (Amendment) (Northern Ireland) Order 2003 and the Planning Reform (Northern Ireland) Order 2006. |
| /6and | Specified landfill – contr255 0r255 0r255 0r255 3 To75C | | |

- limited capacity and small number of facilities for incineration of wastes containing alpha emitting radionuclides;
- the predominance in the UK marketplace of one company in providing incineration capacity for beta/gamma bearing wastes;
- the almost complete absence of landfill sites accepting LLW for controlled burial;
- and the uncertain future and availability of the Low Level Waste Repository near Drigg.

4.32. In recognition of views expressed during the public consultation, and the findings of the pilot study, Government made a commitment to develop a waste strategy across the UK for the non-nuclear sector. It stated that this strategy would require estimation of the extent and geographical distribution of LLW arisings from the UK non-nuclear sector. In 2007, Government established the Programme Board to oversee this new study (which would extend the findings of the pilot study) and prepare recommendations for a waste strategy for the non-nuclear industry. Membership and terms of reference of the Programme Board are in Appendix 1. In September 2007, the Programme Board commissioned the environmental consultancy, Atkins, to undertake UK-wide data collection on LLW and VLLW arisings from the non-nuclear industry. The findings of the Atkins project are summarised and discussed in this strategy. These data and other work have been drawn upon by the programme board to prepare recommendations for a waste strategy for the non-nuclear industry.

# 5. Societal dependence on the non-nuclear industry

## General

5.1 The following section sets out why the different sectors that comprise the non-nuclear industry produce solid radioactive waste. Many organisations use radioactively-labelled chemicals called tracers, to follow chemical and biological reactions in the human body. The ease of detection of the radiations emanating from these radioactively labelled tracers is what makes them so useful. The nature of the chemical to be labelled is dependent on its application, for example, the term 'radiopharmaceutical' applies to tracers used in the diagnosis or treatment of a disease. Radiopharmaceuticals and other radioactive tracers are purchased from specialist commercial organisations that produce the required radioactive isotopes either from a nuclear reactor using the processes of fission or activation, or by the bombardment of a target material with a beam of charged particles in a machine called a cyclotron. The radioactive isotopes are then attached to a pharmaceutical to create the radioactive tracer which targets specific organs or diseased tissue. Examples of radioisotopes commonly used by the non-nuclear industry are given in table 7.

## Hospitals

5.2 Radiopharmaceuticals are essential for the diagnosis and treatment of disease (mostly cancers) and hence are widely used in nuclear medicine departments in the National Health Service (NHS) and private hospitals. In 2003/4, there were 252 nuclear medicine centres in the UK, at which around 670,000 individual procedures were undertaken per year (Ref. 19). Between them, these centres employed 160 clinical scientists, 660 technicians, including radiographers, and 120 dedicated pharmacy personnel (Ref. 20).

5.3 In the 10 years before these data were collected, there was an increase of nearly 40% in the annual total number of nuclear medicine procedures performed, and such procedures are likely to increase as new methods are found involving the use of radionuclides for diagnosing and treating medical conditions (Ref. 20).

5.4 The vast bulk of procedures are for diagnosis of medical conditions (98%). Most diagnostic procedures (93%) involve imaging, in which the patient is administered a radiopharmaceutical which concentrates in the area of the body under investigation (see an example in box 5). Radioisotopes used in imaging procedures are of short radioactive half life and emit gamma rays which can be detected by instruments (scanners) that are outside of the body.

5.5 The remaining diagnostic procedures are called non-imaging, in which the radiopharmaceutical is administered to the patient, again, so it targets the organ of interest, but measurements of the radioactivity are made on material that is eliminated from the body (in particular in excreta or gas from the lungs). Most radioisotopes used in non-imaging procedures are also of short half life – not all rely on gamma rays, and some detection is by way of beta particle emission.

5.6 In a very small number of procedures (2% of nuclear medicine procedures), higher quantities of radioactivity within administered radiopharmaceuticals are used to kill cancer cells. The most established application is the use of iodine-131 for treatment of diseases of the thyroid, though the range of therapies, and radionuclides used, is now expanding. Although much less common than diagnostic procedures, the higher levels of radioactivity used in these therapeutic procedures, coupled with the longer half life of the radionuclides used, and the prolonged inpatient stay, result in the generation of solid waste which is of higher radioactivity and volume.

**Box 5. The use of Technetium-99 (TC-99m) in nuclear medicine**

**The use of Technetium- 99 (Tc-99m) in nuclear medicine**

Tc-99m has a short half life (6 hours), it is readily eliminated from the body, and as it decays with the emission of a gamma ray, its presence within the body can be detected by scanners placed around the patient. It is the most widely used radioisotope in nuclear medicine – accounting for nearly 80% of procedures. It decays into Tc-99 which is a radioisotope that decays via weak beta particle emission, and is of very long half life.

The commonest use of Tc-99m is in the investigation of bone conditions (e.g. detection of cancer) and heart and lung diseases. Different biochemicals labelled with Tc-99m are given to the patient – these target the organs under investigation. Irregularities can be deduced from the picture of Tc-99m distribution that is picked up by the scanners.

Although Tc-99m is very commonly used in nuclear medicine, the practice of “decay storage” means that in most cases, either very little radioactive waste, or only non-radioactive waste, is created.

5.7 Some hospitals also use radiopharmaceuticals to follow (or trace) reactions in materials sampled from the body (known as “in vitro” analysis). In this application, the levels of radioactivity are much lower than in those used directly in people, but the radioisotopes used tend to have a longer half-life, e.g. tritium (H-3), carbon-14, phosphorus-32.

5.8 The bulk of radioactivity administered to patients for either diagnostic or therapeutic purposes is eliminated by them via excreta to the sewers. The environment agencies regulate these discharges from hospitals. Risks to sewage workers and the public from discharges at current levels are calculated to be very low, mainly because the radioisotopes involved are usually of short half life and the radioactivity decays quickly (Ref. 21).

5.9 Solid radioactive wastes arise as a result of traces of radiopharmaceuticals in used syringes, needles, vials from which radiopharmaceuticals have been withdrawn and absorbent or protective materials (e.g. swabs, dressings, sheets and plastic film) which may be contaminated with small amounts of radiopharmaceutical. Many hospitals are encouraged to store solid radioactive waste prior to disposal. This is called “decay storage”, and its purpose is to allow short lived radioisotopes in the waste to decay to very low levels, a practice which minimises the radiological impact of the finally disposed waste. However, this requires the provision of secure storage space and availability of resources to manage the accumulated waste. For the most commonly used radionuclides, particularly technitium-99m (highlighted in Box 5 above), the majority of hospitals can provide such storage resources. However, because EPR 2010 permits contain time limits on the practice of decay storage, wastes containing some of the longer half life radionuclides, such as thallium-201, or chromium-51, and the larger volumes of iodine-131, may in some cases need to be disposed of as radioactive waste. Traditionally, most hospital waste has been designated as clinical waste, much of which is incinerated. However, hospitals are now being encouraged to categorise and segregate wastes at source (see, for example Ref. 22), which may result in some radioactive wastes being discharged into a non-clinical waste route.

## Pharmaceutical Industry

5.10 The pharmaceutical industry carries out drug and technology development in specific areas of disease research, and in doing so, makes wide use of radiopharmaceuticals (Box 6 illustrates how radioactivity is used at all stages of drug discovery). In 2005, the UK pharmaceutical industry directly employed 68,000, just under 40% of whom were directly involved in research, and between 10 and 20% used radioactivity. Solid VLLW from the pharmaceutical industry comprises general laboratory plastics, vials, sharps (i.e. needles and blades), gloves and any material which may be contaminated.

**Box 6. The use of radiopharmaceuticals during disease research**

**The use of radiopharmaceuticals during disease research**

- **Target identification** - studying how diseased tissue differs from normal tissue.
- **Screening** - once the disease target (a type of protein) is known, compounds that interact with the target are labelled with radioactivity and used to identify other compounds (which may be potential treatments for the disease)
- **Selectivity** - the compounds are then tested at other targets where activity might result in side effects
- **Bio imaging** - when a potential drug has been identified, it has to be shown to be selective for diseased tissue. This is a legal requirement before the start of clinical trials.

## Biotechnology industry

5.11 Biotechnology is the exploitation of biological processes for industrial and other purposes, especially the genetic manipulation of micro-organisms for the production of antibiotics and hormones. Biotechnology companies use small amounts of radioactivity in a range of diagnostic and life science research including:

- Genomics, stem cell biology, and bio-nanotechnology, which provide a basis for new technologies in healthcare, food safety, plant and livestock breeding, and bioprocessing;
- Whole organism biology relevant to the understanding of diet and health, ageing, animal health and welfare, infectious diseases and immunity and crop productivity;
- Biological populations and systems that underpin agricultural sustainability, biodiversity and novel bio-based and renewable processes for energy and manufacturing.
- Radioactivity is also used in therapeutic products designed to treat diseases such as prostate cancer and relieve pain in bone metastases.

5.12 VLLW from biotechnology companies includes equipment to count the radioactivity, gloves, protective overalls and vials, and the waste is treated as either clinical or directive waste.

## Universities, colleges and other research laboratories

5.13 Radioactive tracers are used in universities, colleges and other research laboratories, to study the incorporation of chemical compounds into cells and organisms and also to study their transfer and metabolism. Box 7 contains two examples of the use of radioisotopes in disease research.

**Box 7. Examples of disease research using radioisotopes**

| **Examples of disease research using radioisotopes** |
|---|
| Some rare childhood diseases are caused by inherited errors in metabolism. Blockages in various metabolic pathways are investigated using the radioactive labelling of fatty acids (with tritium) and amino acids (with carbon-14) in cell samples taken from the patients, that are then grown in culture. These investigations are a national service and help around 300 patients a year.<br><br>Part of a study into the causes of cystic fibrosis involves the use of the radioisotope calcium-45 in cultured cells from the bronchial tubes, to measure calcium movement across cell membranes.<br><br>In both examples, the use of radioisotopes currently provides the greatest sensitivity compared to techniques not involving radioactivity. This is because of the ease of detection of the radioactive labelling. |

5.14 Some research into plants, microbes and food also involves the use of radioactive tracers, and this work has enabled developments that are of great benefit to people around the world (see Box 8 for examples).

**Box 8. Examples of developments made possible through use of radioactive tracers in research**

| Examples of developments made possible through use of radioactive tracers in research |
| --- |

- Food crops with increased resistance to drought and increased resistance to disease, thereby reducing the need for chemical treatments
- Food crops that can trap their own nitrogen, thereby reducing the need for chemical fertilizers
- Food crops with improved yields and nutritional value
- Characterisation of toxins resulting from food spoilage
- Production of drugs and antibiotics

