RWMAC

Radioactive Waste Management
Advisory Committee

The Radioactive Waste Management Advisory Committee's:

Advice to Ministers on Management of Low Activity Solid Radioactive Wastes within the United Kingdom

March 2003

Department for Environment, Food and Rural Affairs
Nobel House
17 Smith Square
London SW1P 3JR
Telephone 020 7238 6000
Web site: www.defra.gov.uk

Further copies of this publication are available from:

Defra Publications
Admail 6000
London
SW1A 2XX
Tel: 08459 556000
Email: defra@iforcegroup.com

This document is also available on the RWMAC website.

Published by the Department for Environment, Food and Rural Affairs. Printed in the UK, March 2003, on material containing 80% post-consumer waste and 20% totally chlorine free virgin pulp.

ISBN 0-85521-019-2

Product code PB 7955

Sir John Knill (1934–2002)

It is with great sadness that RWMAC notes the death, on 31 December 2002, of Professor Sir John Knill, FREng. Sir John was RWMAC Chairman from 1987 to 1995 and his firm and effective leadership is remembered by several of the current Committee as well as many former members.

In this report, the public body which, under proposals in the White Paper "Managing the Nuclear Legacy", is to be established to undertake the clean-up of those civil nuclear sites responsibility for which falls to the taxpayer is referred to as the *Liabilities Management Authority (LMA)*. At the time of going to press, it appeared probable that the term *Nuclear Decommissioning Authority* would be used, although no formal decision had been taken.

Contents

Foreword

As part of its work programme for 2001–02, RWMAC's sponsoring Ministers requested the Committee to examine the management of low level solid radioactive waste (LLW) in the United Kingdom and to advise on the scope and compilation of the UK Radioactive Waste Inventory (RWI).

From a very early stage in the work, it was clear that the studies were closely interlinked and that it would be necessary to consider all solid wastes extending from the upper radioactivity limits for LLW down to those exempted either from the legislation or from specific regulatory action. We have used the term Low Activity Wastes (LAW) to describe the range of such wastes which are very diverse in form and level of activity. The studies were therefore progressed in tandem, and are being published simultaneously with this Foreword, which is common to both.

The studies raise issues of real concern. As decommissioning of the UK's redundant nuclear facilities and clean-up of its contaminated sites get underway, the need to plan the management of the resulting wastes will become increasingly important. The studies make clear that there will be a great deal of LAW to deal with, and that the RWI must be a key management tool in identifying the scale and nature of the wastes.

Our detailed recommendations are set out in the relevant sections of the two reports. They cover a wide span of issues – the key points may be summarised as follows:

- In order to provide a view of the totality of the UK's potential radioactive waste liabilities, including materials such as uranium, plutonium and spent nuclear fuel which might come to be regarded as wastes in the future, the Government should consider whether the RWI should become a Radioactive *Materials* Inventory.

- The current RWI provides little clarity as to the actual or potential inventory of LAW. There are significant difficulties in estimating the volumes of LAW likely to arise which, in turn, impact on the degree of certainty attaching to RWI data. Taking account of the current state of decommissioning planning, site characterisation, and the absence of clear understanding of suitable end-points for site remediation, we have suggested that "*estimates of waste volumes are highly speculative .. .. and could vary by a large factor*". Some nuclear operators do not report estimates of the volume of LAW – millions of cubic metres are probably involved – partly because they are unsure how it is treated in the RWI and

partly in the hope that disposal routes other than Drigg will ultimately be found. Although other means of LAW disposal exist in principle (including incineration, use of landfill sites, and other forms of burial) they are not widely available in practice.

- Any perception that management of LAW has already been solved for the foreseeable future through the availability of the Drigg facility is therefore misplaced – significant issues pertaining both to Drigg and to other means of managing LAW remain to be addressed.

- European Union Directives are likely to have very significant implications for landfill and incineration. The only certainty on disposal routes is that Drigg will need to be replaced. Even then, policy will have to be developed with great care. There is a quite credible (but in our view undesirable) future scenario in which extremely large quantities of site clean-up wastes, at very low levels of radioactivity, are excavated and then have to be transported across the UK for disposal, at very great cost, in several "Driggs".

One of our recommendations is that the concept of in-situ disposal of some wastes on nuclear sites needs to be investigated. But this is only one option for consideration as part of a strategic review of policy on managing LAW that we believe is needed.

Professor Charles Curtis OBE
RWMAC Chairman

EXECUTIVE SUMMARY

Introduction

This report sets out the findings of a 2001-2002 study by the Radioactive Waste Management Advisory Committee (RWMAC) of current arrangements for the management of low activity solid radioactive wastes within the United Kingdom (UK). Low activity solid radioactive wastes are taken to include all wastes with an activity level lying below the defined Low Level Waste (LLW) category upper limit, but above either the levels specified for exclusion from the provisions of the Radioactive Substances Act 1993 (RSA93) or for exemption from specific regulatory action under the Act as a result of the Substances of Low Activity (SoLA) Exemption Order. This range includes, at the lower end, an officially recognised waste category termed Very Low Level Waste (VLLW) and the proposal for a new category, provisionally termed Very Low Radioactive Material (VLRM), which will also be discussed.

LLW management was a focus of attention in the 1980s when calls for technical improvements were implemented. Since then, the subject has received relatively little attention. In spite of its apparently uncontroversial nature, however, it was thought appropriate to undertake a review. This review was carried out in parallel with another RWMAC study on the Radioactive Waste Inventory, hereafter termed the RWI. The main overall conclusion of this study is that the problem of managing low activity wastes in the future is likely to be greater than has hitherto been generally recognised. The scale of the problem is difficult to scope with accuracy given the current policy void on nuclear facility decommissioning and the absence of end point standards for site clean-up, which could result in waste streams being identified in the future that have not previously been recorded in the RWI.

Data presentation in this report indicates that volumes could be substantially larger than has been previously anticipated, especially for wastes at the lower end of the LLW activity range. “Solutions” to the LLW problem, in the form of licensed disposal facilities are, conversely, diminishing. This is liable to place greater pressure on the UK’s LLW disposal facility at Drigg in Cumbria, the remaining lifetime of which, as a consequence, may be reduced. The future of the Dounreay (Caithness) facility for LLW disposal is uncertain. The availability of landfill sites is diminishing. It is this uncertainty surrounding disposal or long-term management solutions which has been the focus of this study. RWMAC perceives an urgent need for solutions to be found, and this will necessitate engaging the public/stakeholders. To this end, RWMAC makes a number of recommendations for addressing these potential problems.

Recommendations

1. The UK Government, in conjunction with the Devolved Administrations for Scotland and Wales, should review policy and strategy for the management and disposal of nuclear industry and small user LLW and VLLW, putting it on a coherent and openly declared basis. Potential levels of arisings now estimated are several times greater than the capacity of the existing Drigg LLW facility.

2. The review should consider the UKAEA proposal for the formal recognition of a further category of waste, above the activity level of VLLW, likely to arise from nuclear facility decommissioning and site clean-up, which could be dealt with by means other than disposal to Drigg.

3. Consideration needs to be given to future policy for the in-situ burial or on-site landfill disposal of LLW and, in particular, to the suggested VLRM category of waste from nuclear facility decommissioning and site clean-up. Without such consideration, there is the possibility that operators could be committed to inappropriate waste management practices. For example, huge volumes of slightly contaminated waste may be excavated and transported, at enormous public expense and environmental detriment, from one place to another. This would not serve to resolve the problem, but merely to relocate it.

4. The management of Dounreay wastes – both future arisings and those held in the now almost full LLW disposal pits – needs early consideration and decisions. Because national policy issues are involved, such decisions must involve the UK Government and the Devolved Administrations, rather than just the regulatory bodies.

5. The public and stakeholders should be engaged in the development of future policy for the management of LLW to secure their confidence in any proposals. The costs, hazards and risks associated with possible approaches need to be fully set out, understood, and weighed in the balance as part of this process. RWMAC recommends that consideration of LLW issues should be included either within the *Managing Radioactive Waste Safely* programme itself, or, preferably, conducted in parallel with it, employing a similar approach of wide and open public discussion with direct engagement of the public.

Other necessary Government policy decisions

6. The Government's promised review of nuclear facility decommissioning strategy should be completed, and its findings declared, as soon as possible in order to enable operators to refine their plans and be in a better position to estimate future waste arisings.

7. The Government should declare its policy and standards for the remediation of radioactively contaminated land, both on and off nuclear licensed sites, as soon as possible. Accurate estimation of arisings will be impossible until both policy and standards are clear.

8. RWMAC reiterates its call for a comprehensive review of the RSA93 system of Exemption Orders (EOs) to place them on a sound basis and to clarify their applicability to decommissioning and to the clean-up of radioactively contaminated land.

Availability of disposal routes

9. The volume and radiological capacity of Drigg and estimates of its remaining life should be reviewed following evaluation of the British Nuclear Fuels plc (BNFL's) Operational Environmental Safety Case and Post-Closure Safety Case (OESC and PCSC) assessments by the Environment Agency (EA).

10. In deciding how Drigg should be operated as a national asset, the means by which access to it could be made more amenable to small users should be clarified.

11. Government and the regulators need to keep under review the capacity of landfill sites and incinerators willing to accept LLW and VLLW. Such a review should aim to demonstrate how small user wastes and wastes that create direct disposal difficulties are to be dealt with.

12. It is important to determine the precise implications of new or emerging EU Directives that could potentially affect the availability of disposal routes. These include the EU Landfill Directive 1999/31/EC and the EU Water Framework Directive 2000/60/EC in respect of landfill sites and the EU Waste Incineration Directive 2000/76/EC and the EU Landfill Directive 1999/31/EC in relation to incineration facilities. The potential effect of these Directives needs to be fully assessed as a matter of urgency. Where they are found to impact on the availability of existing disposal routes, an alternative strategy needs to be developed.

13. In the light of its intended operational responsibility for both the Drigg and Dounreay sites, the proposed Liabilities Management Authority (LMA) should be asked by the Government and the Devolved Administrations, to undertake, at an early stage, a strategic assessment of the needs of a future programme for developing the UK's long-term management capability for LLW.

UK Radioactive Waste Inventory issues

14. UK Nirex Ltd (Nirex) and the Department for Environment, Food and Rural Affairs (Defra) should review and agree a policy for the inclusion of low activity wastes in the 2004 UK Radioactive Waste Inventory (RWI) to ensure that it reflects all anticipated management liabilities.

15. Refined estimates of LLW and VLLW (or the nuclear industry equivalent) arising from nuclear facility decommissioning and site clean-up activities are needed for inclusion in the RWI.

16. Operators should be required to identify the volume and timing of waste arisings associated with their decommissioning plans; these should be transferred directly and transparently into the RWI.

17. Government and the regulators should seek to establish much clearer estimates of future radioactive waste arisings from oil and gas extraction operations; because of their high radium content, these wastes could give rise to disposal difficulties.

THE RADIOACTIVE WASTE MANAGEMENT ADVISORY COMMITTEE'S REVIEW OF THE MANAGEMENT OF LOW ACTIVITY SOLID RADIOACTIVE WASTES WITHIN THE UNITED KINGDOM

1. Introduction

1.1 This report, prepared by the Radioactive Waste Management Advisory Committee (RWMAC), provides advice to the United Kingdom (UK) Government, and the Devolved Administrations for Scotland and Wales, on the management of low activity solid radioactive wastes within the UK.

1.2 The remaining lifetime of the Drigg low level waste (LLW) disposal facility has been predicted by its operators to be 50 years. This may have given the impression that the management of low activity solid wastes is an issue that has been fully addressed for the foreseeable future. This report will demonstrate that this is not the case. The issues are complex; RWMAC believes that a careful policy review coupled with engagement of, and dialogue with, the public and stakeholders to develop acceptable solutions are necessary.

1.3 Key points within the report include the following. The volumes of low activity solid wastes that will arise are large, difficult to assess, and probably substantially larger than has hitherto been anticipated. The availability of management routes to deal with such wastes is uncertain and appears likely to decline in the medium to long-term. A review of policy for dealing with low activity solid wastes, addressing both technical and societal issues, is needed.

1.4 The low activity wastes study, and preparation of its findings, coincided with another RWMAC study which has examined compilation arrangements for the RWI[1]. Interrelationships between the two pieces of work are referred to, where appropriate, in this report.

2. The form of the study and this report

2.1 RWMAC is an independent committee that advises the UK Government, and the Devolved Administrations for Scotland and Wales, on policy and practices for the management of civil radioactive wastes.

2.2 This study of the management of low activity solid wastes formed part of the Committee's work programme for 2001–2002 which was agreed with its sponsoring Ministers. The task of initial data assembly and analysis was allocated to a RWMAC Working Group, the membership of which is set out in Annex 1.

2.3 The Working Group invited written responses, based on specific questions, from the organisations listed in Annex 2. During the course of its work, the Working Group also held meetings with BNFL Magnox, BNFL Drigg, the Environment Agency (EA) and the Scottish Environment Protection Agency (SEPA).

2.4 The Working Group was responsible for analysing the information assembled and preparing initial drafts of the study report. These drafts, and the conclusions contained within them, were subsequently considered and finalised by the full RWMAC membership during plenary meetings held in September and November 2002.

2.5 The types of radioactive wastes considered in the study are discussed in Section 3. Section 4 provides information on the arisings of such waste and Section 5 describes the way they are managed in the UK. Section 6 discusses the findings of the study in detail, while the recommendations made are set out in Section 7.