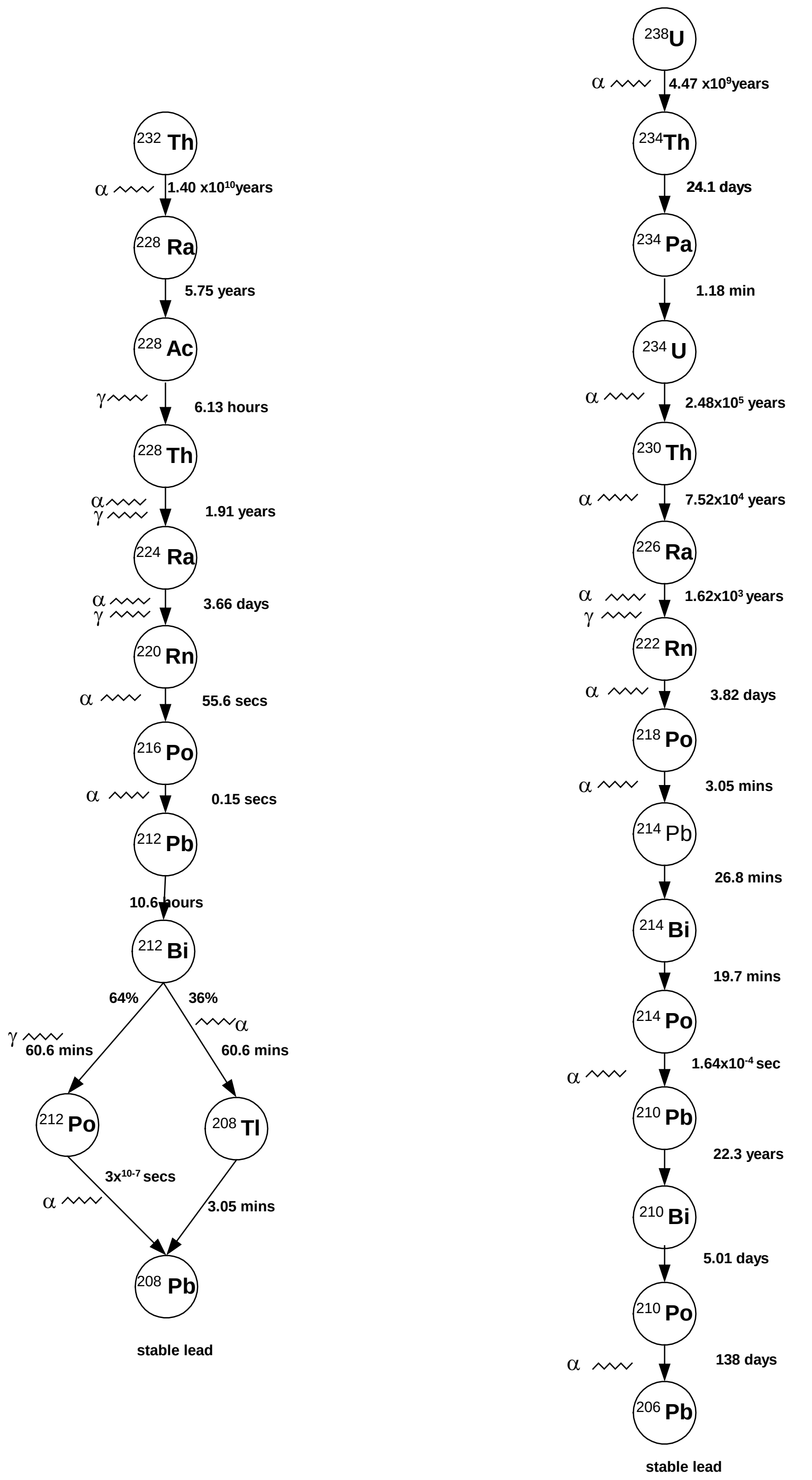
a month, so that their excreta can be collected and stored to allow for decay of the iodine-131. Hence very little solid radioactive waste is generated by the use of radioisotopes in veterinary medicine.

## Oil and gas industries

5.18 The oil and gas industry is an important contributor to the UK economy. In 2008, there were 266 oil and gas production platforms operating in the UK sector of the North Sea and Irish Sea. Up to 2007, these have produced 605 million barrels of oil, and 428 million barrels of oil equivalent in gas. In 2006/7, these industries provided 74% of the UK's total primary energy production and employed 320,000 people in the UK, directly or indirectly. These industries have also contributed a cumulative total of £243 billion in taxes.

5.19 During the process of extracting oil and gas, radioactive waste is generated as a by-product. The waste is radioactive because it contains isotopes that result from the radioactive decay of uranium-238 and thorium-232. Uranium and thorium have very long half lives and have been present since the formation of the earth. As the uranium and thorium “parent” isotopes decay (see box 9), they generate new radioactive “daughters”. Some of these “daughters” are more mobile in the environment than their “parents”, and are extracted along with oil and gas from reservoirs within the earth. Both the parent and daughter isotopes are found in water and solids associated with the extraction of oil and gas and are referred to, collectively, as Naturally Occurring Radioactive Material (NORM).

## Box 9:238U and 232Th Decay series (reproduced from ref 25, with permission)[15]




15 Permission from SNIFFER via S Betts (email to K Mondon 12/2/09)

5.20 On offshore oil and gas production platforms, solid NORM arises from three main sources:

- NORM accumulates as a hard, insoluble scale inside process pipework, equipment and valves. This scale is often referred to as low specific activity (LSA) scale because its level of radioactivity is low. Solid scale must be removed as it can significantly reduce the performance of equipment. Removal takes place during routine cleanout and descaling operations offshore.
- Solid NORM also occurs as a mixture of sand, sludge and other sediments deposited inside vessels which are typically removed during shutdowns.
- Future decommissioning of offshore facilities.

5.21 Overboard discharge and reinjection of material into the seabed subsurface directly from producing fields (intra-field) are the two common practices used in the UK to dispose of NORM waste.

5.22 Reinjection has the advantage that NORM disposal is as near to the source as possible, avoiding transportation and public (involuntary) and workplace (voluntary) exposure risk. Reinjection also has a low dose to the public and returns the material to the environment it originally came from.

5.23 Re-injection offshore to the deep subsurface has a distinct advantage over all the other options due to degree of isolation and minimisation of handling and transportation. However, not all platforms have reinjection facilities as this would require significant investment and further, it is not possible to install injection facilities in some instances due to incompatible reservoir characteristics, reservoir or adjacent formations and/or installation incompatibilities such as lack of sufficient space/weight considerations on the offshore platforms. For those platforms without reinjection facilities, DECC authorises direct discharge of produced water (subject to a 30 ppm oil in water limit) and drill cuttings to sea (subject to a 1% oil on cuttings limit). Reinjection brings increased fuel use and atmospheric emissions. Centralised reinjection (inter-field) has attractions but the legal basis would need affirmation (see below).

5.24 If NORM contains radionuclides above Schedule 1 limits of the radioactive waste regulations for solids (or is above the Phosphatic Substances Exemption Order) an environmental permit is required from the environment agencies (SEPA or Environment Agency). Sand, sludge and other sediments deposited inside vessels are typically removed during shutdowns. For those platforms without reinjection facilities, the environment agencies can authorise direct discharge of sludges, sand and other sediments to sea. However, the practice of re-injection is currently the subject of debate in relation to the UK commitments under the Oslo – Paris Treaty on marine pollution in the North-East Atlantic. For this reason, despite the attractiveness of this disposal method, land-based facilities will undoubtedly be required in the future.

5.25 For practical reasons (insufficient space, lack of facilities or because of health and safety considerations), some equipment containing deposits of NORM scale has to come onshore to be treated and have the scale removed. At present there is only one major facility in the UK where onshore treatment (de-scaling) of LSA scale takes place (Scotoil). Currently, radioactive waste from this facility is disposed of directly to the near-shore marine environment in accordance with a RSA 93 authorisation granted by SEPA. This disposal route will no longer be available after October 2011 when discharges to sea will cease. However, if alternative accumulation and disposal arrangements are put in place then de-

# 6. Waste arisings from the non-nuclear industry

## The Atkins project

6.1. To prepare the non-nuclear industry waste strategy, the programme board sought the following information on waste arisings:

- How much LLW and VLLW are arising from the non-nuclear sector at present (in terms of activity, mass, volume and physical form)?
- What disposal routes or alternative management routes are available (and being used) for the LLW and VLLW?
- What changes are likely in terms of arisings and management facilities?

6.2. Atkins was commissioned to collect these data from across the UK, and the main findings from this project (henceforth called the Atkins project) are summarised below. The full report and associated data file can be obtained from the DECC website16 (Ref. 24).

6.3. The Atkins project was undertaken between September 2007 and the following autumn. Contact details of all organisations holding RSA 93 authorisations17 to dispose of radioactive waste were requested from the environment agencies. Those organisations that could be contacted were asked to submit data on their LLW and VLLW waste streams18 using an electronic questionnaire. Submitted data were sorted as follows: sector (e.g. research, medical, industrial etc.), type of waste (LLW or VLLW), and for each waste stream reported, annual data on the specific radionuclide (or group of radionuclides), physical quantity (volume OR mass), physical form (e.g. clinical, organic liquid etc), and disposal method. These data were requested for current, historical and anticipated waste streams.

6.4. Information on disposal facilities was extracted from the questionnaires, and further data on quantities and disposal routes for secondary VLLW (incinerator residues, being ash and lime) were sought directly from operators of identified plant.

6.5. Of the 877 facilities that held RSA 93 authorisations, 766 were successfully contacted, just over a third of which responded to the questionnaire. However, only 172 organisations provided data on current or recent waste arisings (covering 254 waste streams) that could be analysed for the project19 – this represents just under 20% of all organisations that

[16] see DECC website
[17] The Atkins project was carried out prior to April 2010 and therefore prior to the change to regulations in England and Wales to EPR 2010.
[18] A waste stream is a single record of a waste sent for disposal or treatment –the term is unrelated to quantity of waste.
[19] For example, numerous organisations stated that they had not disposed of any solid waste recently or historically, and were removed from the dataset. In other instances, organisations provided data on liquid waste, and not on solid waste, and were also removed from the dataset.

hold an authorisation to produce solid LLW or VLLW. This was an insufficient statistical base on which to decide if the responding organisations could be treated as representative of the remaining 80%. For this reason, and the overall low response rate, the extrapolation of the data to produce an estimate of UK arisings should be treated with caution. Nonetheless, the survey produced a number of useful indications of waste types, geographical distribution and transport issues. The main findings from the survey are summarised in the following paragraphs (and unless otherwise indicated, are data only from the survey).

6.6. The sectors which provided useful data (split between current, historical and anticipated arisings) are shown in table 2. In summary, 172 organisations provided data on current waste streams, 91 on historical waste streams and 57 provided data on anticipated arisings. The medical and research sectors dominated the survey returns (and hence certain waste types and radionuclide content also dominated the data from the survey).

**Table 2- Number of organisations providing data for different time periods**[20]

| Sector | Current | Historical | Anticipated |
|---|---|---|---|
| Industrial | 13 | 6 | 8 |
| Medical | 70 | 35 | 27 |
| Research | 60 | 39 | 18 |
| Teaching | 4 | 2 | 1 |
| Other | 25 | 9 | 3 |
| **Total** | **172** | **91** | **57** |

6.7. Data on current/recent waste streams were summed to provide overall annual volume and mass of waste21, as follows:

- The total amount of LLW per year was around 4,800 m3 plus 13 tonnes.
- The total amount of VLLW per year was around 46,500 m3 plus 41 tonnes.

6.8. Of the total volume of LLW plus VLLW reported in the survey (approximately 50,000 m3), the medical sector was responsible for 77% and the research sector for 21%. Not

[20] Some organisations provided data for all three time periods, others for only one or two of the time periods.
[21] Volumes and masses are not inter-related. This is because organisations could provide data as either volume or mass according to their custom and practice; few organisations provided data on both volume *and* mass. Density calculations were not applied to obtain total quantities in one or other unit, because of the many different physical waste stream types.

surprisingly, therefore, the radioactivity in the waste was dominated by carbon-14, tritium and technetium-99m, and other short lived beta emitters, with clinical and laboratory wastes22 being the most commonly reported physical waste types.

6.9. Nearly 90% of reported volumes of VLLW came from Scottish non-nuclear organisations (mainly large hospitals), but this is simply representative of the fact that more proportionally more organisations in Scotland responded to the survey. This meant that VLLW from organisations in the rest of the UK amounted to approximately 5,000 m3 per year. (One-off disposals reported in the survey amounted to 30 m3 and were excluded from the analysed data).

6.10. Of the total mass of LLW plus VLLW reported in the survey (around 54 tonnes), nearly 70% came from industrial and laboratory sources, and waste management services. The dominant type of radioactivity was long lived beta emitters as well as carbon-14 and tritium. (One-off disposals amounted to 3.7 tonnes, and were excluded from the analysed data).

6.11. For wastes reported by volume, incineration was by far the most widely used method of disposal, whereas for wastes reported by mass, it was landfill (see table 3), which reflects the domination of the former by clinical wastes, and of the latter by industrial wastes.

**Table 3 – Annual quantities of current/recent waste arisings**[23]

| Type of data | cubic metres | kilograms |
|---|---|---|
| Disposal by incineration (VLLW and LLW) | 50,183 | 17,776 |
| Disposal by landfill (VLLW) | 880 | 32,188 |
| Disposal by controlled burial (i.e. LLW) | 29 | 0 |
| Disposal to LLWR at Drigg | 53 | 270 |
| Use of decay storage (followed by disposal as conventional waste) | 60 | 0 |
| Other (mainly transfer of waste to a waste treatment centre, or decay | 145 | 3,979 |

[22] Examples are gloves, tissues, sharps (needles), paper, organic liquids.

[23] Estimates of annual arisings of LLW and VLLW from the non-nuclear industry were prepared to support the LLW policy (ref 1) – these were: 5,400 cubic metres of primary VLLW and LLW arising annually, 63% of which was incinerated, 32% sent for landfill and the rest sent to the LLWR near Drigg and to controlled burial. Secondary VLLW as incinerator residues were estimated at 42,000 cubic metres per year (but included incineration of nuclear LLW).

| Type of data | cubic metres | kilograms |
|---|---|---|
| storage then incineration) | | |
| Total quantities (the data on volume and mass are mutually exclusive) | 51,350 $m^3$ | 54,213 kg (54.2 tonnes) |
| Estimate of total UK arisings of non-nuclear wastes<br><br>On the basis that the survey included around 20% of all authorisation holders, and that the bulk of the arisings are from one area of the UK that appeared to be well represented in the survey, it is estimated that total UK arisings from the non-nuclear industry are very unlikely to exceed 100,000 $m^3$ per year. In comparison, total directive waste arisings in England are around 272 million tonnesi. Non-nuclear waste arisings are therefore very unlikely to exceed 0.1% by volume of conventional use controlled to be consistent throughout waste arisings from the whole of the UK. | | |

6.12. Organisations participating in the survey were asked to provide information on historical, current/recent and anticipated quantities of LLW and VLLW. Data were sorted in terms of radionuclide content of the wastes (e.g. long lived beta emitters, short lived beta emitters) and on volumes and masses. The results for current versus anticipated quantities of radioactivity are summarised in table 4. In most cases, slight increases in the radioactivity of wastes were anticipated for most radionuclide groups, although the limited number of organisations providing data for this part of the survey, as shown in the table, indicate that these estimates should be treated with a degree of caution. When physical quantities of wastes were considered, about half the volume and about a quarter of the mass were anticipated, compared to currently.

**Table 4 - Comparison of current versus anticipated quantities of radioactivity in wastes**

| | Description of waste | Current versus anticipated arisings |
|---|---|---|
| Radioactivity in waste | Wastes containing alpha emitters | Activity will increase by around 60% (data from 1 organisation) |
| | Wastes containing uranium | Activity will stay the same (data from 1 organisation) |
| | Wastes containing long lived beta emitters | Very slight increase in activity (data from 6 organisations) |

| Description of waste | | Current versus anticipated arisings |
|---|---|---|
| | Wastes containing short lived beta emitters | Very slight increase in activity (data from 13 organisations) |
| | Wastes containing technetium-99m | Very slight increase in activity (data from 3 organisations) |
| | Wastes containing tritium | A reduction of more than 50% in activity (data from 10 organisations) |
| | Wastes containing carbon-14 | Slight increase in activity (data from 9 organisations) |
| Volumes and masses of wastes | | A reduction to about half the volume and a quarter of the mass (data from 57 organisations) |

6.13. Responses to the survey identified 58 disposal facilities currently being used by the non-nuclear industry (31 landfills and 27 incinerators). Only one landfill site (in England) was identified as accepting LLW for controlled burial but this was found to be an erroneous return[24]. Many of the incinerators were connected with hospitals and laboratories, and hence burnt clinical and general laboratory waste (e.g. organic liquids, plastics gloves, needles, paper and textiles).

6.14. Data on incinerator residues were provided from 8 operational incinerators. Current arisings totalled 261 m3 plus 75.2 tonnes per year, all of which was sent for landfill, sometimes via waste treatment centres.

6.15. To try and obtain information on the future provision of disposal facilities for non-nuclear industry wastes, letters were sent to a number of waste disposal companies, asking about their intentions with respect to radioactive waste. This exercise indicated that no major change in available facilities was expected, at least in the foreseeable future (but responses were very limited, possibly because commercial interests deterred some companies from responding). The Atkins report also referred to other evidence external to the survey, indicating that some waste management companies are interested in providing facilities for NDA wastes, mainly in the VLLW category, and possibly also for NORM wastes from the oil and gas sectors. Although the Atkins report mentioned only one UK incinerator that accepts alpha-contaminated wastes, it has subsequently been confirmed

[24] A SNIFFER report on oil and gas (ref 26) stated there were 7 landfill sites in England and Wales in 2003 accepting controlled burials for radioactive waste, and none in Scotland.

that a second large incinerator now has an authorisation to accept alpha disposals. (In principle, there are no significant technical reasons why most of the UK incineration capacity could not apply for, and receive an allowance for, an alpha component to their authorisation) The role of the NDA within the non-nuclear waste strategy is discussed elsewhere in this document.

6.16. To provide an overall view of the waste arisings and disposals from the non-nuclear industry across the UK, data on waste streams originating from the same Waste Planning Authorities (WPA) were assembled from the survey database. Seventy-three English and 7 Welsh WPAs25 had one or more non-nuclear organisations that had taken part in the survey. Scotland was treated as one WPA (and a number of Scottish organisations had provided data). The quantities of waste arising within the WPAs, and associated trends in expected quantities, have been analysed in the sustainability appraisal report (see Ref. 3).

6.17. Information was sought from waste producers, on approximate distances to disposal sites (incinerators or landfill sites) for their wastes. These data were aggregated and sorted to provide average distances for non-nuclear industry waste transportation within each WPA. The data are summarised in table 5. The data show that in the case of incineration, waste is transported to a greater extent than for landfill. This is to be expected, because there are fewer incinerators than landfill sites (particularly in the case of incinerators authorised to accept LLW). It is apparent that most radioactive wastes arising in Scotland have to be transported to England for disposal, as Scotland is virtually without disposal facilities (particularly commercial incinerators) accepting LLW (incinerators taking VLLW do not require authorisation under RSA 93 and therefore will not be identified as specifically available for VLLW). The shortage of disposal facilities taking radioactive waste in Scotland has been identified in other work (Ref. 3).

**Table 5 – summary of average 'waste miles' to disposal sites from each WPA**

| Transportation of waste (in bands of waste miles) | Waste for incineration | Waste for landfill |
|---|---|---|
| Less than or equal to 25 miles | 23 WPAs26 | 28 WPAs |
| Between 25 and 50 miles | 12 WPAs | 1 WPA |
| Between 51 and 100 miles | 18 WPAs | 2 WPAs |

[25] There are 82 mineral and waste planning authorities in England and 25 in Wales.
[26] For example, in the case of waste being transported to incineration plant, for 23 out of 59 WPAs, average waste miles were less than or equal to 25 miles.

| Transportation of waste (in bands of waste miles) | Waste for incineration | Waste for landfill |
|---|---|---|
| Between 100 and 300 miles | 6 WPAs | 1 WPAs |
| Total number of WPAs for which 'waste mile' data were analysed | 59 WPAs | 32 WPAs |

6.18. Organisations that had provided useful data were invited to answer questions designed to identify factors influencing their choice of disposal route, and to determine to what extent the principle of proximity applies to the overall pattern of disposals across the UK. A total of 185 facilities were contacted and 32 responses received. These responses were supplemented by interchanges facilities by non-nuclear industry liaison groups run by the environment agencies.

6.19. The following are the main findings from this qualitative exercise:

- The majority of responses (22) stated they had not experienced any problems in disposing of their wastes. The other responses indicated that although there appeared to be a perception that waste routes are not as numerous as previously, the main problems seemed to be practical, concerning the setting up of contracts and obtaining relevant permits from the environmental regulators.
- When asked about the influence of the 2007 LLW policy on their own waste management, most facilities stated they had not been affected so far (although the new policy was welcomed by some).
- Costs, availability and historical arrangements appear to predominate in the selection of waste routes, although there were some indications that the 2007 LLW policy was being noted.

6.20. A variety of other issues associated with LLW management was raised by respondents. Responses to this qualitative exercise are discussed elsewhere in this strategy.

6.21. It should be noted that all environmental permit holders are required to provide the environment agencies with records of their waste disposals. In the case of LLW, this requirement covers the amount (becquerels per year), types of radioactivity (alpha emitters, short lived beta emitters etc.) and disposal routes, but all similar data are not required for low volume VLLW disposals (i.e. covering most non-nuclear disposals of waste in this category). No requirement is placed on organisations to report physical quantities of either LLW or VLLW, even though these wastes are disposed of to facilities taking conventional wastes, which are normally defined in terms of volume and/or mass.

6.22. In view of the current mismatch of information between what is routinely collected by the environment agencies from the non-nuclear industry, and the information usually required for conventional waste strategies, Atkins was also required to advise the programme board on how data collection from the non-nuclear industry could be improved on a routine basis. If the databases holding information on the non-nuclear sector could be improved, the waste strategy could then be updated from time-to-time without the need for costly one-off surveys. It was for this reason, that Atkins designed an electronic survey form for the project – the idea being that it, or a similar form, could easily then be adapted for routine use.

6.23. The limited response to the electronic survey and difficulties experienced by those using it, as well as the qualitative responses to the later questionnaire led Atkins to question whether routine data collection beyond the current requirements is justified. Other arguments were that considerable improvements would be needed to one of the environment agencies' databases and that legal enforcement would be needed to induce the majority of facilities to provide additional data on their wastes on a routine basis, which would need justification.

6.24. Northern Ireland waste producers only generate very small annual quantities of LLW and/or VLLW (It is estimated that around 6 m3 per year of radioactive waste from Northern Irish non-nuclear industries (mainly hospitals) are sent to Great Britain for incineration. Apart from one incinerator which accepts some clinical wastes, all other waste is exported to the mainland for incineration or landfill. Although (without further evidence) this appears to contradict the principle of proximity, it seems unlikely that the small volumes of such waste would encourage commercial waste disposal operators to enter the market in Northern Ireland.

6.25. During the Atkins project, future disposal arrangements of NORM from the oil and gas sectors were uncertain, pending the outcome of an appeal by a waste facility operator (Scotoil) against a regulatory decision by SEPA that Best Practicable Means were not being used to manage disposals of radioactive waste. There are also considerable uncertainties over volumes of waste that will arise from decommissioning of oil and gas installations. Waste arisings from routine operations have been estimated through other work completed in support of this strategy, and are summarised in section [4.4]. For these reasons, the Atkins project did not cover data collection from the oil and gas sectors, although a summary of the position for NORM disposal was given.

6.26. The Ministry of Defence has a number of sites producing LLW and VLLW that fall within the definition of the non-nuclear sector. However, the MoD was unable to provide a full set of quantitative data within the timeframe required by the project.

6.27. The decision by the programme board to introduce work on sustainability appraisal of the strategy meant that some data collection originally intended for the Atkins project (particularly on available waste disposal capacity) was undertaken by this separate exercise, and is reported in the scoping report on sustainability appraisal (Ref. 3).

6.28. The Atkins project provided an opportunity for non-nuclear organisations to contribute useful data for the development of a UK strategy specifically for their wastes. The role of the survey in the development of the strategy was made clear in the early information sent to organisations, and therefore the response rate to the main survey was rather less than anticipated. Additionally, those who provided data appeared to be managing to find disposal routes for their solid radioactive wastes. For these reasons, the Atkins report recommended that the strategy (and any future data collection initiative) should concentrate on the longer term rather than the immediate future.

6.29. The quantities of waste arising from the non-nuclear sector suggested by the Atkins project are somewhat at odds with previous estimates. For example, the sample from the survey suggested nearly 55,000 m3 per year of primary LLW and VLLW, whereas the previous estimate (Ref. 18) was for less than 6,000 m3 per year for the whole of the UK. This wide discrepancy may be partly due to survey responses being heavily influenced by data from Scottish organisations which make up nearly 90% of the total VLLW volume. However, it should be pointed out that previous estimates of UK arisings from the non-nuclear sector have also been based on very limited data, and in one study (Ref. 18) based on only one part of the UK, and are therefore also likely to be considerably in error when used to extrapolate to a UK-wide position. Nonetheless, the Atkins project has provided broadly indicative information on the geographical distribution of waste arisings, disposal routes and physical descriptions of the wastes, all of which are useful data for the strategy and for waste planning authorities. An estimate of 100,000 $m^3$ per year of LLW and VLLW arising from the UK non-nuclear sector has been made, based on the data, but, this figure should be treated with caution.

6.30. Except possibly for carbon-14 and tritium, there appears to be no significant anticipated increase in most types of radioactivity in wastes that will require disposal from the non-nuclear sector. Anticipated physical quantities are less than at present.

6.31. Controlled burial of LLW by the non-nuclear sector appears to be very rarely undertaken, despite its inclusion amongst disposal options in the 2007 LLW policy statement. It is not possible to determine the relative split between incineration and landfill of LLW and VLLW (because of the mixed reporting of volumes and masses of waste). However, using very rough estimates of densities of waste, it appears that the bulk of primary LLW and VLLW is probably sent for incineration. Data on secondary VLLW (i.e. incinerator residues) were very sparse, as few incinerator companies responded to Atkins' request for information. However, the Environment Agency is currently updating information on the incineration of radioactive waste, and this work should be completed by autumn 2010.