3. Waste categories and disposal routes

3.1 In this study, RWMAC considers the management of low activity solid radioactive wastes and the linking of their definitions to disposal routes. Under current Government policy, two categories of such waste are formally defined (see, for example, reference 2):

– Low Level Waste (LLW); containing radioactive materials other than those suitable for disposal with ordinary refuse, but not exceeding 4GBq/te (gigabecquerels/tonne) of alpha or 12 GBq/te of beta/gamma activity; i.e., wastes that can normally be accepted for authorised disposal at Drigg, Dounreay or other engineered landfill sites by controlled burial (as defined in the *Managing Radioactive Waste Safely* consultation document[2]);

– Very Low Level Waste (VLLW); i.e., waste that can be disposed of with ordinary refuse, each 0.1 cubic metre (m^3) of material containing less than 400kBq (kilobecquerels) of beta/gamma activity or single items containing less than 40kBq.

In the application of the VLLW upper threshold, there are separate, complementary, restrictions on the permissible content of carbon-14 and tritium; these are a factor of ten greater than those set out above.

3.2 The upper threshold levels of activity specified for these two waste categories relate to the environmental impact for two specific disposal options: disposal to the Drigg LLW facility, and disposal of VLLW to landfill along with

normal domestic or commercial refuse without the requirement for any additional precautions.

3.3 The LLW definition corresponds to the general upper threshold for acceptance of waste to Drigg. There is no specific lower acceptance threshold for disposal to Drigg, although, in practice, many would regard the lower threshold for LLW to be either:

(1) for natural radionuclides in the uranium and thorium decay chains, the levels specified in Schedule 1 of the Radioactive Substances Act 1993 (RSA93); or

(2) for other notable artificial or man-made radionuclides, the levels laid down in the current suite of Exemption Orders issued under RSA93. The most notable of these is the Substances of Low Activity (SoLA) Exemption Order. This specifies a level for exemption from regulatory control of 0.4Bq per gram (0.0004GBq/te) for wastes which are essentially insoluble in water.

3.4 There are several important points to note in respect of these levels and the operation of Drigg. First, BNFL submitted an Operational Environmental Safety Case (OESC) and a Post-Closure Safety Case (PCSC) for the Drigg site to EA in September 2002 (see Annex 3). Consideration by EA could lead to amendment of the upper threshold limit for Drigg acceptance of alpha and beta/gamma radioactive wastes, or changes to existing specific limits for key radionuclides, such as carbon-14 and radium-226. It is conceivable that this, in turn, could necessitate re-definition of the LLW category. However, UKAEA has pointed out to RWMAC that the upper activity threshold limit for Drigg acceptance of alpha and beta/gamma radioactive LLW has already been effectively amended by the introduction of secondary "trigger level" controls based on the specific radionuclide content of the waste stream involved. Second, the lower limits for acceptance of wastes to Drigg are, in practice, not defined by the Schedule 1 and SoLA Exemption Order levels, but, rather, by the absence of any alternative disposal route for the waste concerned.

3.5 VLLW is uniquely defined in terms of small volumes of waste because this category of waste is intended to be disposed of with domestic refuse, and the typical volume of a domestic dustbin is of the order $0.1m^3$. Hence, reference is made to "dustbin disposal" which is primarily aimed at wastes arising from small users (i.e., organisations which do not belong to the nuclear sector) that keep and use radioactive materials. RWMAC perceives a lack of clarity in use of the term VLLW when applied to nuclear industry waste, which is liable to arise, and is disposed of (see paragraph 5.7), in much larger quantities.

3.6 In practice, there are other streams of low activity solid radioactive waste that are disposed of to routes other than Drigg and dustbin disposal. These waste streams are associated with controlled burial, in-situ burial on licensed nuclear sites, and incineration. The waste streams deemed suitable for controlled or in-situ burial are generally characterised by radioactivity levels well below the defined LLW upper activity threshold, and by the fact that they may arise in large volumes. Incineration is essentially treatment of LLW and VLLW prior to landfill disposal of the secondary incineration products (hearth ash and gas cleaning residues) as VLLW dustbin disposal.

3.7 Controlled burial in landfill disposal sites was developed for those wastes arising principally in the non-nuclear sector which were above the limits for dustbin disposal and unsuitable for incineration. The activity limit is typically above VLLW, but well below the LLW upper bound. The development of this route depended on the availability of suitable landfill sites with good containment characteristics that had been subject to an environmental assessment satisfying the regulators that public safety was assured, and to an ongoing leachate monitoring programme carried out by the regulators. Controlled burial is subject to issue of an authorisation under RSA93 by the regulators.

3.8 Following on from the development of controlled burial of non-nuclear radioactive waste to landfill, some nuclear operators sought authorisation for in-situ burial or landfill disposal of similarly lower activity wastes on their own sites. Such practices still continue, for example, to the South and Calder Plain Landfills on the Sellafield site for wastes with a total activity of less than 37Bq/g (0.037GBq/te), of which not more than 18.5Bq/g (0.0185GBq/te) is alpha activity (see Annex 3). This limit is approximately 100 times lower than the LLW upper activity limit and about 100 times higher than the SoLA EO level (see Figure 1).

3.9 However, not all the nuclear industry has access to management options other than Drigg. NII reported to RWMAC that operators that have access to landfill disposal for these lower activity wastes have been able to make good progress in decommissioning. UKAEA has recently proposed, and intends to pursue, regulatory acceptance of a new category of radioactive waste, which it has provisionally termed Very Low Radioactive Material (VLRM), for controlled landfill burial either on site or at other facilities. The activity levels proposed for this waste are less than 40Bq/gm (0.04GBq/te) for beta-gamma and 1–2Bq/gm (0.001–0.002GBq/te) for alpha activity. An upper level for alpha activity of 2Bq/g can be measured with more certainty, allowing for a clearer categorisation and, hence, more effective management of alpha-bearing wastes. In particular, UKAEA wishes to apply this means of disposal to potentially very large volumes of nuclear facility decommissioning and site clean-up wastes, but which would exclude organic material.

This contrasts strongly with VLLW – which explicitly relates to small scale arisings.

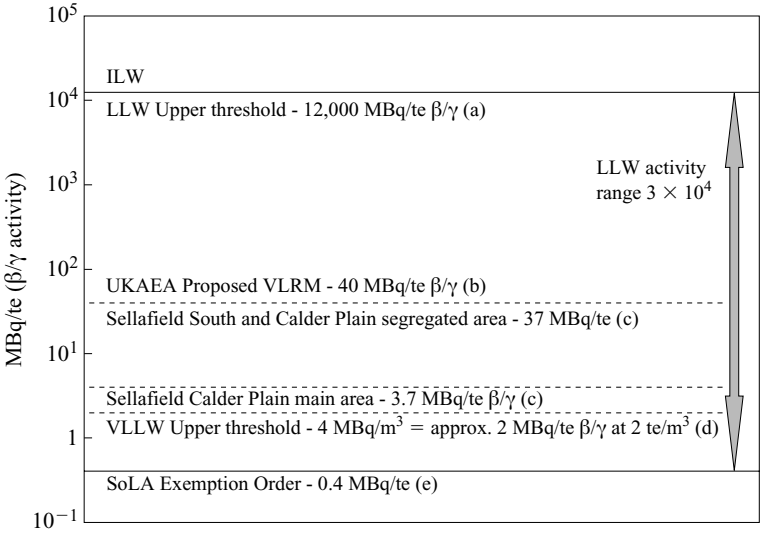

Figure 1. Range of low activity wastes (beta-gamma or all radionuclide concentrations as appropriate)

Notes to Table

1. *β/γ*stands for beta-gamma activity. α stands for alpha activity.
2. Allowable α activity levels are:
   (a) LLW specified α limit is 4,000 MBq/te
   (b) proposed VLRM α limit is 1–2MBq/te
   (c) for Sellafield landfills, α activity must not exceed more than one half of total activity concentration limit
   (d) alpha activity is normally excluded from disposal authorisations for VLLW
   (e) SoLA exemption provides a lower limit of 0.4MBq/te for artificial radionuclide elements which are substantially insoluble in water, irrespective of whether α, β or γ radioactive emissions
3. 1000MBq is equivalent to 1GBq.

3.10 Another term encountered during this study describes waste arising from oil and gas exploration drilling operations, namely "low specific activity", or LSA waste. This waste is known to have a high radium content and could potentially give rise to difficulties in disposal to Drigg.

3.11 An indication of the relative activity levels of the wastes discussed above is given in Figure 1. This is designed to assist in understanding of the very large range of radioactivity values covered by the wastes considered in this report.

4. Arisings

Figures recorded in the UK Radioactive Waste Inventory

4.1 The RWI[3], jointly compiled by Nirex and Defra at about three-yearly intervals, records the UK's holdings and forecast arisings of radioactive waste. The 2001 RWI[3] recorded holdings of LLW at 1 April 2001 of 15,700m^3 and predicted future arisings of 1,490,000m^3. This section discusses: first, some sub-categories of LLW that are not recorded in the RWI and, second, some of the sources of uncertainty that affect the accuracy with which volumes of predicted arisings can be estimated.

4.2 Not all anticipated arisings, between the LLW upper activity limit and the SoLA Exemption Order level, are fully recorded in the RWI. The reasons for this include:

– problems in accurately estimating arisings, particularly for wastes generated by decommissioning of nuclear facilities and nuclear site clean-up. Until decommissioning and clean-up plans have progressed to a sufficient level of detail, with timings clearly defined, it is difficult to estimate remaining residual radioactivity sufficiently accurately to clearly categorise the waste;

– a lack of clarity in policy on decommissioning and radioactively contaminated land giving rise to large uncertainties as to the amount of material that will have to be removed and treated as wastes. Nuclear operators do not submit some of the wastes at the lower end of the LLW activity scale to the RWI, primarily because they think that there might ultimately be non-Drigg, or in-situ, disposal routes available/authorised for dealing with them;

– it is currently accepted practice not to record VLLW in the RWI.

4.3 For these reasons, RWMAC is uncertain as to the precise grouping of wastes currently recorded in the RWI as LLW. The Committee suspects that the data submitted to the RWI relate to those wastes that the operators believe will ultimately be disposed of to Drigg (or, in the past, has been disposed to the Dounreay LLW disposal pits – see Annex 3).

4.4 Estimates of some nuclear facility decommissioning and site clean-up arisings have been progressively included in recent RWIs. Examples of low activity wastes which are still not included are outlined in paragraphs 4.5 to 4.10 below.

4.5 Large volumes of contaminated soil from BNFL Sellafield (see Annex 4), with an overall contamination level below a few tens of becquerels per gram, are expected to arise from nuclear facility decontamination and site clean-up. They have never been recorded in the RWI because BNFL believes that the volume of such material – potentially in excess of 10^6 m^3 – is so large that some form of in-situ management will ultimately be necessary.

4.6 UKAEA has suggested a VLRM category of lightly contaminated material (see paragraph 3.9 and Annex 4). UKAEA is storing this material, hoping that it will be possible to dispose of it by controlled burial. It has not declared this waste for RWI purposes, regarding it as the nuclear industry equivalent of VLLW. Details of possible volumes are given in Annex 4 Table A4.1.

4.7 AWE provided data on potential wastes that it holds that will meet the proposed VLRM definition (see Annex 4 Table A4.1). AWE perceives that disposal as VLRM, if such a category comes to exist in the future, would be simpler than demonstrating exempt status and much less expensive than disposal to Drigg.

4.8 In contrast to this, British Energy includes some VLLW-equivalent waste in its LLW estimates for the RWI. This is because the Drigg disposal route is the only option available to the company.

4.9 An estimate of small user LLW is recorded in the RWI. This has been provided by BNFL, based on extrapolation of past small user disposals to Drigg. The estimated volume is small since most small user LLW is pre-treated by incineration and then disposed of as VLLW to landfill. Very few small users are authorised under RSA93 to dispose of waste to Drigg.

4.10 Small user waste volumes arising directly as VLLW are not recorded in the RWI and cannot be quantified. Some scoping is conceivable, based, for example, on the 900 extant authorisations granted by EA for VLLW dustbin disposal in England and Wales. VLLW volumes increase substantially when small amounts of LLW or VLLW are incinerated with many tonnes of clinical waste, so that the activity becomes dispersed within greatly increased volumes of residues destined for landfill.

Estimation uncertainties

4.11 During this study, and the parallel study of the RWI[1], RWMAC sought from the major waste producers their views of the confidence that could be placed

in volumetric estimates of wastes included in the RWI. Responses did not follow any clear pattern. Estimates of arisings from power generation appeared generally quite stable. In other areas, estimates increased or fell by more than 20 per cent and, in one case, more than trebled. It is clear that some large variations can be explained by better understanding of waste characteristics and pre-treatment requirements. There was a general acknowledgement that procedures for assessing volumes of decommissioning wastes and, to an even greater extent, of contaminated soil are inherently unreliable. Similar patterns apply to conditioned and packaged wastes (the latter will appear for the first time in the 2001 RWI) since, to arrive at these, conversion factors are applied to estimates of raw wastes.

4.12 In practice, several factors can affect the certainty with which future arisings can be estimated. These are:

(i) The state of programme planning

4.13 Future nuclear facility decommissioning and site clean-up programmes have to be planned. This involves assessing the scale and nature of the problem that has to be tackled and devising the means of dealing with it. In particular, characterisation of historic waste and of ground contamination will be needed, although the quality of available records may be poor by present day standards. Project plans may need to be revisited and reassessed as work proceeds. In general, nuclear facility decommissioning and site clean-up planning within the UK remains at an early stage.

4.14 The way in which planning refinements can impact on waste management is illustrated in the estimates of future LLW arisings in the 1998[4] and 2001[3] RWIs. Between these two dates, some new waste streams consisting in total of about 500,000m^3 of contaminated soil from BNFL's Sellafield and Magnox reactor sites and the UKAEA sites at Harwell and Winfrith were identified (contaminated soil at Dounreay and the major Ministry of Defence (MoD) sites was included in the 1998 RWI). Offsetting this, there was a decrease of about 800,000m^3 in arisings of installation decommissioning wastes, primarily from Sellafield. At this site, significant amounts of building rubble, previously assessed as LLW, have subsequently been identified as falling within either BNFL's interpretation of VLLW (a notional 4Bq/g), or as "clean", suggesting, for example, that it could be used for on-site infill purposes. The significance of such reassessment can best be appreciated in the context of the assessed remaining volumetric capacity of Drigg of around 800,000m^3 (see Annex 3).

4.15 Difficulties in characterising the nature and degree of contamination, particularly when measuring at limits of detection of instrumentation, can also lead to uncertainty in estimates of waste arisings. Measurement of levels of contamina-

tion across large volumes of soil and other bulk materials can be difficult, particularly in the absence of clear policy on the integration volumes to be applied when considering these wastes for free release. On MoD sites, for example, there are historic examples of the on-site disposal of radioactive sources.

(ii) Waste minimisation initiatives

4.16 Waste minimisation, or avoidance of the creation of waste, is a key principle of the UK's radioactive waste management policy. For example, the Health and Safety Executive's (HSE's) Licence Condition 32 requires nuclear licensed site operators to make arrangements for minimising, so far as is reasonably practicable, the rate of production and total quantity of waste accumulated on site. Authorisations for the disposal of solid LLW to Drigg include the condition that best practicable means (BPM) should be used to limit the amount of waste consigned.

4.17 There are a number of means of reducing the volumes of particular types of radioactive waste. For example, minimisation of arisings of LLW may be achieved through their better segregation at source. Segregation applies to the category (activity) or type (compactable, flammable or otherwise) of waste for which a suitable route exists. Such work is aided by good waste characterisation, including identification of the radionuclide content of the waste. The extent of segregation that is feasible varies a good deal, but once some wastes are separated out, there may be potential for the less active components to be decontaminated further.

4.18 In practice, there may be a case for separating higher activity LLW from VLLW because of the differing disposal routes available – Drigg on the one hand and dustbin disposal on the other. But, while both routes may be available for small users, this will not apply so readily to the nuclear industry. Moreover, the difficulty and costs of such segregation, and increases in radiation doses to workers, may not make it worthwhile.

4.19 Other means of waste volume reduction include incineration, compaction, and abrading the waste. Incineration is perhaps the most effective of these means, achieving a 15–25 fold reduction, although its use is obviously limited to combustible materials. But the ash and gas cleaning system residues from incineration of radioactive waste at a plant not dedicated solely to burning this type of waste remain to be disposed of as part of the larger amounts of general incinerator waste material with which they will become unavoidably mixed. The use of improved supercompaction techniques, to convert drummed waste into smaller pucks, can also be used to achieve substantial volume reductions for solid wastes destined for disposal to Drigg.

4.20 Use of such approaches and techniques have meant that, over the past 10 years, the volume of LLW that is consigned annually to Drigg has fallen by a factor of three. The 2001 RWI predicts that LLW will continue to arise at its current rate until 2020. Between 2020 and 2040, it is predicted to fall due to cessation of nuclear operations, before increasing significantly as a result of decommissioning.

4.21 Such means of achieving waste minimisation do not, in themselves, affect overall levels of radioactivity. However, they may mean that some activity, as a result of incineration, is released to the atmosphere, or is redistributed, in the case of improved segregation, to some lower category of waste or material deemed suitable for free release.

4.22 The only process that reduces the overall level of radioactivity is that of radioactive decay. In principle, the concept of decay storage can be used to enable radioactive waste to be consigned to a less restrictive disposal route, or permitted for free release. In practice, ability to use this approach effectively will depend on the half-lives of the principal radionuclides contained within the waste. This means that, at present, decay storage is little practised outside the small user sector, except for some short-life wastes from pharmaceutical manufacture. Problems associated with decay storage include the need for dedicated facilities and the implications for worker dose.

4.23 Considerations such as these may mean that early disposal of the waste, to facilities such as Drigg, is a more attractive option. However, there does not seem to be any regulatory presumption against the practice of decay storage, providing the difficulties identified above (paragraph 4.22) can be overcome. A centralised installation, purpose-built to facilitate the decay of LLW down to VLLW, was proposed to RWMAC during the course of this study as a possible means of facilitating LLW management. The "safestore" process for decommissioning nuclear reactors (see paragraph 4.29), where the defuelled reactor is placed in a state of care and maintenance for a period potentially amounting to many decades before final dismantling takes place, is also, in effect, an example of large scale decay storage.

4.24 In several overseas countries, the co-disposal of segregated short-lived intermediate level radioactive waste (ILW) and LLW is practiced. This is on the basis that, within the containment timeframe, the short-lived ILW will decay relatively quickly to LLW. "Short lived" in this context is generally taken to mean materials with a radioactivity decay half-life of 30 years or less. The scope for similar forms of co-disposal is limited in the UK because of the complex radionuclide "cocktails" contained in many historic ILW streams, but could be possible in relation to arisings from power generation. Such a policy could,

ultimately, affect the amounts of waste that have to be managed in LLW disposal facilities.

(iii) Government policies

4.25 The precise state of Government policies can also affect estimation of the levels of future waste arisings. There are various examples of this, set out below in paragraphs 4.26–4.29.

4.26 Within the UK, there are no formal Government policies or standards for remediation of radioactively contaminated land, either on or off nuclear sites, although there are initiatives in hand to address these issues. Until remediation policies are fully defined, estimation of arisings depends on speculation about future clean-up requirements and the volumes of waste that will ultimately be generated and have to be managed.

4.27 RWMAC notes that the outcome of a February 1998 Government consultation on the control and remediation of radioactively contaminated land[5] has never been declared. A number of Government departments participate, together with the nuclear industry, in the Safegrounds project which is managed by the CIRIA Learning Network. RWMAC has commented critically on recent guidance produced by CIRIA for the clean-up of nuclear licensed sites and MoD sites[6] believing that the approach advocated, whereby remediation work would derive from the land management option selected, would lead to inconsistent decision-making. The RWMAC response pointed out that remediation needs to be set within a clear Government policy framework for radioactively contaminated land. In terms of the nature of the guidance required, RWMAC has called for the management regime to be predicated on appropriate risk-based criteria, taking account of the application of nationally and internationally accepted principles of radiological protection.

4.28 RWMAC has also commented on the existing system of RSA93 EOs and recommended[7] that it be placed on a "properly rationalised, sound, scientific, and easily operable basis". The results of the current study have served to reinforce that recommendation for a fundamental review. In particular, RWMAC sees a need for rational and transparent clarification of how the set of EOs would apply to policy on, and standards for, facility decommissioning and site clean-up activities, including use of particular disposal routes, recycling, and free release. This is particularly relevant given that RWMAC believes that such activities should be risk-based, whereas the EOs themselves are likely to be radioactivity-based. In this context, one nuclear operator supplied estimates to RWMAC, albeit indicative, of the significant volumes of LLW and VLLW that might be exempted from regulatory control if the exemption levels contained in Annex 1 of the EU Basic Safety

Standards Directive[8] were to be fully reflected in UK legislation. (RWMAC notes in this context that the Annex 1 figures were themselves derived on the basis of small items or about 1 tonne of waste.) Any review may not necessarily result in greater levels of free release of material, but at least the issue of the relationship between decommissioning and clean-up activities on the one hand, and the application of EOs on the other, would be settled, providing a sounder basis for future planning.

4.29 Decommissioning is another area where the nature of Government policy can affect estimated levels of LLW and VLLW arisings. The potential effects of a safestore decommissioning approach have already been mentioned. In the case of some nuclear facilities, holding back the final stages of decommissioning until 100 years after shutdown could almost halve the levels of LLW that needs to be managed. In practice, some observers are likely to deem such a delay in decommissioning as unacceptable for a variety of reasons. The Government has recently promised a review of decommissioning policy, in its *Managing the Nuclear Legacy* White Paper[9] and in statements about the means of carrying forward the *Managing Radioactive Waste Safely*[2] initiative on the formulation of future policy for the long-term management of solid radioactive wastes

(iv) Changes in existing activities

4.30 Changes in the existing activities of the nuclear industry and of small users will also potentially impact on the level of LLW arisings, for example, any new nuclear build will certainly do so. Arisings of solid radioactive wastes from any new nuclear power plants would depend on the number and type of reactors built. A full study would be required to determine the precise types and quantities of waste produced by new reactors in both operational and decommissioning phases. In practice, decisions on future policy for managing solid wastes should, insofar as is reasonably practicable, incorporate sufficient flexibility to allow for different future new build scenarios. On a much lesser scale, changes in National Health Service practices, aimed at increasing levels of medical diagnosis and radiotherapy treatments, could also have implications for arisings of LLW and VLLW from hospitals.

5. Waste management

5.1 The nature of the radioactive wastes that are the subject of this study are bounded by a lower threshold set out in Schedule 1 of RSA93 and the SoLA Exemption Order and by an upper threshold equivalent to the LLW definition upper activity limit. This spans four and a half orders of magnitude (see Figure 1). Government policy for this waste has been one of immediate disposal, given that suitable disposal routes are in existence. Further details of these routes are given in Annex 3.

5.2 The main producers of these low activity wastes are the civil nuclear industry, and MoD and its civilian contractors, which, together, manage the UK naval nuclear propulsion and nuclear weapons programmes. Smaller amounts are generated by a range of non-nuclear organisations, collectively known as "small users". The latter consist mainly of hospitals and educational establishments, and several commercial sectors, including life sciences and offshore oil and gas exploration. Management of wastes by the nuclear industry and small users is discussed in the following sub-sections.

The nuclear industry

5.3 The UK has 40 sites licensed under the Nuclear Installations Act 1965 (NIA65) all of which produce low activity solid wastes from both ongoing operations and nuclear facility decommissioning and site clean-up activities.

5.4 Low activity wastes that arise from nuclear industry current operations typically consist of worn out and redundant equipment (notably metallic ducting, pipework and reinforcement), some products of abatement technology such as ion-exchange resins, and lightly contaminated organic materials such as protective clothing, paper towels and plastic wrappings. Potentially much larger volumes of LLW will arise as nuclear power generating and related plant is shut down, and nuclear facility decommissioning and site clean-up begins. These nuclear site decommissioning and site clean-up wastes can include large quantities of building rubble and contaminated soil, as well as other material such as reactor graphite.

5.5 The major route for disposal of nuclear industry solid LLW is the Drigg near-surface disposal facility described in Annex 3 of this report. Drigg policy is not to accept waste for which another route is available, either landfill or dustbin disposal. This reflects Government policy as set out in the *Guide to Administration of the Radioactive Substances Act 1960*[10]. As Annex 3 points out, Drigg has a remaining capacity of about 800,000m^3 and, on the basis of the 1998 UK RWI figures[4], a remaining life of around 50 years. A near surface LLW disposal facility was, until recently, also available at Dounreay to take LLW from that site, but this facility is currently not operational (see Annex 3).

5.6 The nuclear industry makes only very limited use of off-site LLW disposal to landfill. In a 1994 consultation document[11], the Government suggested that "there are sound economic and radiological grounds" for encouraging greater use of controlled burial for nuclear industry LLW. However, following consultation, and in light of the responses to it, the resulting 1995 White Paper – *Review of Radioactive Waste Management: Final Conclusions* (Cm 2919)[12] said that the Government had decided "not to encourage greater use of controlled burial by the

nuclear industry" due to the anxieties that this proposal had aroused among local residents.

5.7 There appears to be somewhat more off-site disposal of wastes below LLW activity limits from nuclear industry operations. For example, wastes from BNFL's fuel fabrication plant at Springfields and its uranium processing facility at Capenhurst (a notional 4Bq/g activity which BNFL terms VLLW: see A4.12) are consigned to the Clifton Marsh landfill site. VLLW from two nuclear sites operated by Rolls Royce plc in Derby are sent to Hilts Quarry, a site owned by that company. Amersham plc and Devonport Royal Dockyard Ltd are authorised to send relatively small amounts of VLLW for burial at other sites.

5.8 Such off-site disposal of VLLW accounts for only an extremely small percentage of potential VLLW arisings from nuclear sites. In addition, the environment agencies, EA and SEPA, have indicated an unwillingness to allow the practice to be extended – on the basis that the definition of VLLW is inconsistent with disposal of the large volumes of such waste generated by the nuclear industry.

5.9 A few nuclear licensed sites have authorised on-site disposal for certain categories of solid radioactive waste. The Sellafield South and Calder Floodplain Landfill disposal areas (see Annex 3) are examples. A number of other sites, such as AWE Aldermaston, have operated on-site disposal facilities for various low activity wastes in the past, but these are now closed. The Dounreay LLW disposal pits (see Annex 3) have very limited remaining capacity and cannot currently be used – pending the outcome of a PCSC assessment.

5.10 Some wastes produced on nuclear sites, both LLW and VLLW, are suitable for incineration. Incineration is used both as a method of waste reduction and as a means of obviating the dangers that would arise from the direct disposal of some wastes, including reactive organic wastes (i.e., the risk of gas build-up). It is also used for wastes that cannot easily be contained, such as contaminated waste oil. However, burning results in the partitioning of radionuclides between the atmosphere and the secondary incineration products (ash and lime residues).