6.32. The scoping report on sustainability appraisal of the waste strategy also has drawn upon data from the Atkins project.

## Contaminated land

6.33. The UK has a legacy of contaminated soil, some of which contains above-background concentrations of certain naturally occurring radionuclides. This contamination has resulted from past industrial activities that pre-date the proper control of the use and disposal of radioactive wastes. An example is the processing of uranium ore by a number of businesses during the 1940s and 50s, to extract radium which was then incorporated into paint and used to illuminate aircraft dials, watches and other products. When these businesses ceased to exist, they often left behind soil contaminated by radionuclides in the natural decay chains of uranium and thorium, the most significant of which is radium. Where such contaminated soil presents significant risks to people (defined as greater than 3 millisieverts per year), the land may be determined as "contaminated land" in the Environmental Protection Act 1990.

6.34. The Government's long-term aim is to work towards a future where all the contaminated land presenting significant risks in the UK has been identified and dealt with. Some land is voluntarily remediated (for example, in cases where land is being redeveloped under the planning system, or because land owners want to increase the utility and value of their land). However, legislation under Part 2A of the Environmental Protection Act 1990 has been developed to cover situations where the contamination presents significant risks and there is unlikely to be a voluntary solution. Examples could be contaminated sites which have been developed without being cleaned-up and sites where the person who polluted the land, and/or the current owner, is unwilling to deal with the problem voluntarily27. The scale of the remediation and who is responsible for carrying out the actual work, depend on the circumstances of each case.

6.35. In cases of change of use of land, if this is covered by the planning system, it is the responsibility of local authorities to ensure that the contamination is dealt with through the planning system, and that remediation takes place where required. If remediation results in the generation of radioactive waste, an authorisation issued by the environment agencies under the RSA 93 would be required, to accumulate or dispose of the waste. Depending on the level of contamination of soil, disposals may be to landfills used for conventional (controlled) wastes.

6.36. Whilst they are potentially significant in terms of volumes, the ad hoc nature of arisings from remediation of land contaminated with radioactivity does not allow for long term planning for disposal of associated soils etc. This non-nuclear strategy does not therefore include any requirements on planning authorities to make specific provision within their planning frameworks. There does not seem to be any reasonable alternative to the present position, which is that each case should be dealt with by the affected local authorities and the environment agencies as it arises. However, it would be prudent for waste planning authorities to make reference in their planning documents to the possibility that contaminated land might arise in their area, and that some disposals of contaminated soil might be required within local landfills.

6.37. Further information on contaminated land can be obtained from the Defra website, including an assessment of historical industries which are likely to have given rise to radioactive wastes28.

## Spent sealed sources

6.38. Radioactive sealed sources (i.e. where the radioactivity is contained in a welded metal capsule) are used for a wide variety of purposes by the non-nuclear industry. They range from very high activity sources comprising energetic gamma emitters (for example as used in radiotherapy and industrial radiography) down to low activity sources comprising alpha

[27] Land contaminated by artificial radioactivity resulting from a nuclear accident in an overseas country would be an example.
[28] http://defraweb/environment/land/contaminated/index.htm

or weak beta emitters (for example, as used in smoke detectors and illuminated signs). Once the source has reached the end of its design life, or is no longer required, it requires disposal.

6.39. Some very low activity sources fall within the exemption order regime under RSA 93 (for example exemption orders covering smoke detectors and testing instruments) and can be disposed of with municipal/industrial wastes to landfill or incineration. Some spent sealed sources can be recycled at specialised facilities, where the radioactivity is recovered for another use. All other sealed sources require either to be disposed of as LLW that has to go to the LLWR near Drigg, or storage as intermediate level waste (ILW) at Sellafield or Harwell (ILW has no disposal route at present).

6.40. Many public sector organisations that had been using sealed sources for a long time, had resorted to simply storing them, because they could not afford to dispose of them. The Government was concerned about the security implications of this practice, and in 2004, provided over £7 million for a subsidised disposal campaign, the Surplus Sources Disposal Programme (SSDP). This programme of disposal has now largely been completed, and was highly successful as it resulted in the collection of many thousands of small spent sources from hospitals, universities, schools, colleges, museums and other organisations. Some large sources were also safely disposed of as a result of the SSDP.

6.41. Since 2005, certain types of higher activity sources fall under the High Activity Sealed Radioactivity Sources and Orphan Sources (HASS) Regulations 2005. These regulations place additional requirements on users to those in previous authorisations issued under the RSA 93. In particular, they require those wishing to use HASS sources to register them with the environment agencies, and demonstrate suitable security arrangements for their storage and use. They must also make financial provision for their disposal prior to their purchase. However, the majority of sealed sources used by the non-nuclear industry do not fall under the definition of those covered by the HASS Regulations, and each user must make arrangements for their disposal. With the imminent completion of the SSDP, the environment agencies will ensure that the disposal of all sources is adequately addressed by users, before they purchase them. Nonetheless, in the case of spent higher activity sources that cannot be disposed of to the LLWR near Drigg (or any replacement), the UK will continue to require a facility for their treatment and/or storage, until permanent disposal facilities are available for ILW. Up to now, storage has been undertaken in facilities operated under contract from the NDA at Sellafield or Harwell.

# 7. Assessment of risk from disposals of non-nuclear industry radioactive waste

## Introduction

7.1. Only the radiological risks associated with VLLW and LLW disposals are considered in this document. Whether the waste goes for incineration, or directly to landfill depends on its non-radioactive properties. Hence, if it is combustible and/or clinical, it will usually go for incineration. Otherwise, it will usually go directly to a landfill type that is appropriate to its physical form29.

7.2. The risk of health effects to people from the disposal of VLLW and LLW from the non-nuclear industry are very low, being of the order of one in a million per year or less. The demonstration of these low risks is through the study of possible ways in which people could receive a radiation dose from the radioactivity present in the waste, called 'potential exposure scenarios'.

## Estimating doses using potential exposure scenarios

7.3. Radiation exposure can result from;

- external irradiation from radioactivity that is outside the body, called 'external radiation exposure', mostly from gamma-ray emitting radionuclides, and from
- inhaling radionuclides in air, and/or
- ingesting radionuclides present in water, food, or dust particles, called 'internal radiation exposure', which can arise from any type of radiation.

7.4. The assessment of potential radiation doses to people from disposals of LLW and VLLW starts with a study of possible sources of external and internal exposure, using theoretical scenarios covering both those who work in the waste industry, and members of the public, including children (see table 8). The purpose of using scenarios to undertake dose assessments is to calculate maximum theoretical doses. In reality, the majority of people living close to waste disposal facilities will receive very small doses as a result of these waste disposals.

[29] Landfills take inert, hazardous or non-hazardous waste. These terms are defined in the Landfill Directive 1999 (99/31 EC).

**Table 6: Theoretical scenarios used in the assessment of doses from radioactive waste disposals**

| | Scenario | Radiation Exposure Route |
|---|---|---|
| **Workers** | Handling VLLW along with other non-radioactive waste, at waste transfer stations, composting and recycling facilities, landfills and incinerators. | • Direct radiation<br>• Inhalation and ingestion of dust particles |
| | Working at a landfill site or incinerator accepting LLW and/or VLLW | • Direct radiation from standing close to waste items containing gamma-emitting radionuclides<br>• Inhalation and ingestion of dust particles<br>• At landfill sites, some radioactive gases may also be inhaled. |
| **Members of the Public** | Combustion of VLLW and LLW at incinerators, and discharge of some radioactivity to air and water | • Direct radiation<br>• Inhalation of radioactive gases<br>• Deposition of radioactivity on the ground, or into water, followed by ingestion via food and/or water |
| | Disposal of ash and incinerator residues from incinerators to landfill, and dispersal of radioactivity into the environment via leachate | • Direct radiation from standing close to waste items containing gamma-emitting radionuclides |
| | Some incinerator residues may be reused (e.g. in construction) or recycled (e.g. in the chemicals industry) | • Inhalation of dust<br>• Ingestion of radioactivity<br>• via water or food |
| | Inadvertent excavation of a landfill site used for VLLW or LLW many years after closure | • Direct radiation from standing close to waste items containing gamma-emitting radionuclides<br>• Inhalation and ingestion of dust particles<br>• Some radioactive gases may also be inhaled. |

## Potential exposure of workers

7.5. VLLW and LLW are usually physically indistinguishable from other non-radioactive waste. As the radiological risk from low volume VLLW is so low, no specific precautions are taken on account of its radioactivity. Hence, workers may handle low volume VLLW from time to time, along with non-radioactive waste, at waste transfer stations, composting and recycling facilities, landfills and non-authorised incinerators where VLLW may be received. In contrast, LLW is labelled as radioactive waste when it leaves the premises at which it has arisen, and it does not pass through waste sorting and handling stations used for conventional waste30.

7.6. Potential exposure scenarios for workers from VLLW and LLW disposals are direct radiation exposure from standing close to waste items containing gamma-emitting radionuclides, and internal exposure from inhalation and ingestion of dust created by site operations. Some radioactive gases may also be inhaled by workers at a landfill site. These gases are produced from biodegradable wastes containing certain radioisotopes, in particular tritium (H-3) and carbon-14. The radioactive gas, radon, may also diffuse from a landfill site, and be inhaled by workers. Radon gas is part of the natural decay chains of uranium and thorium. Small quantities of uranium and thorium, and their daughter products may be present in some radioactive waste.

## Potential exposure of the public

7.7. Members of the public may be exposed to very small amounts of radiation because of the operation of incinerators and landfill sites that dispose of VLLW and/or LLW (see figure 1). Combustion of the waste at an incinerator results in some of the radioactivity being emitted as gases (called incinerator flue gases). Air pollution from incinerator gases, including some radionuclides, is reduced by passing them through cleaning systems (called scrubbers). These scrubbers remove most radionuclides. However, the most volatile radionuclides are not removed and are dispersed into the environment via the incinerator stacks. Very small amounts of discharged radionuclides may then be breathed in, or may be deposited onto the surface of water bodies used as drinking supplies, and onto fields and crops and hence enter the foodchain. The least volatile of the radionuclides mostly remain in the ash left behind after combustion, or are retained by the cleaning systems.

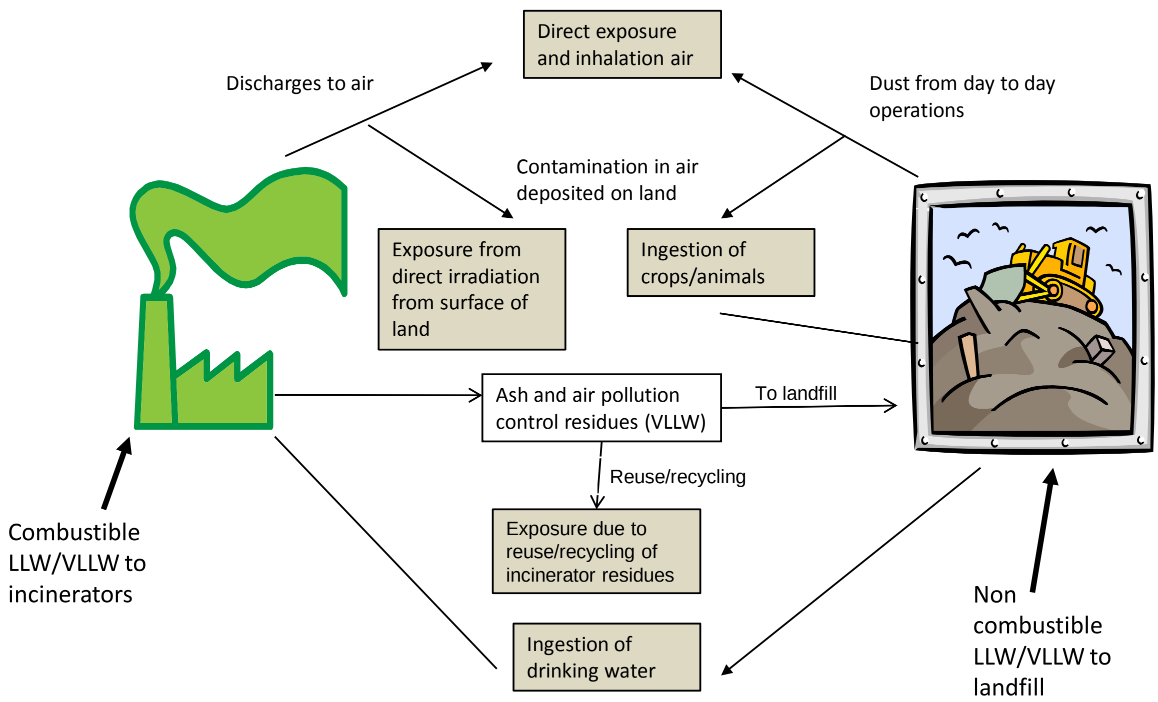
7.8. Most disposal of ash and the residues arising from the cleaning systems or air pollution controls (lime, bicarbonate and sludge) is to landfill. Once the waste is in a landfill, potential exposure scenarios for members of the public are similar to those arising from direct disposal of VLLW and LLW to landfill. These exposures may occur both at the time of waste disposal, and later, including the period after the site has closed and any barriers between the waste and the environment have deteriorated. At landfills, the key

[30] Exposure of workers to ionising radiation (in this context, LLW) is regulated by the Health and Safety Executive.

engineered barriers are the liner and the cap. The liner delays the movement of leachate from the site, and hence allows time for degradation of the initial wastes. Once a landfill liner has started to degrade (a process that takes many years), it may result in leachate reaching groundwater. Leachate could also discharge to a spring, river or lake. Degradation of a landfill cap may not lead directly to exposure, but will allow more water to infiltrate into the facility and then potentially overflow into the surrounding soils. Once a landfill has ceased to be under control, at some time in the future the cap and the underlying waste could theoretically be excavated by people who are unaware of the existence of the landfill. Potential exposure scenarios from such "inadvertent excavation" could therefore be similar to those considered during the operation and closure of a known site.