5.11 Public opposition has prevented the commissioning of two LLW incinerators (for solid wastes and contaminated oil) at the Bradwell nuclear site. More stringent environmental standards in respect of emissions, arising out of the Environmental Protection Act 1990 (EPA90), have required substantial modifications to existing plant to deliver effective abatement. The costs, in many instances, are prohibitive, and coupled with public opposition to incineration in general, have resulted in the near-cessation of incineration operations by the nuclear sector. Some forms of low activity waste, for example contaminated waste oil, are still transferred

from nuclear facilities to commercial incinerators as this is perceived to be the best management option for these wastes.

5.12 Incineration is constrained by the clear tension between benefit and detriment. In general, EA has expressed an interest in exploring this "trade-off" further. There is very limited capacity in the UK for incineration of alpha bearing wastes. Although EA has indicated it would look carefully at any application to incinerate these wastes, a view was expressed that the agency would prefer to see waste minimisation obviate the need for further incineration capacity. There are restrictive limits on the disposal of alpha emitting and fissile radionuclides to Drigg.

5.13 EA has indicated that quantities of rubble, monitored to ensure that it is below levels set out in the SoLA EO, have been used as infill on nuclear licensed sites where they have arisen. The free release, and subsequent recycling, of some materials of relatively high value has taken place, mainly aluminium and steel from decommissioning at Capenhurst.

Small users

5.14 There are many thousands of small users of radioactive materials in the UK. The range of small user wastes is extensive. Unlike the nuclear industry, the small user sector benefits from clearly defined routes for disposal of both its LLW and VLLW.

5.15 Small users of radioactivity can also, in theory, use disposal to Drigg or controlled burial at landfill sites for the management of their LLW. However, they are likely to experience difficulties in assembling their waste into suitably large consignments for Drigg disposal and, therefore, they find this route both relatively difficult to use and costly. They also experience difficulties in maintaining the systems and preparing the documentation necessary for the quality plans required by Drigg to underpin the disposal of a particular waste stream. For these reasons, most small users are likely find controlled burial of their LLW at landfill sites to be the preferred of these two options. Many landfill sites formerly used for controlled burial of small user LLW have been filled and closed and, in most cases, it has not been possible to establish a replacement disposal site.

5.16 VLLW can be removed from small user premises by local authority collectors and disposed of with ordinary waste to landfill under arrangements, known as dustbin disposal. The nature of dustbin disposal is such that the amount of VLLW sent to landfill is not recorded.

5.17 Some medical radioactive wastes are within the dustbin disposal activity limit but, because of their particular properties (for example, contaminated bio-

logical samples, organic and putrescible wastes, and syringes and other sharp objects) cannot be buried directly and must first be burned in clinical waste incinerators authorised under RSA93. Unlike dustbin disposal, the radionuclide content has, in this case, to be declared. Authorisations for incineration are usually granted on a case by case basis, taking all the local circumstances into account. Provided that the resulting radioactive incineration residues fall within the VLLW limit, they may, without the radionuclide content having to be declared, be authorised for disposal to landfill as dustbin disposal.

5.18 Incinerator provision for small users is now mainly in the hands of the private sector. Legislative changes requiring adoption of higher environmental standards have resulted in the closure of many incinerators (about 600 in total) previously operated, within the public sector, by bodies such as hospitals, and their replacement by approximately forty commercially owned incinerators located around the country.

5.19 It is probable that Government policy, essentially transferring landfill responsibility from local authorities to private sector commercial operators, has resulted in a decline in the number of landfill sites willing to accept small user LLW for controlled burial, although it is difficult to be precise about the scale of the contraction. Regulatory records are focused on the waste producer rather than the landfill operator and little hard evidence exists. There was no response to a RWMAC request for information made to the Environmental Services Association, which is the trade association for landfill operators.

5.20 The problem is likely to increase as existing landfill sites situated across the UK continue to close. Private operators who develop new landfill sites appear reluctant to accept radioactive waste due to the requirement for public consultation that goes with it. Public concerns about the burial of radioactive waste generally are likely to lead to strong opposition to any such proposals. There are also perceived problems on the part of the site owner regarding radioactive contamination and the ongoing liability attaching to him or her at the point at which the site closes and the operator seeks to surrender the waste management licence. Radiological assessments undertaken by the National Radiological Protection Board (NRPB)[13] suggest that these concerns are largely unfounded.

6. Discussion of findings

This section discusses a range of issues that have emerged as a result of this study.

Nuclear operations

6.1 Nuclear operators send their current LLW arisings mainly to Drigg. Some

also have limited access to off-site landfill sites and on-site disposal facilities for wastes at the lower end of the LLW activity range, but this is the exception rather than the rule. Controlled burial at landfill sites of waste at the higher end of the LLW activity range has now effectively been terminated for nuclear operators.

6.2 Against this background, a problem which is beginning increasingly to confront nuclear operators is what to do with the large volumes of building rubble and contaminated soil, at the lower end of the LLW activity range, that are now being identified. These wastes need to be dealt with as nuclear facility decommissioning and site clean-up programmes get underway.

6.3 The waste referred to in the previous paragraphs is, in general, that with contamination of the order of 10Bq/g (0.01GBq/te) or less, i.e., about a factor of 1,000 below the LLW upper activity limit (a lower limit applies for waste containing a high concentration of alpha activity). An example is the waste for which UKAEA has proposed the term "VLRM".

6.4 In theory at least, all these decommissioning and clean-up wastes could be sent to Drigg. RWMAC does not believe that moving very large volumes of waste, at the lower end of the LLW activity range, from one site to another is likely to be an effective and efficient means of dealing with it, particularly if the site to which it is moved is Drigg, a scarce UK national resource.

6.5 What RWMAC believes to be necessary, therefore, is serious consideration of the ways in which such wastes might be safely left on, or close to, the site at which they arise, in some suitably located, engineered and, possibly, access-controlled facility. The location and engineering requirements are likely to be substantially less specialised than those of Drigg, but should be subject to discussion with stakeholders, including the local community.

End points for decommissioning and clean-up

6.6 A closely related issue is identification of the appropriate "end points" for licensed nuclear facilities following decontamination and clean-up, and interpretation of the "no danger" criterion for site delicensing under NIA65, upon which, it is understood, HSE is currently working.

6.7 In RWMAC's view, it is becoming increasingly important to identify the desired site condition end point early in the planning process. In the Committee's opinion, any perception that sites can be returned to a totally uncontaminated "green field" status, such as existed before the nuclear facilities were built, is likely to be unrealistic for the vast majority of large installations. One example is the

Dounreay Site Restoration Plan[14] (DSRP), which suggests that some parts of the site will need to be access-controlled for more than 300 years.

6.8 Such a view has clear implications for interpretation of the "no danger" criterion. It might mean, for instance, that some form of access control might need to be linked to its interpretation. It might also mean that parts of the site cannot be delicensed. Or it could imply that some parts might have to be transferred to some other form of regulation – say as landfill sites – to allow them to be released from nuclear site licensing under NIA65.

6.9 For these reasons, RWMAC foresees that interpretation of the "no danger" criterion is likely to be a challenging task for HSE.

Dounreay wastes

6.10 In RWMAC's view, the destiny of Dounreay wastes is a fundamental question in relation to the management of LLW within the UK.

6.11 Central to this issue is whether new disposal facilities for the full spectrum of wastes covered by the LLW and VLRM definitions will be opened either on, or near, the Dounreay site and precisely what form of wastes these facilities might take. This, in RWMAC's view, is an issue that, although clearly complex and controversial, needs to be resolved as soon as possible, not only in the context of delivery of the DSRP, but also in respect of its likely impact on the UK's LLW management policy and its implications for the future of Drigg. Under the DSRP, UKAEA is carrying out a Best Practicable Environmental Option (BPEO) assessment to decide the best means of dealing with Dounreay LLW over the longer-term.

6.12 RWMAC believes that it is necessary to decide not only what is to happen to future Dounreay LLW arisings, but also whether the existing Dounreay disposal pits can sustain a rigorous PCSC assessment and, if not, what is to happen to the wastes contained within them.

6.13 RWMAC notes that UKAEA, in response to regulatory pressure following a HSE-SEPA audit[21] of safety conditions at the site in 1998, has submitted an application to SEPA seeking authorisation to dispose of operational wastes to Drigg. Although UKAEA has indicated that it perceive this as an interim measure, it is believed that SEPA recognises it as establishing the use of an existing disposal route, consistent with current Government policy. While this might appear to have the advantages of making use of existing disposal capacity and averting the need for on-site storage of LLW, it also, in RWMAC's view, raises some potentially fundamental issues for longer-term policy for the management of LLW that need to

be given full consideration by the UK Government and the Devolved Administrations. Otherwise, there is a danger of national policy effectively being pre-empted by specific regulatory decisions.

6.14 For example, RWMAC finds it difficult to see how the BPEO study to decide the future management of Dounreay's LLW will not be effectively pre-empted by a decision to open up the Drigg disposal route. UKAEA has indicated to RWMAC that it concurs with this view. There is then the question of whether it is right to move large volumes of radioactive waste over long distances, and across national borders, from a site where the waste was generated, and which has benefited from past employment opportunities, to place further pressure on the Drigg facility. If this is allowed, the possible future implications for ILW and High Level Waste (HLW) must also be considered. Such a move could prove particularly contentious if, as a result of a future PCSC assessment, it was, in due course, found necessary to recover the waste in the Dounreay LLW disposal pits for some other means of long-term management.

6.15 RWMAC believes, therefore, that such issues need to be fully considered and addressed before any decision is taken to allow the disposal of Dounreay wastes to Drigg, even if made only as an interim measure for operational wastes.

Clarification of Government policies

6.16 RWMAC takes the view that there are a number of aspects of Government policy that need to be clarified to allow effective management of LLW. These are set out in paragraphs 6.17 to 6.21 below.

6.17 In particular, RWMAC believes it would be helpful for Government to clarify, in conjunction with the regulators, the roles which disposal routes other than Drigg should play in the disposal of wastes at the lower end of the LLW activity range. These include, in particular, the roles of local landfill sites and in-situ burial.

6.18 RWMAC is, in principle, supportive of the use of these routes for disposal of such lower activity wastes, particularly the large quantities that will arise as a result of nuclear facility decommissioning and site clean-up activities, subject to preparation of the necessary safety cases, and public and stakeholder confidence. RWMAC can see little point in transporting large quantities of waste over long distances to take up space at Drigg if other demonstrably safe options become available. It should be noted that, historically, the 1982 Guide to the Administration of the Radioactive Substances Act[10] did discuss the use of some non-Drigg disposal routes for demolition waste, specifically controlled burial and in-situ burial. (The fact that this guidance is now very dated is demonstrated by its reference to sea disposal as an option). This exemplifies one of the reasons why RWMAC has, for a

number of years, been calling for an updated version of the Guide to the Act – which could potentially serve as a means of clarifying the role to be played by these other non-Drigg routes in the future. The cost savings to be achieved for the taxpayer through such an approach could ultimately run into many hundreds of millions, or even billions, of pounds (see Annex 4).

6.19 RWMAC understands that the regulators, HSE and the environment agencies, might also be supportive of such an approach provided the necessary safety cases can be made and there is the necessary policy backing from Government. SEPA is currently awaiting the outcome of research into controlled landfill burial funded by the Scottish and Northern Ireland Forum for Environmental Research (SNIFFER) before reaching any decision. Any future approach will also require consideration of appropriate end points for nuclear facility decommissioning and site clean-up activities.

6.20 There is also a need to formulate and state clear policies and standards for remediation of radioactively contaminated land, both on and off nuclear licensed sites. This is an issue that has been ongoing within Government for a number of years, with no clear outcome to date. Put simply, there is no way that any party can reliably identify the volumes of waste that are likely to arise until decontamination targets are determined. This will have a clear impact on the ability of the LMA to accurately assess its liabilities and its requirement for resources for dealing with them.

6.21 Coupled with this is another key issue. If, as RWMAC strongly believes it should be, decontamination is a risk-based activity, how does achievement of risk targets relate to the lower end activity concentration cut-off points for regulation defined by the RSA93 exclusion, and SoLA exemption, provisions? This relationship between risk criteria and activity concentrations needs to be decided and explained.

6.22 There will be an increasingly urgent need to resolve these issues as decommissioning and clean-up work gathers pace.

Interaction with the public

6.23 It is clear that all forms of radioactive waste management, even that involving low activity waste, arouse strong public feelings and emotions.

6.24 This report has identified the need for clarification of Government policy on the management of LLW, and for early discussion of the end points for nuclear facility decommissioning and site clean-up, in the belief that, in many cases, it will be unrealistic to remove all radioactivity from the majority of sites.

6.25 This would appear to pose an intractable problem. Most nuclear facilities will inevitably be left with large volumes of VLRM category waste, irrespective of whether there is any new build. Many local people would undoubtedly wish to see the radioactivity removed. Many (elsewhere) would not wish to see it dug up and buried near them, while the majority of the public would probably be alarmed by the prospect of large volumes of radioactive waste being transported over long distances, especially if it passed near their homes. The most obvious destination for any such waste movements, given concern over landfill, is Drigg. This would serve to fill up Drigg with waste arguably of such low activity that it should not be there. Long before Drigg is full, there will be a need to find a replacement, or indeed replacements, elsewhere. These considerations clearly indicate that not everyone can be satisfied, and the aim, therefore, should be to find the "least-bad" solution.

6.26 This suggests that some form of open public debate of the issues, with the pros and cons of each option clearly set out, is necessary. The *Managing Radioactive Waste Safely* initiative[2] is to consider future policy for the long-term management of the UK's solid waste on the basis of a wide and open public debate. This initiative appears to be aimed at higher activity wastes which, to date, have had no final disposal options identified. RWMAC recommends that consideration of LLW issues should either be included within the *Managing Radioactive Waste Safely* initiative itself, or, preferably, conducted in parallel with it, on a similar basis of wide and open public discussion, with direct engagement of the public.

The LLW classification

6.27 In light of this study, RWMAC believes that the current LLW classification should be reviewed. The VLLW and demolition waste categories are taken to be included within this observation.

6.28 RWMAC takes the view that any radioactive waste classification system should have two main aims: to be informative, and to be indicative of the waste's eventual disposal route.

6.29 The existing LLW definition effectively extends, for much of the nuclear sector, from the upper limit of the definition to the RSA93 exclusion and SoLA exemption levels. There are, potentially, alternative disposal routes to Drigg for some of this waste, notably landfill and in-situ disposal. In RWMAC's view, it would be useful to consider whether sub-categories of LLW, or new categories, could be identified and associated with these potential disposal routes. In this context, RWMAC believes that a new category, akin to the waste activity level that UKAEA has proposed to term VLRM, although differently named, (see Annex 4), is worthy of further consideration.

6.30 The nomenclature of the existing VLLW category also poses difficulties because it is linked with the dustbin disposal route for the small quantities of waste produced by small users. The term VLLW therefore cannot legitimately be associated with nuclear industry operations, and although it is being used by some nuclear facilities, it is assigned a notional activity limit. RWMAC perceives a lack of clarity in use of the term VLLW when applied to nuclear industry waste.

Strategic assessment of UK disposal capacity

6.31 For LLW management, the key question is the future disposal capacity of Drigg. The Drigg OESC and PCSC assessments were supplied to EA by BNFL in September 2002 (see Annex 3). It is thought that it will take EA about a year to consider them. Subsequently, EA will conduct a review of the RSA93 authorisation for Drigg which is anticipated to commence in September 2003, with public consultation in mid-2004. A new authorisation for the site is unlikely to be granted before 2005.

6.32 It will be important to update, as a result of this review process, both the volume and radiological capacity estimates for the Drigg site. This information should then be used to decide the optimum policy for acceptance of waste at the site in future. This will, potentially, be a complex task involving decisions concerning which forms of waste will be accepted for disposal to Drigg in future, and which will be set aside for other forms of long-term management. If radiological capacity is the key controlling factor, it may be appropriate to consider whether some lower activity waste could sensibly be accepted by the site.

6.33 The lifetime of Drigg, currently seen to be some 50 years, may seem to be long. But, if the facility fills up quicker than this, as a result of greater volumes of low activity wastes being disposed of than is anticipated, action will need to be taken soon to start the process of finding alternative LLW disposal sites. Given the probably lengthy period that will be required to find alternative sites, it is inappropriate to wait a few decades before taking action.

6.34 Another key question is the future of LLW disposal at the Dounreay site. Is a new LLW disposal facility to be built at the site and will it take only Dounreay waste? Any Dounreay facility would be small in comparison to Drigg. The total estimated capacity of the current Drigg consented area is of the order of 1,740,000m^3, whereas the volume of LLW disposed of in the existing Dounreay pits is about 33,000m^3 and future site arisings are estimated to be of the order 80,000m^3, of which about 43,000m^3 will be low activity VLRM (see Annex 4).

6.35 LLW disposal capacity will also depend in future on the availability of landfill sites willing to accept controlled burial of radioactive waste, and, to a lesser

extent, on the availability of incinerators. It will also depend on any future policy decided for the in-situ disposal of nuclear facility decommissioning and site clean-up wastes, including contaminated soil. Landfill site and incinerator availability will be particularly important for small users.

6.36 While it may not be an immediately pressing need, RWMAC notes that, at some point in the not too distant future, the Government will need to allocate responsibility for maintaining a strategic overview of predicted LLW arisings and the availability and capacity of disposal routes to deal with them.

6.37 At some point, there will need to be a body that is charged with planning and seeking a replacement for Drigg. The lead time for identifying and constructing a replacement facility will inevitably be long. It is the Government's intention that the proposed LMA will be charged with operating Drigg and this body will, presumably, be allocated responsibility for securing the future arrangements for Dounreay.

6.38 Unless a comprehensive review of waste generation and capacity is conducted early enough, the UK may ultimately face, at the national level, a repetition of what has occurred in respect of the Dounreay pits, where existing capacity is almost used up and no solution for future management has been decided. The proposed LMA, in light of its intended operational responsibility for both the Drigg and Dounreay sites, should be asked by the UK Government and the Devolved Administrations, at an appropriate point in the not too distant future, to undertake a strategic assessment of the needs of a future programme for developing the UK's long-term management capability for LLW.

Small users

6.39 For the most part, small users are able to find ways of managing their LLW and VLLW within current procedures and arrangements.

6.40 Drigg is also potentially available for the disposal of suitable small user LLW, although volumes are small. For the reasons detailed in paragraph 5.15, small users tend to look to controlled burial as one means of disposal of their LLW. The continuing closure of landfill sites across the UK that are willing to accept LLW for controlled burial is, therefore, a development that could, ultimately, lead to problems for small users.

6.41 Dustbin disposal of small user VLLW is an ongoing practice. It is not clear that particular difficulties exist, but the numbers of privately-owned landfill sites that are prepared to accept such waste, and the potential impacts of the implementation of the EU Landfill Directive 1999/31/EC[15] and the EU Water

Framework Directive 2000/60/EC[16], are matters that should, sensibly, be kept under review to avoid possible difficulties in future.

6.42 There is also a need to keep under review the ongoing availability of incinerators, not least to deal with the problem of wastes, which, because of their nature, cannot be buried directly. This is particularly relevant for the medical sector where almost all combustible LLW and VLLW is incinerated. There appears to be little evidence of integration between the EU Waste Incineration Directive 2000/76/EC[17] and the 1999 EU Landfill Directive[15] for conventional and radioactive wastes, which could cause future problems for small users.

The UK Radioactive Waste Inventory

6.43 RWMAC believes[1] that the joint sponsors of the RWI, Nirex and Defra, should identify, and set out clearly, what wastes are to be included under the LLW heading in the RWI. The scope of RWI data for the lower activities of waste requires revision if it is to be of value to the LMA.

6.44 It is clear from the points raised earlier in this report that not all potential LLW is included under the RWI LLW heading. RWMAC's suspicion is that it is more akin to the volumes of LLW that nuclear operators currently anticipate they will send to Drigg. Whatever intentions apply, the issue needs to be clarified in order to ensure that the RWI is as accurate and informative as possible.

6.45 Efforts should be made to improve the accuracy of forecasts of future LLW arisings. As nuclear facility decommissioning and site clean up plans are prepared, and approved by the HSE, they should be required to include estimates of waste arisings that can be fed directly into the RWI.

7. Recommendations

Policy for the management of low activity radioactive wastes

7.1 The Government should review policy and strategy for the management of nuclear industry and small user LLW and VLLW to put it on a current, coherent, and openly declared basis. The management of such wastes is essentially being decided by default rather than design. Within such a review, the meaning of VLLW, where applied in the context of the nuclear industry (e.g., in respect of volume restrictions), should be made clear.

7.2 The review should include consideration of the UKAEA proposal for recognition of VLRM (see Annex 4), which could be dealt with by means other than disposal to Drigg. This is not least because estimates of the potential volume

of such wastes are a number of times larger than the capacity of the existing Drigg facility.

7.3 Consideration of the role of in-situ burial and on-site landfill disposal of LLW and VLLW (or the nuclear industry equivalent) for arisings from nuclear facility decommissioning and site clean-up programmes will be necessary. Without this, there is the possibility that operators could be committed to inappropriate waste management practices. For example, huge volumes of slightly contaminated wastes might be excavated and transported from one place to another. The environmental detriment and enormous public expense, and hence the justification for such a practice, need to be evaluated and considered. The use of in-situ or on-site disposal routes could have major implications for the volumes of such wastes that have to be accommodated off-site, either by Drigg or by landfill sites. HSE would need to be clear how in-situ burial or on-site landfill disposal related to its interpretation of the "no danger'" criterion applied to the delicensing of nuclear sites.

7.4 The way in which Dounreay wastes are to be managed – both future arisings and those already held in the LLW disposal pits – needs to be considered and decided as soon as possible. This must involve the UK Government and the Scottish Executive, not just the regulatory bodies, because national policy issues are involved. Opening of the Drigg disposal route through regulatory decision alone is liable, in RWMAC's view, to compromise seriously the BPEO studies that UKAEA is undertaking to assess the best long-term means of dealing with Dounreay's LLW. Communities far from Dounreay, and across national borders, will be affected by any Drigg disposal decision.

7.5 The public and stakeholders should be engaged in the development of future policy for the management of low activity wastes in order to secure their confidence in any proposals. The relative costs, hazards, and risks associated with the various possible approaches, evaluated across all those groups potentially affected, need to be fully set out, understood and weighed in the balance as part of this process. RWMAC recommends that consideration of LLW issues should be included either within the *Managing Radioactive Waste Safely* programme itself, or, preferably, conducted in parallel with it, employing a similar approach of wide and open public discussion with direct engagement of the public.

Other necessary Government policy decisions

7.6 The review of approaches to decommissioning promised in the *Managing the Nuclear Legacy* White Paper[9] and the Government's July 2002 statements on delivery of the *Managing Radioactive Waste Safely* programme could have major implications for future arisings of LLW and VLLW. Hence, the review of, and the

decisions made concerning, decommissioning policy all need to be completed as soon as possible.

7.7 The Government should declare its policy on, and the standards to be used for, the remediation of radioactively contaminated land, both on and off nuclear licensed sites, as soon as possible. This would help to guide the work of the waste producers, including, most notably, the proposed LMA, in refining their estimates of future LLW and VLLW arisings from nuclear facility decommissioning and site clean-up programmes. Accurate estimation of arisings will be impossible until the policy and the standards are made clear.

7.8 RWMAC also reiterates its call for a comprehensive review of the RSA93 system of Exemption Orders in order to place them on a sound basis and to clarify their applicability to the decommissioning of nuclear facilities and the clean-up of radioactively contaminated land.

Availability of disposal routes

7.9 The volume and radiological capacity of Drigg, and estimates of its remaining life, should be reviewed following evaluation of BNFL's OESC and PCSC assessments by EA.

7.10 In deciding how Drigg should be operated as a national asset, the means by which access to the facility could be made more amenable to small users should be investigated and clarified.

7.11 Government and the regulators need to keep under review the capacity of landfill sites for controlled burial and dustbin disposal, and of incinerators willing to accept LLW and VLLW. Such a review should encompass how small user wastes, and wastes that create direct disposal difficulties, are to be dealt with. This recommendation is consistent with a previous recommendation to Ministers[18]. There are signs that the availability of such sites, which are particularly important to small users, is in decline. If necessary, the UK Government, the Devolved Administrations and the regulators, should plan for alternative management approaches for such waste.

7.12 An important and pressing need in this respect is a review of the implications of the EU Landfill Directive 1999/31/EC[15] and the Water Framework Directive 2000/60/EC[16] for the future disposal of LLW and VLLW to landfill sites. Similarly, the implications of the EU Incineration Directive 2000/76/EC[17] and the 1999 EU Landfill Directive[15] for the operation of incineration facilities need to be assessed. Definitive reviews of these issues need to be undertaken as soon as possible.

7.13 In light of its intended operational responsibility for both the Drigg and Dounreay sites, the proposed LMA should be asked by the UK Government and the Devolved Administrations, to produce, at an early stage, a strategic assessment of the needs of a future programme for developing the UK's long-term management capability for LLW.

UK Radioactive Waste Inventory Issues

7.14 Nirex and Defra should review and agree a policy for the inclusion of low activity wastes in the 2004 RWI, to ensure that it reflects all management liabilities. It is not clear to RWMAC precisely what has not been included in previous RWIs. Exclusion of large volumes of waste from nuclear facility decommissioning and site clean-up programmes seriously limits the RWI's use as a planning tool e.g., by the proposed LMA. At the very least, all exclusions must be specifically and clearly stated.

7.15 Refined estimates of LLW and VLLW (or nuclear industry equivalent) arisings from nuclear facility decommissioning and site clean-up activities are needed for inclusion in the RWI. The extreme fluctuations recorded for LLW arisings between the 1998 and 2001 RWIs are worrying, and call into question its adequacy for future planning requirements.

7.16 Operators should be required to identify the volume and timing of the waste arisings associated with their decommissioning plans; these should be transferred directly into the RWI. Such direct linkages would, in RWMAC's view, be more transparent and therefore beneficial. They would also help with more accurate estimation of the potential remaining lifetime of Drigg. Much of this work may conceivably fall to the proposed LMA.

7.17 RWMAC has failed to establish the extent of probable future LLW and VLLW arisings from oil and gas extraction operations. This is because no responses were received from the industry to the Committee's enquiries. Government and the regulators should pursue this issue with those concerned.

References

1. The Radioactive Waste Management Advisory Committee's Advice to Ministers on the United Kingdom Radioactive Waste Inventory, Department for Environment, Food and Rural Affairs, March 2003.

2. Managing Radioactive Waste Safely: Proposals for Developing a Policy for Managing Solid Radioactive Waste in the UK, Department for Environment, Food and Rural Affairs et al, September 2001.