7.9. It is also feasible that very small doses of radiation may be received as a result of some VLLW ending up in reused or recycled materials, for examples plastics, or building materials that include some incinerator residues.

Figure 1: disposal of solid LLW and VLLW, and potential exposure scenarios



## The calculation of radiation doses from potential exposure scenarios[31]

7.10. Predictive models are used to assess potential exposure scenarios resulting from disposal practices (for further information on the modelling of doses from solid radioactive waste disposal to landfills and incinerators, see Ref. 13 & 26)32,33. In the case of discharges into the air from incinerators, the models are used to calculate the concentration of radioactivity in air, and deposition on land, as a function of distance from the stack. This enables calculation of potential exposures from inhaling the air, and from consuming contaminated food and water. In the case of landfill disposals, the models are used to calculate the amount of radioactivity that may arise in evolved gas and leachate as a function of time, and then, in the case of leachate, the concentrations in potential drinking water or food. The models have been developed over many years, using data from both environmental and laboratory studies.

7.11. The environmental models are set up to take account of how much radioactivity present in the original waste is likely to reach the environment. Many of the radionuclides present in non-nuclear low volume VLLW and LLW are of short half life (see examples in table 7) and will have decayed away to negligible levels well before material containing it reaches the environment. The models also include data on the behaviour in the environment of each element, because this affects how soon, and how much radioactivity might end up in air, on the land, in drinking water, and in different types of food (called the foodchain).

7.12. Once theoretical concentrations of radioactivity have been calculated for the surface of land, in air, and in drinking water and food, assumptions are made about the habits of potentially exposed people (i.e. where they spend their time in relation to contaminated land, and air, and how much locally grown food and water they consume). These assumptions are based on the selection of conservative data from surveys of the habits of real people. That is, it is assumed that potentially exposed people will have well above-average occupancies of contaminated land, and consumption rates for food and water.

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[31] The Environment Agency is currently reviewing methods of calculating radiation doses from the incineration of radioactive waste, and will be obtaining information on the volume and radionuclide content of the waste, and associated incineration practices. The project is expected to be completed in the autumn of 2010. Specifically, the project aims to: derive improved parameters for calculation of doses arising from radioactive substances disposed of via incineration; review partitioning and abatement factors in incinerators and perform more realistic dose calculations of doses arising from radioactive substances disposed of via incineration.

[32] For information on the assessment of doses from gaseous and aquatic discharges from non-nuclear sites, see http://www.ndawg.org/non_nuclear.htm

[33] See also Ref. 12 for advice from the HPA on radiological protection objectives for the land-based disposal of solid radioactive wastes

**Table 7: Examples of radioisotopes found in waste arising from the non-nuclear industry**

(A = of artificial origin; N = of natural origin)

| Radionuclide | Origin | Half life | Type of emitted radioactivity |
|---|---|---|---|
| Americium-241 | A | 458 years | Alpha particles and gamma rays |
| Caesium-137 | A | 30 years | Beta particles and gamma rays |
| Calcium-45 | A | 165 days | Beta particles |
| Carbon-14 | A+N | 5760 years | Beta particle |
| Chromium-51 | A | 27.8 days | Gamma rays |
| Cobalt-60 | A | 5.26 years | Beta particle and gamma rays |
| Fluorine-18 | A | 110 minutes | Gamma rays |
| Indium-111 | A | 2.8 days | Gamma rays |
| Iodine-123 | A | 13 hours | Gamma rays |
| Iodine-125 | A | 60 days | Gamma rays |
| Iodine-131 | A | 8 days | Beta particles and gamma rays |
| Iron-55 | A | 2.7 years | Gamma rays |
| Lead-210 | N | 22.3 years | Beta particles and gamma rays |
| Phosphorous-32 | A | 14.3 days | Beta particle |
| Phosphorous-33 | A | 25 days | Beta particle |

| Radionuclide | Origin | Half life | Type of emitted radioactivity |
|---|---|---|---|
| Plutonium-241 | A | 14.4 years | Beta particle |
| Polonium-210 | N | 138 days | Alpha particle |
| Radium-226 | N | 1620 years | Alpha particles and gamma rays |
| Radium-228 | N | 5.75 years | Beta particle |
| Radon-222 (gas) | N | 4 days | Alpha particle and gamma rays |
| Rubidium-86 | A | 18.7 years | Beta particles and gamma rays |
| Strontium-89 | A | 51 days | Beta particles |
| Sulphur-35 | A | 87 days | Beta particle |
| Technetium-99m | A | 6 hours | Gamma rays |
| Thallium-201 | A | 73 hours | Gamma rays |
| Thorium-232 | N | 14 billion years | Alpha particles |
| Tritium (H-3) | A+N | 12.26 years | Beta particle |
| Uranium-238 | N | 4.5 billion years | Alpha particles |
| Yttrium-90 | A | 64 hours | Beta particle |

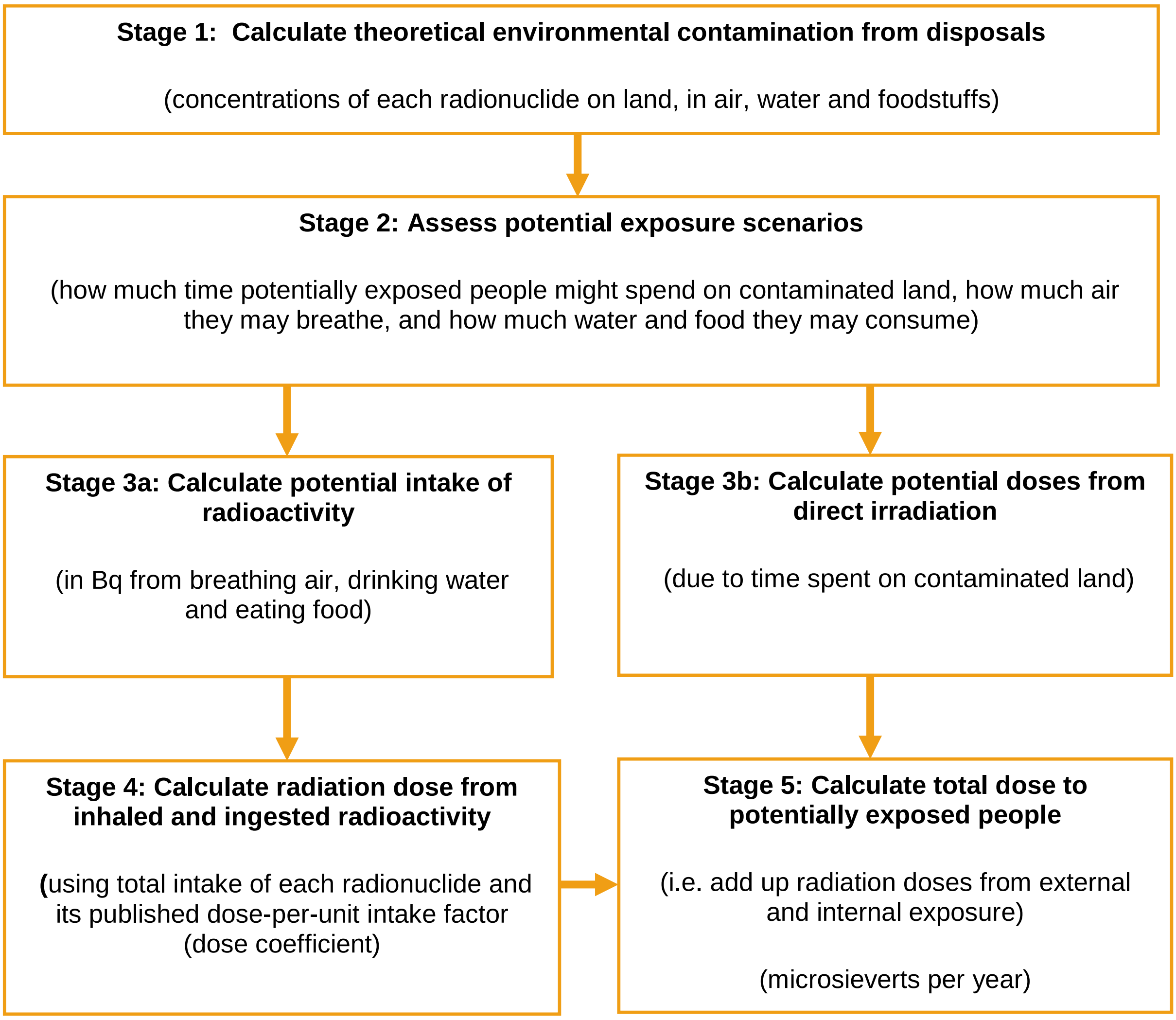
7.13. The dose from inhaled and/or ingested radioactivity is calculated using factors called dose coefficients; in effect these are factors which express radiation dose (in sieverts, Sv) per unit intake (in becquerels, Bq). Dose coefficients for each radionuclide take account of the type of emitted radiation, its half life and its behaviour in the body (where it goes and how long it stays), and are age-specific. Dose coefficients for different radionuclides therefore can have very different values, for example, for polonium-210 (an alpha emitter) , it is nearly 9 microsieverts per Bq ingested (i.e. 8.8x10-6 Sv per Bq) in the case of a one-year old child, whilst for tritium (H-3 - a soft beta emitter ), the dose coefficient is around half a million times less (i.e. 1.8x10-11 Sv per Bq) if ingested as tritiated water by an adult. These data are derived from a large body of experimental data, and are reviewed and revised from time to time by international experts, as new information becomes available. The lists within the BSS Directive 96/29/Euratom are mainly used in the UK, and these in turn are based on values published by ICRP.

7.14. As well as incorporating conservative assumptions regarding people's habits, the models used to estimate potential radiation doses to workers and members of the public from VLLW and LLW are based on maximum radioactive inventories of the waste that are disposed. For example, in estimating annual doses from landfilling of VLLW, it is assumed that each radionuclide that could be present in VLLW, is at the maximum amount allowed within the definition of VLLW. Also, the potential doses from a landfill containing VLLW are assessed assuming all the VLLW produced in the UK per year is sent to a single landfill. In reality, the VLLW from across the UK is distributed to a number of landfill sites. Box 10 summarises the steps involved in carrying out a dose assessment from radioactive waste disposals.

## Controlled burial (special precautions burial) of Low Level Waste

7.15. LLW from non-nuclear industries may be disposed of to landfills, along with other non-radioactive waste, under environmental permits issued by the environment agencies. These environmental permits differ from those for VLLW because they stipulate additional conditions for disposal. The designation of landfills suitable for LLW is based on the concept of radiological capacity, that is, how much radioactivity can be consigned to a landfill such that radiation doses to people are very unlikely to exceed a dose of 20 microsieverts per year (the latter is called a dose constraint, on the basis that the environment agencies regard the practice of landfilling such material to be constrained by this level of dose). In this approach, instead of calculating the dose from an assumed amount of radioactivity present in a landfill site, a "back calculation" is undertaken, in which peak doses to workers and the public from a wide range of potential exposure scenarios are compared with the dose constraint, and then disposal limits for categories of different radionuclides are derived (Ref. 26). To ensure that the radiological capacity of such a landfill is not exceeded, one of the environmental permit conditions is that records should be kept by the landfill operator, of what LLW has already been received by the site. The methodology for calculating radiological capacities includes assumptions about other potential disposals of radioactivity to the site being assessed, in particular from wastes that are exempt from the requirements of an authorisation, and VLLW (which may go to an unspecified landfill).