3. The 2001 United Kingdom Radioactive Waste Inventory, Department for Environment, Food and Rural Affairs and Nirex, Department for Environment, Food and Rural Affairs and UK Nirex Limited, December 2002.

4. The 1998 United Kingdom Radioactive Waste Inventory, Department for the Environment, Transport and the Regions and Nirex, July 1999.

5. Control and Remediation of Radioactively Contaminated Land: a Consultation Paper, Department for the Environment, Transport and the Regions, February 1998.

6. Twenty Second Annual Report of the Radioactive Waste Management Advisory Committee, Department for Food, Environment and Rural Affairs, October 2002.

7. Nineteenth Annual Report of the Radioactive Waste Management Advisory Committee, Department for the Environment, Transport and the Regions, August 1999.

8. Council Directive 96/29/Euratom of 13 May 1996, laying down basic safety standards for the protection of the health of workers and the general public against the dangers arising from ionising radiation, Official Journal of the European Communities L-159 of 20 June 1996.

9. Managing the Nuclear Legacy: a Strategy for Action (Cm 5552), TSO (The Stationery Office), July 2002.

10. Radioactive Substances Act 1960, A Guide to the Administration of the Act, Department Of the Environment et al, HMSO, 1982.

11. Review of Radioactive Waste Management Policy: Preliminary Conclusions, Department of the Environment, August 1994.

12. Review of Radioactive Waste Management Policy: Final Conclusions (Cm 2919), HMSO, July 1995.

13. Harvey, M P et al, A Review of the Radiological Implications of Disposal Practices for Very Low Level Solid Radioactive Waste, DoE Report No. DoE/HMIP/RR195006, 1995.

14. Dounreay Site Restoration Plan, The United Kingdom Atomic Energy Authority, October 2000.

15. Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste, Official Journal of the European Communities L-182 of 16 July 1999 and L-282 of 5 November 1999 (corrigendum).

16. Council Directive 2000/60/EC of 23 October 2000 establishing a framework for Community action in the field of water policy, Official Journal of the European Communities L-332 of 28 December 2000.

17. Council Directive 2000/76/EC of 4 December 2000 on the incineration of waste, Official Journal of the European Communities L-332 of 22 December 2000.

18. The Radioactive Waste Management Advisory Committee's Advice to Ministers on The Problems of "Small Users" of Radioactive Materials, Department of the Environment, Transport and the Regions, September 2000.

19. Disposal Facilities on Land for Low and Intermediate Level Radioactive Wastes: Guidance on Requirements for Authorisation, The Environment Agency et al, January 1997.

20. The Radioactive Waste Management Advisory Committee's Advice to Ministers on Restoration of the UKAEA Dounreay Nuclear Site, Department for Environment, Food and Rural Affairs, September 2001.

21. Safety Audit of Dounreay 1998, Health and Safety Executive and the Scottish Environment Protection Agency, August 1998.

Annex 1

RWMAC Low Activity Wastes Working Group

The members of RWMAC's Low Activity Waste Working Group charged with securing data, undertaking their analysis, and preparing draft reports for this study were:

Mrs Catherine Griffiths (Chair) Consultant Medical Physicist, Sheffield Teaching Hospitals NHS Trust

Professor Andrew Blowers, OBE Professor of Social Sciences, the Open University

Professor Keith Boddy, CBE, OBE Former Head of Regional Medical Physics Department, Newcastle General Hospital

Dr Martin Courtis, OBE Consultant specialising in radioactive waste management

Miss Frances Fry Division Head, National Radiological Protection Board

Professor Tony Harris Emeritus Professor of Geology, University of Liverpool

Mr John Hetherington Consultant with interests in radioactive waste management and radiological safety

Dr Les Mitchell Consultant specialising in environment and energy issues

Mr George Reeves Postgraduate Course Director in Engineering Geology, University of Newcastle upon Tyne

Miss Susanne Stoessl Former Head of Broadcasting Research, BBC

Annex 2

Collection of information and data for study

A2.1 Information and data for the low activity wastes study were assembled in the following manner. In some cases, follow-up enquiries were made.

Waste holders

A2.2 Written questions were sent to BNFL, UKAEA, British Energy, MoD and Amersham plc on 13 March 2002. All responded.

A2.3 The Working Group met BNFL Drigg managers on 20 January 2002 to discuss operation of the disposal facility and preparation of the OESC and PCSC statements for the Environment Agency (see Annex 3).

A2.4 Working Group members visited the Bradwell nuclear power plant on 22 April 2002 to discuss with BNFL Magnox managers the way in which low activity wastes were managed.

A2.5 Working Group representatives attended the VLRM management seminar organised by UKAEA and held at NRPB, Chilton, on 19 September 2002.

Regulatory bodies

A2.6 Written questions were sent to HSE on 13 March. A response was received.

The Working Group met EA on 19 February 2002 and SEPA on 20 May 2002. Copies of questions were sent in preparation for the meetings.

NGOs

A.2.7 Written questions were sent to Greenpeace, Friends of the Earth and the Nuclear Free Local Authorities on 8 February 2002. All responded.

Associations

A2.8 RWMAC wrote to the Environmental Services Association (including landfill operators), the Association of the British Pharmaceutical Industry and the United Kingdom Offshore Operators Association on 8 February 2002. No response was received from any of these organisations.

A2.9 Some relevant information was also gathered during the RWMAC's UK Radioactive Waste Inventory study.[1]

Annex 3

Details of UK LLW disposal sites

A3.1 This annex gives further details of the various routes for LLW disposal discussed in chapter 3, namely Drigg, Dounreay, in-situ burial on licensed nuclear sites and controlled burial to off-site landfill.

Drigg

A3.2 Drigg is central to the management of UK LLW. It is a near-surface disposal facility able to accept the majority of LLW streams, which opened for disposal operations in 1959. About one third of the site has planning consent for the development of waste disposal facilities (the "currently consented area"). Tumble-tipping of waste into seven clay-lined trenches took place until 1995 (all these trenches are now covered over). There is also a concrete-lined vault for the disposal of ISO containers that is expected to be full before 2006. Plans are in hand for a deeper vault to accept waste after this date. Altogether, about 950,000m^3 of waste has so far been buried at the Drigg site.

A3.3 The RSA93 authorisation for Drigg covers more than the current consented area in order to control off-site emissions. Leachate is collected and discharged to sea through a marine pipeline. The geology of the site is complicated and, consequently, the means by which radionuclides can migrate off-site is not easy to predict.

A3.4 Although it is a large facility, Drigg still has a finite capacity and therefore a limited lifetime. Various limits and conditions are used, among other things, to optimise its working life. Not all LLW is suitable for disposal at Drigg and these wastes have to be conditioned and stored pending an alternative solution. The way Drigg is managed is likely to undergo significant change if, as proposed in the Government's White Paper *Managing the Nuclear Legacy*[9], it is taken over by the LMA.

A3.5 Drigg currently forms part of BNFL's profit-earning activities. The site appears to enjoy a high degree of legitimacy in the eyes of the public. In terms of a secure management route for large volume disposals, it has, at present, few, if any, rivals. This gives BNFL an effective monopoly. At present, it is run on a commercial basis, albeit with arrangements in place to ensure that non-BNFL customers are not unfairly treated. The question of Drigg charging policy and associated issues are highly current in view of the *Managing the Nuclear Legacy* White Paper statement that the proposed LMA should take on responsibility for the

site. This states that the management contract to be placed by the LMA will *"require the site to be operated as a national asset open, as now, to all waste producers with a need to use it"*. The precise meaning of this statement, and its implications, will need to be decided, including how the LMA's interest in running Drigg as a national asset can be effectively separated from its interest in use of the facility to support its clean-up activities. In this context, consideration will also need to be given to how Drigg can, in future, best meet the relevant needs of small users.

A3.6 Drigg has a finite volumetric and radiological capacity. This, in conjunction with estimates of rates of disposal, can be used to assess the likely lifetime of the existing facility. Current estimates of Drigg lifetime, developed from a 1987 NRPB assessment of radionuclide capacity, were based on a dose target of 0.1mSv/yr, which, at that time, was taken to deliver a 10^{-6} per year risk target. NRPB estimates were divided by 30 to derive the current radionuclide annual disposal limits. For example, the annual radiological limit for radium-226, based on this formula, is 30GBq. It should be noted that tritium is an exception in that lower annual limits were set by the regulators. As the upper limit for LLW is 4GBq/te, potentially only 7.5 tonnes of LLW containing radium-226 can be disposed of annually.

A3.7 In practice, there are a range of radionuclides which are subject to rather restrictive annual disposal limits. In addition to radium-226, these include uranium, thorium-232, other alpha emitters, carbon-14 and tritium. The current BNFL planning assumption, based on the 1998 UK RWI is that disposal of carbon-14, cobalt-60 and some other radionuclides are, ultimately, likely to exceed the site capacity. The Drigg OESC and PCSC assessments currently being considered by EA (see paragraph 3.4) should shed further light on this matter and could, ultimately, affect the view of Drigg's radiological capacity.

A3.8 Preservation of capacity has been, and will continue to be, an issue for BNFL until the proposed LMA inherits the problem along with the site itself. BNFL maintains a system of protection of Drigg radiological capacity by restrictions on the disposal of certain key radionuclides. The volume of waste disposals can also be restricted, for example, by placement of annual limits, as part of RSA93 authorisations, on waste-producing sites. There are potential tensions between volume limits and radiological limits, i.e., optimum use of physical space could be achieved by restricting the specific activity of the waste disposed of. Conversely, the aim could be to optimise Drigg's radiological capacity at risk of leaving physical space unfilled.

A3.9 The site's remaining volumetric capacity is currently estimated to be of the order of 800,000m^3. The 2001 UK RWI estimated the volume of LLW in store,

plus predicted arisings, to be 1,500,000m^3. This RWMAC study has shown that this figure could be a substantial underestimate if the complete range of LLW is taken into account. For present BNFL operational planning purposes, 2050 is taken to be the date at which the currently consented area at Drigg will be full. If this proves to be accurate, replacement provision will be needed after 2050.

A3.10 BNFL submitted its OESC and PCSC assessments for the Drigg site to EA on 30 September 2002. The OESC covers the period during which Drigg is still actively managed and the PCSC deals with the period beyond managed control of the site. The aim of these assessments is to demonstrate that disposal to Drigg is consistent with Government policy and can meet legal requirements. They are also intended to inform the regulatory decision-making process in relation to the limits and conditions included in future disposal authorisations. In particular, they will be a highly important factor in looking again at the operational lifetime of the facility.

A3.11 The OESC and PCSC assessments will require lengthy scrutiny by EA. Given the processes necessary, a new authorisation for Drigg is unlikely to be in place before 2005 (see paragraph 6.31). While it is possible to identify some of the key issues, notably whether historic and future disposals can meet the 10^{-6}/y risk target that EA requires to be met[19], it would not be helpful to speculate on the outcome at this point in time. Suffice it to say that EA has confirmed, in light of consideration of the possible OESC and PCSC outcomes, that its view of the lifetime capacity of the site could ultimately prove to be quite different to the present operational reference case of about 50 years.

A3.12 Forecasts of the timescale for exhaustion of Drigg capacity are central to any strategy for managing the UK's low activity wastes. However, there are uncertainties which inevitably impact upon such forecasting. They include:

– the reliance that can be placed on estimates of the volume and timing of future arisings that will need to be disposed of at Drigg;

– trends in availability, and use of, other disposal routes, which could place added pressure on Drigg (but could also, quite possibly, relax that pressure);

– the outcome of the present Drigg OESC and PCSC assessments (covering the period to around 2050);

– the scale of the possible additional waste burden consequent on decisions about the clean-up of Dounreay.

A3.13 These issues are discussed elsewhere in this report. But, depending on

their resolution, the end-date for Drigg operations could turn out to be either optimistic or pessimistic. It is very unlikely indeed, unless current estimates of waste are wildly overestimated (and this is highly unlikely), that the UK can avoid having to secure additional capacity sometime during the present century.

Dounreay

A3.14 UKAEA's Dounreay nuclear site, situated in Caithness, Scotland, was commissioned as the major UK centre for research into fast reactor technology. Its three reactors have been shut down for some time and are now being decommissioned. Work at Dounreay now focuses on site environmental remediation and waste management. During the operational phase, and into decommissioning, all low activity wastes above VLRM levels (see paragraph 3.9) were disposed of to the Dounreay pits – seven trenches that are about seven metres deep. Some capacity, about $100m^3$, remains in one of the pits, but no further disposals are being made. The volume of waste in the pits is of the order of $33,000m^3$.

A3.15 Past disposal practices at Dounreay sometimes fell short of what would be acceptable today. Although the total volume and activity of disposals made to the pits are known, there is a significant degree of uncertainty about the detail of the contents of some pits, and variability in the quality assurance of some historic disposals.

A3.16 Like Drigg, the Dounreay pits represent, in principle at least, the "final disposal" of the wastes buried in them. It would be the intention to leave the waste in place over a long period allowing the radioactivity to decay, with suitable safeguards in place to prevent intrusion and the release of radioactivity from the pits. There is no real precedent because the Drigg facility is not yet full, but an assessment of the long-term safety of the wastes would normally be carried out. On the face of it, therefore, a PCSC is required. (It is of course possible to argue that, in both cases, the assessment should have taken place well before the bulk of the wastes were buried.)

A3.17 In its report on the DSRP[20] issued by UKAEA in October 2000, RWMAC stated:

> "An early action in development of the DSRP should be to examine, more critically, the longer term sustainability of the … LLW pits, including whether their location, and the condition of the historic arisings they contain, can possibly sustain a rigorous post-closure safety assessment. If not, there are implications for the way in which all Dounreay LLW, both historic and future arisings, are to be managed."

A3.18 The RWMAC report was sceptical as to whether a satisfactory PCSC could be made. The possibility that the waste contents of the pits might, at some

stage, have to be dug up and either stored or transferred to some other disposal location could not be ruled out. At the same time, it was made clear that the waste in the pits did not currently raise practical problems, at least in the short term. RWMAC was informed that, at the time of preparation of this low activity wastes report, some safety assessment studies of the pits had been carried out by UKAEA, as part of a BPEO study of the long-term strategy for managing LLW waste at Dounreay, but that this did not as yet constitute part of a full PCSC assessment of the kind that has been undertaken for Drigg.

A3.19 Present management practices at Dounreay are driven by the outcome of an HSE-SEPA Safety Audit, undertaken in 1998[21], which recommended that UKAEA should develop a modern, engineered, on-site LLW facility. The audit required that, in the meantime, UKAEA should dispose of waste to Drigg wherever possible, and make adequate arrangements for interim storage. Current LLW arisings are currently treated and placed in an on-site store. In April 2002, UKAEA applied to SEPA for authorisation to send LLW to Drigg for disposal. Full details of the application have not yet been made public, but UKAEA has indicated that it is seeking agreement to transfer some 750m^3 of current arisings per annum. UKAEA has also indicated that in order to carry out the planned site restoration programme, approximately 80,000m^3 of LLW would be generated, with no more than 4,000m^3 in any one year. Not all such arisings are suitable for disposal at Drigg, notably alpha bearing wastes.

A3.20 Work is also being carried out at Dounreay to develop a long-term waste management facility as part of UKAEA's BPEO study of the long-term strategy for managing LLW arisings from the site. This is notable in the sense that it represents a unique attempt by a nuclear site to find a solution to its waste problem. RWMAC has said that this "*needs to be made a key output of the DSRP*"[20]. However, on the basis of the information available to RWMAC, UKAEA – in response to regulatory pressure to comply with the 1998 Safety Audit requirements – also appears to have effectively pre-empted the outcome of the BPEO study by seeking approval for transfer of LLW to Drigg.

A3.21 The recommendation of the Safety Audit that existing disposal routes should be used is, in itself, logical and sensible. Indeed, RWMAC itself has said that storage is not an acceptable long-term solution for the waste[20]. However, the transfer proposal raises an important issue in relation to how waste management policy at Dounreay is being decided, and its consequent implications. First, it appears to cut across the reference case for LLW management in the DSRP which envisages interim site storage pending the development of a long-term management solution. Second, it gives the impression of policy being made "on the hoof" by the regulators and not, as it should be, in the context of an appropriate UK radioactive waste management strategy, backed up by national debate.

A3.22 Hence, management of LLW at Dounreay also poses a degree of uncertainty for the development of a management strategy for low activity wastes:

– the effect of the transfer of operational wastes to Drigg on estimates of that facility's capacity lifetime;

– the possibility of a negative PCSC assessment of the Dounreay pits and the resulting impact on the amount of waste that would, then, need to be managed;

– the successful development of a new LLW facility at Dounreay that would, effectively, take site restoration wastes out of the strategy.

A3.23 UKAEA proposes a different strategy for dealing with its VLRM (see Annex 4). The absence of an appropriate management route for this material could, potentially, constitute a bottleneck in site restoration operations. The strategy involves segregation of VLRM from LLW and its disposal by means of controlled burial, although whether this would involve on-site landfill or use of some other facility is not yet clear. In the interim, until the necessary planning and regulatory consents are in place, VLRM is to be stored.

A3.24 UKAEA is currently seeking technical and other stakeholder views on its proposed strategy for VLRM. The aim of self-sufficiency in management of these large-scale wastes, with the explicit aim of obviating the need for additional transfers to Drigg, is to be welcomed.

In-situ disposal on licensed nuclear sites

A3.25 Some LLW arisings from nuclear operations can, in principle, be disposed of at the point of arising as opposed to being transferred for disposal off-site, although the types of wastes suitable for this are likely to be limited.

A3.26 In the past, in-situ burial or on-site landfill disposal of low activity wastes has been authorised at a number of UK nuclear sites including, for example, Dounreay and AWE Aldermaston. Such arrangements have been progressively discontinued in the more recent past. The most notable examples that continue to exist are the South Landfill and Calder Plain Landfills at Sellafield.

A3.27 The proposed decision for the future regulation of disposals of radioactive waste from BNFL, Sellafield, published by EA in August 2002, included provision for disposal of certain categories of low activity wastes, including building rubble and contaminated soil, to these two landfill areas. The proposed authorisation will permit the disposal of material at the South Landfill, and a segregated area of the Calder Plan Landfill extension, at contamination levels of not greater than 37Bq/g

(0.037GBq/te) total activity with not greater than a 18.5Bq/g (0.0185GBq/te) alpha component. For the main part of Calder Plain Landfill extension, the limits for disposal are 3.7Bq/g (0.0037GBq/te) total activity with not greater than a 1.85Bq/g (0.0017GBq/te) alpha component. Annual limits of 36,000m^3 and 24,000m^3 were placed on these two routes for disposal. The limit of 37Bq/g (0.037Bqte) is set approximately 100 times lower than the upper LLW activity limit and about 100 times greater than the SoLA EO level.

A3.28 In its decision document[22], EA revoked other previously authorised forms of in-situ burial, as opposed to landfill disposal, previously authorised on the Sellafield site. In so doing, it deemed in-situ burial to be a contaminated land, rather than a radioactive waste disposal issue, that should be regulated in future by HSE under its site licensing arrangements.

A3.29 The concept of in-situ, or on-site landfill, disposal has some obvious difficulties. There is a statutory requirement that before nuclear sites can be released from HSE's regulatory control ("delicensed"), there should be "no danger" from radiation. This has served to provide the view that such sites are to be returned to their original "greenfield" state available for completely unrestricted future use. In RWMAC's opinion, such a view is being called increasingly into question. For example, the DSRP suggests that some parts of the Dounreay site may need to be access-controlled for up to 300 years.

A3.30 The Committee believes that the impracticability of all radioactivity being removed from decommissioned nuclear sites, an impression that may still exist to a significant extent, needs now to be recognised. There is a probability that some waste will have to remain, potentially through practices such as in-situ burial. This could, in turn, imply some form of ongoing access control and/or restriction of use. Ultimately, the objective should be to decide how to deal with the existing radioactivity in the manner that achieves the best societal and environmental outcome. RWMAC perceives that such considerations represent a major challenge to HSE in deciding its interpretation of the "no danger" criterion.

Landfill sites

A3.31 Landfill sites are used for burial of LLW and dustbin disposal of small user VLLW. They are also sometimes used for the disposal of low activity nuclear industry wastes that are equivalent to VLLW. Landfill disposal of LLW requires use of a technology known variously as "controlled burial" or "special precautions" or "trench" burial (most commonly the first of these). The waste producer is authorised for controlled burial in relation to landfill sites that have good containment characteristics. It is a process carried out separately from the disposal of other forms of waste. The wastes are packaged in bio-degradable sacks, and special trenches are excavated to take them. The trenches are situated around the site and

are covered in a minimum of 1.5 metres of soil immediately the disposal has taken place. Non-radioactive wastes are disposed of on top of the sacks before top-surfacing of each section of the site takes place. Amersham plc also uses controlled burial for low activity waste arisings (mainly from decommissioning) that are equivalent to VLLW; in this case, the wastes are buried in trenches with non-radioactive wastes, in generally bulk form, placed on top. Small user VLLW is disposed to landfill as part of normal domestic refuse arrangements.

A3.32 As noted elsewhere in this report, the numbers of landfill sites that are prepared to accept radioactive waste appear to be diminishing, although the situation does not appear to have yet reached the stage which, in terms of availability, is critical. Potentially, the implementation of EU Landfill Directive 1999/31/EC[15] and the EU Water Framework Directive 2000/60/EC[16] could be seen to point to the further curtailment, and possible cessation, of such activities. This may also affect incineration in respect of disposal of the secondary residues. The EU Incineration Directive 2000/76/EC[17] may also have implications for management of low activity wastes.

A3.33 The Landfill Directive aims to prevent, or reduce as far as possible, the negative effect of use of landfill on the environment and on human health. A key provision is the separation of Member State landfills into three classes of sites, dealing with hazardous, non-hazardous and inert wastes, restrictions on the first being the most stringent. Co-disposal of hazardous waste with non-hazardous or inert waste is not permitted. This runs counter to UK practice of using landfill for radioactive waste disposal.

A3.34 However, it is currently the Government's and EA's view that radioactive waste is outside the scope of the Directive, although this could, of course, be challenged. The key point may be whether the waste has other hazardous properties, such as the presence of spent lime from the gas cleaning systems of incinerators authorised to burn radioactive waste.

A3.35 If it were to be decided that co-disposal could not take place, all disposals of low activity wastes might have to take place at Drigg, which is the UK's only dedicated facility for radioactive waste. In principle, this would include some secondary radioactive residues from incineration. In practice, Drigg acceptance criteria place restrictions on disposals on account of both radionuclide content and other properties such as the presence of corrosive or organic material, which are characteristic of some small user waste streams, particularly from hospitals. These waste streams are currently disposed of to landfill.

A3.36 Dustbin disposal has its origin in the disposal of suitable radioactive waste, together with domestic refuse, to landfill without the need for additional

precautions or any site specific radiological assessment. This situation was last reviewed in 1994/95[13]. Local Authorities are currently revising their domestic waste management strategies as landfill becomes a scarce resource. There is an increasing move towards sorting, recycling and re-use of waste where possible, and increased introduction of the use of municipal incineration to minimise waste volumes. The strategy for VLLW dustbin disposal needs to be reviewed in conjunction with the LLW review, including developing confidence in the outcome through public and stakeholder engagement.

Annex 4

UKAEA Proposal for VLRM waste category

A4.1 This annex discusses outline details of a new category of radioactive waste provisionally termed Very Low Radioactive Material (VLRM), proposed by UKAEA. This proposal was discussed at a by-invitation seminar in September 2002, which RWMAC representatives attended. The details, and estimates, of VLRM given here are quoted with the agreement of relevant seminar participants.

What is VLRM?

A4.2 UKAEA has suggested that VLRM be defined to cover large quantities of low activity radioactive waste, that are currently stored in its nuclear licensed facilities or are anticipated to arise from future site decommissioning activities, with an activity level not exceeding 40Bq/g (0.04GB/te) for beta/gamma radionuclides and 1–2Bq/g (0.001–0.002GBq/te) for alphas.

A4.3 RWMAC sees the proposed term VLRM itself to be problematic as, within the context of RSA93, "material" is taken to mean a radioactive substance or article which is not waste. A possible more appropriate term could be something like "Site Restoration Waste" (SRW).

A4.4 Taking account of all forms of radioactivity, VLRM has a declared upper activity limit substantially above the SoLA exemption level of 0.4Bq/g (0.0004GBq/te), but several orders of magnitude below the upper threshold activity level for LLW.

Why the need for VLRM?

A4.5 Large volumes of relatively low activity radioactive wastes are predicted to arise from decommissioning and clean-up of nuclear licensed facilities.

A4.6 The current LLW disposal facility at Drigg has finite capacity and needs to be managed as a national resource. The volumes of VLRM that have been undeclared to date in the RWI could account for a substantial portion of the remaining Drigg volume capacity. If all the VLRM were to be sent to Drigg, it could seriously constrain disposals of other wastes with an activity level closer to the upper end of the LLW activity range.

A4.7 In general, it is the belief of the nuclear industry that wastes with activity towards the lower end of the LLW activity range can be managed safely and cost-

effectively in simple disposal facilities. Drigg is believed to be over-engineered and over-priced in respect of disposals of VLRM.

A4.8 Some very approximate estimates of the potential levels of arisings of VLRM-comparable wastes were given at the UKAEA seminar. Indications of these amounts are given in Table A4.1. It should be noted that different operators estimate arisings using different definition (see A4.12) and also that estimates will vary depending on assumptions as to the timing of the arisings.

Table A4.1: Some very approximate estimates of VLRM- comparable arisings

Site(s)	Volume (m^3)	Comment
UKAEA		
Dounreay	33,000	Demolition wastes
	10,000	Contaminated soils
Harwell	15-20,000	Contaminated land
Winfrith	10-15,000	Concrete, etc
Culham	1-2,000	Tritiated Torus Hall and scrap metal
Windscale	Unknown	
BNFL		
Sellafield		
– building foundations	100,000	Volumes are for all waste below
– demolition wastes	1,000,000	ILW; full characterisation has not yet been carried out so the boundary
– South and Calder Floodplain Landfills	1,000,000	between LLW and VLLW is not
– contaminated soil	>1,000,000	known with any certainty but it is believed a large fraction will be VLLW.
Magnox sites	low tens of thousands of m^3	Will arise from contaminated land clearance after approx. 100 years of care and maintenance of reactor safestore
AWE		
– excavated soil	20,000	
– site tip	100,000	Historic facility, activity content uncertain, although probably NORM.
– Waste Management-Compound	thousands of m^3	Used for historic waste treatment activities
Old North Ponds	2000	Sediments in North Pond
Pangbourne pipeline	Unknown	

In practice, there could be other arisings from British Energy and other MoD sites.