**Box 10: Modelling radiation doses from radioactive waste disposals**




NB: Due to the conservatisms built into the models, it is highly unlikely that people actually receive the assessed doses. It is also unlikely that all the possible exposure pathways would apply to a single group of people.

7.16. The latest assessments of worker and public doses from LLW and VLLW disposal to incinerators and to landfill are all less than 20 microsieverts (see table 10 for assessments of dose from different disposal practices).

7.17. The risks associated with the disposal of VLLW from the non-nuclear industry (excluding the oil and gas sectors) have recently been reviewed by SNIFFER (Ref. 13)[34]. As a consequence of this review, SNIFFER has concluded that “current practices of

[34] The objectives of this SNIFFER study were to establish whether current practices of VLLW management and disposal remain acceptable, and to provide guidance on any necessary revisions to the conditions of authorisation governing VLLW disposal.

management and disposal of VLLW from the non-nuclear sector remain acceptable, and that the increasing occurrence of waste segregation and recycling does not appear to be significant in terms of radiological safety...".

## Environmental monitoring around landfills taking solid radioactive waste

7.18. Regular UK-wide monitoring of food and the environment for radioactivity is conducted by the Food Standards Agency and the environmental regulators, and the results reported annually in the "RIFE" reports (Radioactivity in Food and the Environment, the latest being RIFE 13, containing data for 2007 – Ref. 29). The bulk of the monitoring is related to discharges from the nuclear industry, including the environment around the LLWR near Drigg. Leachate and water from boreholes are also monitored at a number of landfill sites known to have accepted (or still be accepting) solid radioactive waste, both as controlled burials and as VLLW as part of conventional waste. The sites are named and displayed on a map of the UK in the RIFE report and data are presented (Bq per litre) for a range of artificial and natural radionuclides. Most results are beneath limits of detection, and in 2007, the programme of monitoring landfill sites in England and Wales was reduced significantly because data from the previous, larger programme, collected over many years, showed that any enhancements in concentrations were predictable and gave rise to doses of very low significance (for latest data on a number of landfills in England, Wales and Scotland, see ref 28; data in RIFE 13 are mainly from Scottish landfill sites). However, low levels of caesium-137 are found in some leachate and there is evidence for the migration of tritium at some sites. This is considered a "worst case" scenario and assumes an inadvertent consumption of 2.5 litres of leachate containing the highest concentration of tritium would result in a dose of less than 5 microsieverts. Leachate is extremely unlikely to be drunk directly – it is discharged to streams and very quickly becomes highly diluted. Therefore consumption of drinking water which might have had some leachate discharged into original water sources is likely to result in extremely small doses. The RIFE reports also contain data on radioactivity levels in freshwater before its treatment and supply to the public water system. Levels of tritium and other radionuclides are well below EU and WHO screening values.

**Table 8: Summary of assessed radiation doses from management of LLW and VLLW from the non-nuclear industry**

| Type of disposal or practice | Assessed doses - microsieverts (μSv) per year |
|---|---|
| Handling of VLLW by workers | Doses to workers from handling wastes and working in close proximity to bulk wastes: maximum doses of just under 20Sμv/year from certain items of waste; around 0.2μSv/year from routine handling of waste items; around 0.08μSv/year from handling of bulk wastes (Ref. 14) |
| VLLW (primary) to landfill | Maximum dose to public: around 1μSv/year (ref 13) |
| VLLW for incineration (at non licensed[35] incinerator) | Maximum dose to public: in case of a medium sized incinerator, around 0.001μSv/year; and for a large incinerator to be significantly less than 20μSv/year (Ref. 14) |
| LLW to controlled burial | Maximum doses to workers and the public of 20 μSv/year, based on the concept of radiological capacity, and subsequent authorisation conditions. |
| LLW for incineration[36] (at licensed incinerator) | Doses to public from exposure to discharges from incineration (gaseous and aqueous) are less than 20μSv/ year. |
| VLLW management from operation of licensed incinerators – creating "secondary VLLW" | The SNIFFER 2007 report (Ref. 14) states that a single landfill could take approximately 3000 tonnes of secondary VLLW at the limit of activity for low volume VLLW (i.e. 400 kBq per 0.1 $m^3$) without calculated doses exceeding 20 μSv/year. |
| VLLW and LLW disposal from oil and gas sectors | Apart from the LLWR near Drigg in Cumbria, no landfill sites currently take VLLW or LLW NORM from the oil and gas industries[37]. Dose assessments from landfill disposals would need to be done on a site-specific basis. However, authorisations to dispose of the waste to landfill would only be permitted if the levels of predicted dose to members of the |

[35] "Licensed" in this table means under radioactive waste regulations.

[36] The Environment Agency is currently reviewing all aspects of dose assessment associated with the incineration of radioactive waste.

[37] NORM that is exempt from radioactive waste regulations may be landfilled without an associated environmental permit.

| Type of disposal or practice | Assessed doses - microsieverts (µSv) per year |
|---|---|
| | public met the regulators' dose constraint for this disposal route[38]. |

[38] The Environment Agency will not authorise disposals to landfills unless they are satisfied that any exposures will be beneath a dose constraint of 300 µSv per year. In most cases, they expect them to be no greater than 20 µSv per year.

# 8. Risks from radiation

## Health effects arising from a radiation dose

8.1. The main impact that a low level exposure to ionising radiation has on the health of an exposed person is the possibility of a small increase in the chance of that person developing cancer at some time, usually many years, in the future. The higher the level of dose that is received, the higher the level of increased risk of developing cancer. There is no direct evidence that very low levels of radiation cause cancer but evidence is available from higher levels of exposure.

8.2. This increased chance of developing cancer occurs because, when ionising radiation passes through living tissues, some of the energy carried by the radiation is lost to the tissue's cells and this energy may cause damage to the genetic material (DNA) within those cells. Cells have very effective mechanisms for the repair of DNA damage resulting from radiation exposure and other causes but some damage is more difficult to repair and sometimes mistakes occur, called mutations. Some mutations can result in changes in the characteristics of cells and set them on a path towards proliferation of cancer.

8.3. As well as the possibility of causing cancer in the exposed individual, it is biologically feasible that mutations to genetic material could be passed on to future generations (this is called a hereditary effect). However, there is no direct evidence of radiation-induced hereditary effects in humans and this genetic risk is judged to be much lower than that of cancer.

## Estimating risks from radiation doses

8.4. Radiation risk factors are used to relate the exposure to radiation (measured in Sv, see section 3 for explanatory information) to the additional risk of developing cancer and to the additional risk of dying from that cancer. An estimation of the level of risk per unit of dose received has been made by the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). This estimation is largely based on epidemiological studies of the Japanese atomic bomb survivors, supported by studies of other populations such as patients given medical exposures and workers receiving occupational exposures.

8.5. The atomic bomb studies in particular are concerned with medium to high dose and high dose rate exposures, while radiation protection of workers and the public is generally concerned with much lower doses and dose rates. At very low levels of dose the assumed increase in the risk of cancer is very small and impossible to detect in epidemiological studies, so it is not possible to determine whether there is a dose level below which no effects occur at all. However, current knowledge of biological mechanisms does not support a low dose threshold below which cancer risk can be discounted. Accordingly, to protect people as much as possible, it is commonly assumed that any level of exposure, however small, may cause harm, and that the relationship between risk and dose is linear, with the increased risk being proportional to the dose received. The International Commission on Radiological Protection (ICRP) made adjustments to the risk factor for high dose and high dose rates to allow for the lower doses and lower dose rates typical of occupational or environmental exposures, and this led to their recommendation (in 2007 – Ref. 5) that a fatal cancer risk from ionising radiation of 5% per Sv continued to be appropriate for radiation protection.

## Confidence in the value of the radiation risk factor

8.6. It is recognised that there are some unavoidable uncertainties in the calculation of the radiation risk factor, and that there are alternative views to those held by UNSCEAR and ICRP. However, based on the body of evidence that has been collected over a large number of years, including detailed, regular and recent reviews of biological and epidemiological data, the Health Protection Agency (HPA) has confidence that the radiation risk factors recommended by ICRP provide a sound basis for the protection system and standards which are applied in the UK and internationally.

## Levels of risk arising from disposal of non-nuclear industry radioactive waste

8.7. The doses from non-nuclear industry radioactive waste are presented in Table 10, and the highest level of dose given is 20 μSv (20 millionths of a sievert) per year to workers handling certain items of VLLW wastes (see Box 3 for definition of VLLW) and working in close proximity to bulk wastes. A rough estimate of the associated risk can be obtained by applying the ICRP risk factor of 5% per Sv, giving a risk of 10-6 or one in a million (0.0001%) of dying of cancer as a result of such exposure.

8.8. The current average risk of dying from cancer in the UK is one in four (25%) (Ref. 30). Therefore the total risk of dying of cancer rises to around 25.0001% for each worker handling the waste who is exposed to 20μSv annual radiation dose. Expressed differently, this estimate of risk indicates that if 1 million workers handled this waste and each received this dose, then only one worker would be expected to die of a corresponding radiation induced cancer, while about 250,000 naturally occurring cancer deaths would be expected. Such an increase is not detectable because of the normal variations in cancer incidence within populations.

## Comparison with other risks

8.9. When considering a risk in terms of a numerical value, it is important to be aware of what the term risk actually means. A numerical risk is a likelihood that something undesirable might happen as a result of a particular hazard. In this case radioactive waste is the hazard which leads to a risk that the people who receive a radiation dose from the management of the radioactive waste may develop or die from cancer.

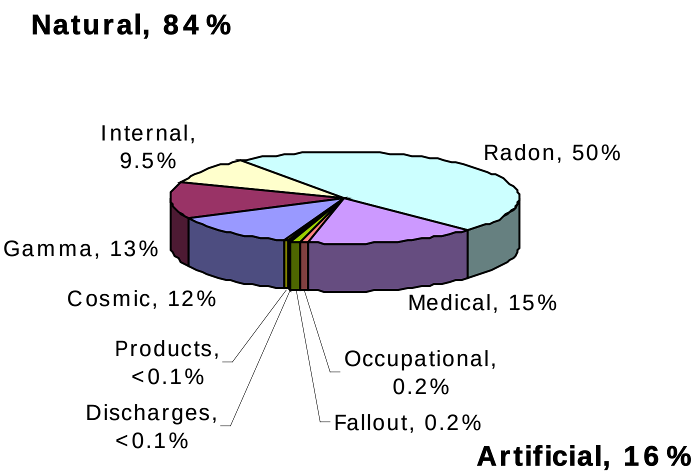
8.10. It is also important to compare the level of risk with other risks, to help give an idea of exactly how dangerous the hazard is. As indicated above, the risk of dying of cancer as a result of the highest estimated radiation dose arising from management of waste from the non-nuclear industry is estimated to be around one in a million (0.0001%). The Health and Safety Executive (HSE) have looked at levels of risk, and in particular have assessed tolerability and acceptability of different levels of risk (Ref. 31). They found that an additional level of risk of one in a million per year to a person is generally considered to be "acceptable", where an "acceptable" risk is one "that for purposes of life or work, we are prepared to take pretty well as it is" (Ref. 32).

8.11. With the average annual dose of 1.6 mSv from occupational exposure to radiation (Ref. 33) equating to a risk of 80 per million, it can be seen that the estimated one in a million maximum risk from management of waste from the non-nuclear industry is 80 times lower than the average occupational risk due to ionising radiation. The one in a million can also be compared to the 0.1% (1 in a thousand) risk associated with the 20 mSv (20 thousandths of a sievert) annual dose limit for employees working with radiation (Ref. 34). The estimated risk to workers involved in the management of waste from the non-nuclear industry is one thousand times lower than this limit. Even when compared with the lower risk associated with the maximum dose allowed for a member of the public in the UK (1 mSv per year) (Ref. 7), the maximum risk level associated with waste disposal from the non-nuclear industry is a factor of 50 lower than this public limit.