A4.9 At its seminar, and in subsequent communications, UKAEA gave its approximate estimates of the costs of disposing of low activity wastes: clean/exempt wastes – £30–60 per m^3; burial of VLRM – £800 per m^3; disposal to Drigg – £5,000 per m^3 of raw waste. Whilst acknowledging that these figures are only very approximate, a key point to note is that for each 100,000m^3 of VLRM that is sent to Drigg, as opposed to being somehow buried on-site, the additional cost could be of the order of £420 million. Given that, overall, there could be much more VLRM material than 100,000m^3 (see Table A4.1), RWMAC believes that alternative forms of management in addition to Drigg disposal must seriously be considered by Government and the regulators.

Issues in respect of VLRM

A4.10 The options for disposing of VLRM would need-to be explored and subject to a BPEO assessment, but could include burial on-site, or close by, possibly with regional or national centres for its management.

A4.11 UKAEA has stated that it has engaged consultants to carry out two independent assessments of the potential exposures that could arise as a result of burial of VLRM on-site, either in trenches below ground or in mounds above ground. RWMAC has been informed that the assessments reported public doses to be insignificant in that they were two orders of magnitude below safety targets and four orders of magnitude below background radiation levels. RWMAC understands from UKAEA that these reports will be published in due course.

A4.12 BNFL Sellafield has a current authorisation for burial of waste in its South and Calder Floodplain Landfills of activity comparable to that proposed for VLRM. BNFL does not use UKAEA's VLRM category and instead applies a notional 4Bq/g activity limit for VLLW. This is inconsistent with the accepted definition of VLLW (see paragraph 3.1). Other sectors of the nuclear industry are now seeking comparable arrangements for their VLRM provided that the radiological and BPEO assessments meet Government policy and regulatory requirements.

A4.13 Dounreay is currently working on a BPEO assessment for LLW and VLRM which, it anticipates, will be available in March-August 2003 (see Annex 3).

A4.14 In some European countries, specific arrangements are in place for the disposal of the equivalent of VLRM. RWMAC understands that in Sweden, VLRM is disposed of in mounds above ground at the Forsmark nuclear facility. In France, Andra proposes to build a short-lived low activity waste disposal site at Morvilliers (see www. andra.fr/eng/dechets).

A4.15 NII reported that sites which have a disposal route for VLLW have been able to make good progress in decommissioning. The acceptance of VLRM linked to an appropriate disposal route would facilitate decommissioning activities on nuclear licensed sites.

Potential advantages and difficulties of the proposed VLRM concept

A4.16 Potential advantages and difficulties associated with VLRM arising out of the seminar discussions may be summarised as follows:

(a) potential advantages of VLRM or similar classification:

- would reduce needs for radioactive waste transport and preserve Drigg capacity;
- would reduce the need for additional decontamination of lower activity wastes in order to achieve free release, thereby reducing worker doses;
- fingerprinting of the waste activity is easier at 40Bq/g than at SoLA activity levels;
- would save taxpayer money currently projected to be spent on over-cautious management of low hazard waste. Proportionality is one of the principles of good regulation and is a societal issue.

(b) potential difficulties associated with VLRM or similar classification:

- the term VLRM would need to be reconsidered given the legal meaning of "material" in RSA93;
- there is no existing VLRM or similar waste classification;
- policy and provision for the management of any such classification would need to be decided by Government and the regulators;
- public perception and acceptability may be an obstacle;
- not least, there could be difficulty in securing disposal sites;
- there would need to be assurance of compatibility with any

future contaminated land regime, with interpretation of the “no danger” criterion associated with declicensing of nuclear sites, and with the EU Landfill Directive.

Glossary

Alpha particles	Relatively large particles emitted from the nucleus of a decaying atom which lose their energy over a very short range in air and have little penetrating power
AWE	Atomic Weapons Establishment; an organisation which designs and manufactures nuclear weapons, conducts research and development, and decommissions redundant warheads and associated process plants. The AWE sites are owned by the Government but operated by the private sector
BE	British Energy Generation Ltd; an operator of several UK nuclear power plants
Becquerel	Bq; the standard international unit of measurement of radioactivity – equivalent to one disintegration per second
kBq	Kilobecquerel; one thousand Bq
GBq	Gigabecquerel, one thousand million Bq
Beta radiation	Fast moving electrons emitted from the nucleus of a decaying atom, smaller than alpha particles and with more, although limited, penetrating power
BNFL	British Nuclear Fuels plc; a Government-owned company with interests in electricity generation, nuclear fuel manufacture and spent fuel management, and nuclear decommissioning and clean-up
BPM	Best practicable means; within a particular waste management option, the level of management and engineering control that minimises, as far as practicable, the release of radioactivity to the environment whilst taking account of a wide range of factors, including cost effectiveness, technological status, operational safety, and social and environmental factors
BSS Directive	Basic Safety Standards; Council Directive 96/29 Euratom

	lays down basic safety standards for the protection of the health of the general public from the dangers of ionising radiation
Carbon-14	A radionuclide that emits soft beta particles, with a half life of about 5,700 years
Cm 2919	A statement of Government policy for the management of radioactive wastes, published in 1995
Cm 5552	The Government's July 2002 White Paper "Managing the Nuclear Legacy" setting out its proposals to establish a LMA
Controlled burial	Defined in Cm 2919 in terms of the authorised disposal of some LLW at suitable landfill sites that possess good containment characteristics
Defra	Department for Environment, Food and Rural Affairs, the Government department responsible for environmental protection policy in England
Dounreay	A site licensed under the Nuclear Installations Act (NIA65), managed by UKAEA, formerly the UK centre for research into experimental fast reactor technology, now being decommissioned
Dounreay pits	A facility at Dounreay consisting of seven trenches, used for the disposal of low activity wastes above VLRM levels, which are now full
Drigg	The facility for the near-surface disposal of most of the UK's solid LLW operated by BNFL, near the company's Sellafield site, in Cumbria
DSRP	Dounreay Site Restoration Plan; UKAEA's strategy for decommissioning Dounreay's nuclear facilities, decontaminating the site, and managing the resulting wastes
Dustbin disposal	The process of collection of VLLW from small user sites by local authority refuse collectors and its disposal with ordinary waste to landfill

EA	The Environment Agency; one of the regulators for radioactive waste management in England and Wales. EA's powers are provided under RSA93
EOs	Exemption Orders; Regulations made under RSA93 which remove the need for individual regulatory approval of some activities and some classes of materials/wastes where provisions included in the orders themselves are sufficient to assure protection of the public
EPA90	The Environmental Protection Act 1990; legislation that, among other things, made changes to the management and regulation of the disposal of waste on land ("land-fill") and to incineration of wastes
Exclusion	A term associated with some materials and wastes that are not regarded as radioactive under the provisions of RSA93
Gamma particles	Energy emitted from the nucleus of atoms but without the movement of material (i.e., similar to X-rays). Gamma radiation has great penetrating power and substantial shielding is needed
HSE	The Health and Safety Executive; the governmental body responsible for regulating places of work. The Nuclear Installations Inspectorate, part of HSE, is responsible for regulating the safety of nuclear sites
In situ burial	The concept of the authorised burial of solid waste at the site at which it arises, including leaving contaminated soil in place
Incineration Directive	Waste Incineration Directive; European Council Directive 2000/76 which introduces stringent operating controls and sets minimum technical requirements for incinerators in EU Member States. A public consultation managed by Defra on proposals to implement the Directive in the UK ended in September 2002
Landfill Directive	European Council Directive 1999/31; the Directive aims to prevent, or reduce as far as possible, the negative effect of use of landfill on the environment and on human

	health. A key provision is the separation of landfill sites into three classes, dealing with hazardous, non-hazardous and inert wastes
Landfill disposal	The burial of waste, including some radioactive waste, in near-surface excavations, or landfills, operated by local authorities and the private sector
LLW	Low level radioactive waste; defined in Cm 2919 as "waste containing radioactive materials other than those acceptable for disposal with ordinary refuse, but not exceeding 4 gigabecquerels per tonne (GBq/te) of alpha or 12 GBq/te of beta/gamma activity (e.g., wastes which, under existing authorisations, can be accepted by BNFL's disposal facility at Drigg in Cumbria)"
LMA	Liabilities Management Authority; the public body which, under proposals in Cm 5552, will undertake the clean-up of those civil nuclear sites responsibility for which falls to the taxpayer. It is probable that the LMA's name will be changed to Nuclear Decommissioning Authority (NDA)
Low activity wastes	A term used in this report describing various solid radioactive wastes with low radioactivity levels – most LLW, and all VLLW and other wastes subject to EOs
LSA	Low specific activity; a term mainly used for LLW produced by the oil and gas industry (predominantly radioactively contaminated pipework scale). LSA scale has a relatively high radium content and, consequently, the majority of LSA waste streams do not meet the Drigg waste acceptance criteria
Magnox	Term for a design of nuclear reactor used in the UK's first generation nuclear power plants
MRWS	Commonly used abbreviation for "Managing Radioactive Waste Safely", a Government consultation paper on the future management of long-lived solid radioactive waste, published in September 2001
NAW	The National Assembly for Wales; the elected assembly for Wales, and the body responsible for most aspects of

	environmental protection policy in Wales under devolution arrangements
NIA65	The Nuclear Installations Act 1965; legislation covering the licensing and safety of nuclear sites, from which the Nuclear Installations Inspectorate (part of HSE) derives many of its powers
Nirex	United Kingdom Nirex Ltd; a company owned by the Government and the civil nuclear industry, the work of which mainly relates to advice on the management of intermediate level radioactive waste and some LLW, and production of the RWI
"No danger"	A term associated with the requirements of NIA65 relating to the delicensing of nuclear sites at a point where there is "no danger" from residual radiation. This is an issue currently being addressed by the HSE
OESC	Operational Environmental Safety Case; a means of appraising the operation of a radioactive waste disposal site, in terms of compliance with radiological protection standards, covering the period up to its closure
PCSC	Post Closure Safety Case; a means of appraising a radioactive waste disposal site, in terms of compliance with radiological protection standards, focussing on assurance that the site can eventually be closed and on its post-closure performance
Radium-226	A radionuclide that emits alpha particles, with a half-life of 1,600 years, often used in the manufacture of luminising materials
RSA93	The Radioactive Substances Act 1993; Legislation which provides for the regulation of the disposal of radioactive wastes (including discharges to the environment). The Act also provides for regulation of the accumulation and storage of radioactive wastes on non-nuclear sites (storage and accumulation on licensed nuclear sites being provided for by NIA69). The provisions of the Act also specify which materials and wastes are regarded as being radioactive for the purpose of regulation

RWI	The United Kingdom Radioactive Waste Inventory; a published record of information on the origins, quantities and properties of radioactive wastes in the UK, both currently managed and predicted to arise
Safegrounds	Term for an initiative by the CIRIA Learning Network, which is supported by the Government and parts of the nuclear industry, addressing issues associated with the clean-up of nuclear and major defence sites in the UK
Safestore	A decommissioning strategy, described in Cm 2919, whereby the more active buildings of a nuclear facility would be prepared for a long (around 100 years) period during which no routine maintenance would be required, the intention being to facilitate radioactive decay prior to final dismantling
Schedule 1	Schedule 1 of RSA93; a provision that, for eight identified elements in the uranium and thorium radioactive decay chains, defines lower limits of activity concentrations above which materials are treated as radioactive
SE	The Scottish Executive; the Cabinet of the Scottish Parliament, which, in turn, is the body responsible for most aspects of environmental protection policy in Scotland under devolution arrangements
SEPA	Scottish Environment Protection Agency; the regulators for radioactive materials and radioactive wastes in Scotland. SEPA's powers are provided under RSA93
Small users	Organisations that use radioactive materials and create radioactive wastes that are not part of the nuclear sector licensed under NIA65, including hospitals, universities, and industrial undertakings
SoLA	Substances of Low Activity EO; among other things, SoLA removes the need for individual authorisation of disposal of some solid radioactive wastes the activity of which is less than 0.4 becquerels per gram (Schedule 1 activity limits are disregarded for the purposes of SoLA)
Tritium	The radioactive form of hydrogen

UKAEA	A state-owned nuclear operator largely responsible for the decommissioning of nuclear facilities, including those at Dounreay
VLLW	Very low level radioactive waste; defined in Cm 2919 as "waste which can be safely disposed of with ordinary refuse ("dustbin disposal"), each $0.1m^3$ of material containing less than 400 kilobecquerels (kBq) of beta/gamma activity or single items containing less than 40 kBq of beta/gamma activity". VLLW normally excludes alpha-bearing waste and sets specific limits for tritium and carbon-14
VLRM	Very Low Radioactive Material. A radioactive waste classification, proposed by UKAEA for nuclear plant decommissioning and site clean-up purposes, falling at the lower activity end of the LLW range. VLRM incorporates wastes containing up to 40 Bq/g of relatively short-lived beta/gamma activity and long-lived alpha-bearing wastes of about 1–2Bq/g. The category is expressly restricted to large scale arisings of construction wastes from decommissioning and contaminated soil and rock
Waste Incineration Directive	Council Directive 2000/76/EC to prevent or limit as far as is reasonably practicable negative effects on the environment, in particular pollution by emissions into air, soil, surface water and groundwater, and the resulting risks to human health, from the incineration and co-incineration of waste
Water Framework Directive	Council Directive 2000/60/EC establishes a community framework for the protection of inland and surface waters, transitional waters, coastal waters and underground waters in order to prevent and reduce pollution, promote sustainable water use, protect the aquatic environment, improve the status of aquatic ecosystems and mitigate the effects of floods and droughts

PB 7955

ISBN 0-85521-019-2

£10