8.12. Other levels of risk that are often found helpful for comparison purposes are the projected annual risk from the average natural radiation dose in the UK (100 in a million) –and the annual risk of death from lightning (1 in 18.7 million) (Ref. 32).

8.13. The doses and risks from non-nuclear industry radioactive wastes can also be put into context by considering the average annual dose of radiation received by people in the UK. The average annual dose of 2.7 mSv is made up of naturally occurring and artificial radiation sources, as shown in Figure 2. Thus the 20 µSv per year discussed above equates to 0.75% of the average annual dose of 2.6 mSv.

**Figure 2 - breakdown of the average annual dose of ionising radiation received in the UK**



## Protection of the environment and habitats

8.14. Until recently, radiation protection philosophy has been based on the premise that if humans are adequately protected, then the natural environment will also be protected. However, the Water Framework Directive and the Habitats Directive have been the driving force behind recent work by the Environment Agency and SEPA to consider the potential effects of anthropogenic radioactivity (i.e. radioactivity derived from human activities) on wildlife. The agencies have concluded there was little risk to wildlife inhabiting Natura 2000 sites[39] from the permitted discharges of radioactive substances from nuclear and non-nuclear sites to the environment (Ref. 35)[40]. Further work by the Environment Agency has considered risk to Natura 2000 sites from radioactive discharges within England and Wales (Ref. 36). Screening assessments have been made to identify those Natura 2000 sites which may be affected by permitted releases of pollutants and thus require a more detailed assessment. These assessments have now been undertaken for all Natura 2000 sites in England and Wales. Only one site in England and Wales (the Ribble and Alt Estuary Natura 2000 site) has required further attention. In this case, radionuclides released from a nuclear licensed site were identified as the dominant source of exposure but from January 2008 their permitted releases were reduced due to changes in operational practice on site. A reassessment of the Natura 2000 site was undertaken at these new discharge limits and has shown the potential impact is now at a level that the Environment Agency can be confident will have no adverse impact on the Natura 2000 site.

## Sustainability Appraisal

8.15. Early on in its work, the programme board considered the need to undertake a Strategic Environmental Assessment (SEA). On the grounds of very low risks to health from non-nuclear industry disposals, but more particularly because the board would produce a high level strategy and not one based on specific disposal sites, advice from SEA experts was that the requirements for SEA would not apply. However, the process of undertaking some aspects of a sustainability appraisal (SA) of the strategy was thought to be of value. For this reason, a scoping report on SA for the strategy (Ref. 3) was developed and consulted on from 9 January - 13 February 2009. This report included:

- The identification of other plans and programmes of relevance to the strategy;
- The development of sustainability themes and their relationship to draft SA objectives;
- Baseline information and associated UK maps on:

[39] A Natura 2000 site is a protected ecological area within the European Union containing threatened habitats and/or species. Previously established Special Protection Areas (SPAs) for Birds and Special Areas of Conservation (SACs) for other species make up the Natura 2000 network of protected sites.

[40] This report states: Given the cautious assumptions adopted, the results of this assessment of discharges from non nuclear sites to water bodies suggests there is no significant risk of exceeding screening levels arising from non nuclear discharges". In the report, the regulators proposed screening levels for each radionuclide, such that if concentrations of a radionuclide in the water were less than this value, there would be an insignificant effect on wildlife within the water course.

- Current and predicted conventional waste arisings and disposal capacity by region;
- A spatial analysis of data from the Atkins project in terms of waste planning authorities;
- A summary of health and environmental impacts of LLW waste transport and disposal;
- An analysis of disposal facilities currently available to take LLW, mostly identified from the Atkins project;
- Identification of key sustainability issues and implications and opportunities for the strategy;
- Development of draft objectives and indicators.

8.16. Thirteen responses were received to the scoping report consultation. These were analysed and are reported on separately.

8.17. As it had been determined that SEA/SA were not requirements for the non-nuclear industry waste strategy, further work on the SA in line with statutory procedures was not thought to be justified. Nonetheless, the process has been useful in considering the strategy, and key SA issues identified in the scoping report have been cross-referenced to items in the strategy in appendix 2. The indicators developed under the SA objectives will also be valuable for any future review of the strategy.

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# 10. Glossary

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| **Activity** | The number of atoms of a radioactive substance which decay by nuclear disintegration each second. The unit of activity is the Becquerel (Bq) which is equivalent to one disintegration per second. |
| **Air pollution control residues (APCR)** | During incineration, the emissions are cleaned using various systems (scrubbers) before being finally discharged to the atmosphere. The cleaning systems result in residues which require disposal (or some may be recycled into other materials). See also ash, lime and sludge. |
| **As Low As Reasonably Achievable (ALARA)** | The ALARA principle is contained in the European Basic Safety Standards Directive 96/29, which is transposed into UK law. Essentially, it requires that all reasonable steps should be taken to protect people and the environment. In making this judgement, factors such as the costs involved in taking protection measures are weighed up against benefits obtained, including the reduction in risks to people and the environment. |
| **Alpha radiation** | Alpha radiation takes the form of particles (helium nuclei) ejected from some decaying (radioactive) atoms. Alpha particles cause ionisations in biological tissue which may lead to damage. The particles have a very short range in air (typically about 5cm) and if present in materials |

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| **Becquerel (Bq)** | The standard international unit of radioactivity equal to one radioactive transformation per second. LLW and VLLW are classified according to their radioactive content per unit mass. Multiples of becquerels commonly used in quantifying radioactive waste are: kilobecquerel (kBq) equal to one thousand Bq and megabecquerel (MBq) equal to one million Bq. |
| **Best Available Technique (BAT)** | BAT is defined (using the definition in article 2 of the PPC Directive) as the most effective and advanced stage in the development of activities and their methods of operation, which indicates the practical suitability of particular techniques for providing, in principle, the basis for emission limit values designed to prevent and where that is not practicable, generally to reduce emissions and impact on the environment as a whole. |
| **Best Practicable Means (BPM)** | BPM is a term used by the environment regulators (agencies) in authorisations issued under EPR 2010. It requires operators to take all reasonably practicable measures in the design and operational management of their facilities to minimise discharges and disposal of radioactive waste, so as to achieve a high standard of protection for the public and the environment. BPM takes account of factors such as the availability and cost of relevant measures, operator safety and the benefits of reduced discharges and disposals. If the operator is using BPM, radiation risks to the public and the environment will be As Low As Reasonably Achievable (ALARA). |
| **Beta radiation** | Beta radiation takes the form of particles (electrons) emitted from the nucleus of some decaying (radioactive) atoms. Beta particles cause ionisations in biological tissue which may lead to damage. Most beta particles can pass through the skin and penetrate the body, but a few millimetres of light materials, such as aluminium, will generally shield against them. |
| **Beta/gamma radiation** | Beta radiation is usually accompanied by the emission of gamma rays, hence the term “beta/gamma activity”. |
| **Clinical waste** | A special type of directive waste that must be disposed of to certain types of facility (usually incinerators). |
| **Contaminated land** | In this report, contaminated land refers to radioactive contaminated land. It is a special case of land that is determined as Contaminated Land under Part 2A of the Environmental Protection Act 1990 as it is causing harm or |

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| | there is a significant possibility of such harm being caused. Harm is defined as "lasting exposure resulting from the after effects of a radiological emergency, part practice or past work activity". |
| **Controlled burial (also known as special precautions burial in Scotland)** | A process for disposal for solid LLW that has an activity level above that which would allow it to be disposed of as VLLW. Controlled burial takes place at landfill sites used for the deposit of substantial quantities of non-radioactive waste but which are approved for the disposal of radioactive substances. Controlled burial has various limitations placed on its use in terms of maximum activity per waste container, type of container, surface dose rate of container, and depth of burial beneath earth or non-radioactive waste. |
| **Directive waste** | Defined in the Environmental Protection Act 1990 as waste arising from household (municipal), industrial and commercial premises. Ultimate disposal is via landfill and incineration. |
| **Decay chains** | These generally refer to the three naturally occurring series of radionuclides, all of which start with a single parent (uranium-238, uranium-235 and thorium-232) each of which decays via a number of radioactive daughters of different half-lives, eventually ending with stable nuclides of lead. |
| **Decay Storage** | The process of allowing material containing short-lived radionuclides to decay so that the final waste is easier to dispose of as radioactive waste, or until the point where the waste becomes exempt from specific regulatory requirements. Used extensively in hospitals and research establishments, and to some extent by the nuclear industry. |
| **Disposal** | In the context of solid waste, disposal is the emplacement of waste in a suitable facility without intent to retrieve it at a later date; retrieval may be possible but, if intended, the appropriate term is storage. Disposal may also refer to the release of airborne or liquid wastes to the environment (e.g. emissions and discharges). |
| **Dose constraint** | When a practice involving ionising radiation is being planned, a level of dose is often set to restrict future doses that might be received from that practice. This level of dose is called a dose constraint, and will differ depending on the practice being planned. Dose constraints are less than the legal dose limit. |

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| **Dose limit** | Dose limits are maximum levels of radiation dose per year which are laid down in UK Law. For members of the public, the dose limit is 1 millisievert per year. Dose limits apply to all non-medical practices which involve a risk from ionising radiation coming from an artificial source, or from a natural radiation source in cases where natural radionuclides are, or have been, processed because of their radioactive, fissile or fertile properties. Different dose limits apply to workers. |
| **Environment Agency (EA)** | The environmental regulator for England and Wales. The Environment Agency's role is the enforcement of specified laws and regulations aimed at protecting the environment, in the context of sustainable development, predominantly by authorising and controlling radioactive discharges and waste disposal to air, water (surface water, groundwater) and land. In addition to permits under EPR 2010, the EA also regulates nuclear sites under the Pollution Prevention and Control Regulations and issues consents for non-radioactive discharges. |
| **Environmental Permitting Regulations 2010** | In England and Wales, these have replaced a suite of current environmental legislation which includes the Radioactive Substances Act 1993. |
| **Exemption Orders (EO)** | The radioactive waste regulations make provision for certain low activity wastes, when used for certain purposes and when managed in particular ways, to be excluded from particular regulatory provisions made under the regulations. |
| **Gamma radiation** | An electromagnetic radiation similar in some respects to visible light but with higher energy. Gamma rays cause ionisations in biological tissue which may lead to damage. Gamma rays are very penetrating and are attenuated only by shields of dense metal or concrete, perhaps some metres thick, depending on their energy. Their emission from a radionuclide during radioactive decay is usually accompanied by particle emissions (beta or alpha particles). |
| **Half life** | The time required for one half of the atoms of a given amount of a particular radionuclide to disintegrate through radioactive decay. Each radionuclide has a unique half-life and half-lives |

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| **Hazardous waste** | A special type of directive waste that must be disposed of to certain types of facility (usually special landfills). |
| **Ionising radiation** | When radiation (alpha or beta particles and gamma rays) interacts with matter, it can cause atoms and molecules to become unstable (creating ions). This process is called ionisation and alpha and beta particles and gamma rays are often referred to collectively as ionising radiation. Ionisation within biological tissue is the first stage in radiation leading to possible change or damage within the tissue. |
| **International Commission on Radiological Protection (ICRP)** | An advisory body founded in 1928 providing recommendations and guidance on radiation protection. ICRP recommendations normally form the basis for EU and UK radiation protection standards. |
| **Labelling of chemicals (with radioisotopes)** | See Radioactively labelled tracers. |
| **Leachate** | Liquid that has seeped through a landfill (waste disposal) site, and which contains a variety of soluble constituents of the waste. |
| **Lime (in the context of incineration)** | Lime is used to neutralise acidic gases present in emissions. Reacted lime is part of an incinerator's air pollution control residues (along with ash and sludges), and is sometimes reused or recycled in the chemicals industry. |
| **Low Level Waste (LLW)** | Covers a variety of materials which arise principally as lightly contaminated miscellaneous scrap and redundant equipment from both the nuclear and non-nuclear industries. Organic materials in LLW are mainly in the form of paper towels, clothing and laboratory equipment that have been used in areas where radioactive materials are used – such as hospitals, research establishments and industry. See box 2 for formal definition of LLW. Both waste producers and sites accepting LLW as controlled burials have to have permits under the radioactive waste regulations, although this requirement on waste facility operators has only applied recently, as a consequence of the Government's new policy statement on the management of LLW. |
| **Low Level Waste** | A facility taking only LLW. The UK's only LLWR is currently near Drigg in Cumbria, which has operated as a national LLW |

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| **Repository (LLWR)** | disposal facility since 1959. Wastes are compacted and placed in containers before being transferred to the facility. Following a major upgrade of disposal operations in 1995, all LLW is now disposed of in engineered concrete vaults. The LLWR near Drigg is owned by the Nuclear Decommissioning Authority and currently managed by UK Nuclear Waste Management Ltd. |
| **Microsievert** | One millionth of a sievert (see sievert) |
| **Natura 2000** | A Natura 2000 site is a protected ecological area within the European Union containing threatened habitats and/or species. Previously established Special Protection Areas (SPAs) for Birds and Special Areas of Conservation (SACs) for other species make up the Natura 2000 network of protected sites. |
| **Non- nuclear industry** | A collective term for a wide range of organisations that handle radioactivity for specific purposes, and/or that create radioactive waste as a result of their operations, as a consequence of which they are required to be registered or authorised under the RSA 93/ EPR 2010. The non-nuclear industry is distinguished from the nuclear industry by the fact that the latter covers industries involved with nuclear energy, the production of nuclear weapons and large scale radioisotope production. The nuclear industry is subject to additional regulation. |
| **NORM** | Naturally occurring radioactive material arising principally from the oil and gas industries. |
| **NORM wastes** | Radioactive waste produced by organisations as a by-product of their processing of material containing natural radioactivity. |
| **Nuclear Decommissioning Authority (NDA)** | The NDA was set-up on 1 April 2005, under the Energy Act 2004. It is a non-departmental public body with designated responsibility for managing the liabilities at specific sites. These sites are operated under contract by site licensee companies. Its sponsoring Government department is the Department of Energy and Climate Change (DECC) which approves its strategy, plans and budget. The NDA also reports to the Scottish Ministers who agree its strategy and plans for Scottish sites. |
| **Nuclear medicine** | The use of radioisotopes and radioactivity in the diagnosis and treatment of diseases. |

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| **Radioactive decay** | The process by which a radionuclide undergoes transformation with the emission of ionising radiation (see also half life). |
| **Radioactive Substances Act 1993 (RSA 93)** | Legislation used in Scotland and Northern Ireland which provides for regulation of the disposal of radioactive wastes, including liquid and gaseous discharges to the environment and provided for the regulation of the accumulation of radioactive wastes on non-nuclear sites (see also Environmental Permitting Regulations 2010). |
| **Radioactively labelled tracers** | Chemicals in which some stable atoms are replaced by (i.e. labelled with) radioisotopes. The radioactive decay of the radioisotopes then allows chemical and biological reactions involving the tracer to be followed. |
| **Radioisotope** | Different radioactive forms of the same element, for example phosphorous-32 and phosphorous-33 arei a diul exo58d-6.15 0.004ol sn[( |

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| | radioactive discharges and waste disposal to air, water (surface water, groundwater) and land. In addition to authorisations issues under the RSA 93, SEPA also regulates nuclear sites under the Pollution Prevention and Control Regulations and issues consents for non-radioactive discharges. |
| **Sievert (Sv)** | (See also Box 1) A unit of radiation dose to living tissue, equal to 1 joule per kilogram (which is a measure of energy lost as radiation passes through matter). It is a very large unit, and sub multiples of the Sv are more commonly used, for example:<br>• the microsievert is one millionth of a Sv, or<br>• the millisievert is one thousandth of a Sv. |
| **Sludge (in the context of incineration)** | Incinerator gases are usually passed through sprays (wet scrubbers) as part of the air pollution control systems. Very small sized particles are removed by this process and are then passed as suspensions through waste treatment plant which concentrate these particulates into sludges. Sludges are therefore part of the incinerator's air pollution control residues, along with ash and residues from gas neutralisation (see lime). |
| **Small Users' Liaison Group (SULG)** | An Environment-Agency run group of non-nuclear industry representatives that meets approximately twice a year. HSE and DECC are also on the membership. SULG's objectives are to provide: a forum for effective liaison, communication and consultation between non-nuclear users of radioactive substances and the EA; an improved understanding of EA and Users' objectives, priorities and constraints in respect of the management of radioactive waste, with the aim of improving both the clarity and consistency of regulation. |
| **Strategic Environmental Assessment (SEA)** | In this document, SEA refers to the type of environmental assessment legally required by EC Directive 2001/42/EC in the preparation of certain plans and programmes. The authority responsible for the plan or programme must prepare an environmental report on its likely significant effects, consult the public on the report and the plan or programme proposals, take the findings into account, and provide information on the plan or programme as finally adopted. |
| **SNIFFER** | Scotland and Northern Ireland Forum for Environmental Research. A limited company and registered charity which organises and publishes research on behalf of its members. Recent publications relating to radioactive waste have covered |

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| | arisings from the oil and gas industries (UKRSR07), controlled burial of LLW at landfills (UKRSR03), and a review of the management of VLLW (UKRSR09)<br><br>See www.sniffer.org.uk |
| **Sustainability Appraisal (SA)** | A form of assessment used in England covering the social, environmental and economic effects of proposed plans and appraising them in relation to the aims of sustainable development. SAs fully incorporating the requirements of the SEA Directive (2001/42/EC) are mandatory for a range of regional and local planning documents under the Planning and Compulsory Purchase Act 2004. |
| **Tracer** | See radioactively labelled tracers (Box 5) |
| **Tritiated water** | Tritium (H-3) is the radioisotope of the element hydrogen. It can replace hydrogen atoms in molecules, which then become "tritiated". If the molecule is water, this is then called tritiated water. |
| **UNSCEAR** | The United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) is an expert body that assesses the consequences to human health of a wide range of doses to ionising radiation and estimates the dose to people all over the world from natural and man-made radiation sources. It presents its reports and scientific annexes to the General Assembly of the United Nations. |
| **Very Low Level Waste (VLLW)** | Covers miscellaneous waste arising from both the nuclear and non-nuclear industries with very low concentrations of radioactivity. VLLW is divided into two types: low volume VLLW and high volume VLLW (see Box 2 for formal definitions of low volume VLLW and high volume VLLW). VLLW producers must hold environmental permits under the EPR 2010/ RSA 93. Depending on its physical form, low volume VLLW is incinerated or disposed of to landfill, and neither type of facility has to hold an environmental permit. However, high volume VLLW will need to go to landfills that do hold environmental permits under EPR 2010/ RSA 93. |

# Appendix 1:

## Membership and terms of reference of the Non-Nuclear Industry Waste Strategy Programme Board

**Chairmen**: Robert Jackson (Defra) from June 2007 to April 2008; Steve Chandler (Defra/DECC) from April 2008.

**Technical Secretariat**: Katherine Mondon (up to December 2009), Hannah Manson (from January 2010 )and Allan Ashworth (Atkins Ltd).

**Defra/DECC Secretariat**: Sophie Shepherd (up to April 2008), Stephen Allen (up to December 2009) and Sam Bains from January 2010.

| Members | |
|---|---|
| Arkins, Gerry | Department of the Environment, Northern Ireland |
| Borwell, Mick | Oil and Gas UK |
| Cairns, Bruce | Department of Energy and Climate Change |
| Chandler, Steve | (Chairman) Department of Energy and Climate Change |
| Fisher, Joanne | Nuclear Decommissioning Authority |
| Goan, Kate | Scottish Non-Nuclear Industry Liaison Group |
| Greedy, Derek | West Midlands Regional Technical Advisory Body |
| Linksey, Diana | Department of the Environment, Food and Rural Affairs |
| Marsden, Peter | Small Users Liaison Group |
| McNulty, Greg | Huntsman (NORM Industries) |

| Members | |
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| Murfin, Rob | English Regional Technical Advisory Bodies |
| Plummer, Mark | Department for Communities and Local Government |
| Regnier, Tony | OED DECC |
| Russ, Bob | Environment Agency |
| Stackhouse, Adam | Scottish Environment Protection Agency |
| Williams, Robert | Welsh Assembly Government |
| Young, Ewan | Scottish Government |

## Terms of reference

The principal objective of the Board was to develop and recommend to Government a Non-Nuclear Industry Waste Strategy for the whole of the UK. The work of the Board covered one-off targeted data collection across the UK from the non-nuclear industry, with the subsequent development of an initial non-nuclear industry waste strategy. The board was also asked to recommend work to improve routine data inputs to the regulators from the non-nuclear industry. Further updates to the strategy that might be required from time-to-time, were outside the scope of the work of the board.

During its work, the Board would liaise with organisations that were likely to be most affected by the strategy – that is the non-nuclear industry, waste disposal facility operators, the Nuclear Decommissioning Authority and local authorities. These bodies would be included in a consultation on a scoping report for sustainability appraisal of the strategy. This intermediate consultation would be followed by a public consultation on the strategy.

## Success criteria

Success criteria and how they would be assessed were as follows:

1. Improved understanding of the problems faced by the non-nuclear industry in dealing with their arisings – assessed from contractor's report on collection of data from the non-nuclear industry;
2. Broad support for the strategy during the public consultation;
3. Inclusion of requirements identified in the non-nuclear industry waste strategy within local authority planning frameworks – assessed by feedback from the Department for

Communities and Local Government (DCLG) in the case of England, and the devolved administrations in the cases of Wales, Scotland and Northern Ireland;

4. A range of identified disposal facilities across the UK that can (or could, in the case of planned facilities) also take non-nuclear industry wastes e.g. regional incinerators and local landfills – assessed by feedback from users and individual EA and SEPA inspectors that these disposals are adequately catered for;
5. An overall reduction of “waste miles” compared to the current position – assessed by data gathered from the non-nuclear industry;
6. Clarity for the non-nuclear industry, environment agencies and local authorities as to what facilities are available for what sorts of wastes – assessed in terms of production of guidance.

# Appendix 2:

## Cross referencing of key issues and implications and opportunities for the strategy, identified in the scoping report on sustainability (ref 3, 3a) to the non-nuclear waste strategy

| Key issue from table 4.1 in SA Scoping report | Implications and opportunities for strategy from table 4.1 | Relevant aspects of the strategy |
|---|---|---|
| 1. Changes in activities, amounts and sectoral distribution of non-nuclear LLW/VLLW | Strategy should:<br>a) encourage waste generators to minimise LLW and VLLW arisings;<br>b) help identify disposal routes for future arisings | a) See para 139<br>b) See paras 17-20 |
| 2. Lack of information on LLW and VLLW arisings | Strategy should:<br>involve and be informed by data collection on waste arisings. | See Chapter 4 |
| 3. Limited capacity and uncertain future of LLWR near Drigg | Strategy should:<br>encourage waste generators to minimise LLW arisings and seek disposal routes other than the LLW near Drigg to relieve pressure on it. | See paras 139-143 |
| 4. Limited opportunities for LLW and VLLW landfilling | Strategy should:<br>a) identify UK requirement for non-nuclear industry LLW disposal and key areas where there are constraints;<br>b) help ensure fuller integration of LLW disposal considerations in WPAs plans;<br>c) help reverse the decline in landfills accepting LLW. | a) see para 133<br>b) see section 7.3.<br>c) see sections 7.3 and 7.4 |
| 5. Barriers to LLW and VLLW incineration | Strategy should:<br>promote use of incineration as one of the means of managing radioactive waste, especially for waste not suitable for disposal to landfill. | Strategy does not directly 'promote' incineration, but rather sets out that BPM arguments should apply, and incineration is not precluded. |

| Key issue from table 4.1 in SA Scoping report | Implications and opportunities for strategy from table 4.1 | Relevant aspects of the strategy |
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| 6. Lack of certainty regarding options NORM waste disposal | Strategy should:<br><br>a) help facilitate the identification of feasible disposal options for NORM;<br><br>b) help increase access to landfill sites for NORM. | See paras 52-54 and 206 |
| 7. Disincentives to dispose of LLW locally, resulting in increasing transportation | Strategy should:<br><br>a) encourage engagement and consultation with the public;<br><br>b) help promote proximity principle for non-nuclear industry LLLW;<br><br>c) identify UK requirement for non-nuclear industry waste disposal and key areas where there are constraints;<br><br>d) help ensure fuller integration of LLW considerations in WPA plans;<br><br>e) help identify cost-effective options for non-nuclear industry waste disposals. | See sections 7.3 and 7.4 |
| 8. Climate change consequences | Strategy should:<br><br>inform stakeholders on need to consider coastal erosion and climate change issues etc when developing recommendations for disposal routes. | Mainly a matter for the regulators, and covered in 2007 LLW policy statement |
| 9. Cumulative effects from radionuclide accumulation | Strategy should:<br><br>Confirm radiological effects from solid LLW and VLLW disposals remain low. | See table 10 |