SD:SPUR Scoping Document
Waste Management Framework Guidance Note No.1

Waste Characterisation and Management of Residual Wastes

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PREFACE

This is the first in a series of four scoping reports that have been developed on behalf of the SD:SPUR Learning Network by Quintessa and Golder Associates. The scoping reports are intended to support the development of detailed guides relating to the management of decommissioning wastes and items from nuclear licensed sites. The need for such guides, covering activities and decision processes implemented by waste management practitioners, has been identified by members of the SD:SPUR Project Steering Group.

It is important to stress that the scoping documents are not themselves intended to serve as formative guidance. They are deliberately short in length, being aimed at identifying key issues that will need to be addressed, rather than developing such ideas to the level at which they can be considered to represent practical guides. A common format is followed in each case; following a brief introduction to the document, the text is then structured to provide a discussion of:

- Context: identification of the main considerations associated with this particular stage in the management process, including any relevant policies and regulations.
- Need: discussion of any existing guidance that may be relevant, and the scope of the guidance that ought therefore be provided by SD:SPUR.
- Relevance: consideration of the target audience and how the guidance might be used, wider concerns and developments, and the potential for referencing existing good practice guidance.
- Format: anticipated length and other features relating to presentation of the guidance document.

At the time of preparing this draft, there remains uncertainty as to whether the proposed guidance is best presented as a single document, or in four separate guides. A single document would have advantages in terms of emphasising the degree of feedback and iteration that is inherent in developing and implementing a management strategy; however, it could prove to be of considerable bulk. For present purposes, the scoping documents have been developed assuming that separate guides will be produced. If this path continues to be followed, a companion general 'handbook' for the process as a whole (e.g. drawing on the existing outline description in earlier SD:SPUR material) could help to present a more integrated picture and avoid duplication in the individual guides.

1 INTRODUCTION

This scoping report considers the characterisation of items, materials and wastes arising from the decommissioning of nuclear licensed sites. The term "items" is used to mean buildings, including their fixtures and fittings, plant and equipment.

Characterisation is the process of identifying the physical, chemical, and radiological hazards associated with the items on the site as well as areas of the site, such as contaminated ground. This is an essential element in the process of sentencing decommissioning arisings. The proper characterisation of the material arisings from decommissioning, and the effective management of the data and documents essential for the tracking and sentencing of these materials, are critical to the definition of management strategy (Egan and Walker, 2009) and the subsequent selection and implementation of processing and treatment options for dealing with the decommissioning arisings (Penfold and Paulley, 2009). Without a sound and clearly documented knowledge of their characteristics, both radioactive and non-radioactive, then reliable decisions on the management and available options for these materials can neither be made nor be demonstrable to stakeholders.

The process of characterisation is not a one-time event but is conducted at stages during the life of a project, such as at the onset of a project; during de-planting and decontamination; prior to demolition; and the final stage of managing any residual decommissioning wastes. Residual wastes are, for example, wastes which were stored to allow radioactive decay or while a disposal facility was being constructed, and wastes generated during previous management stages. These residual wastes have to be characterised and management options (largely disposal) selected for them, in the same way as for the other decommissioning wastes. Questions of quality control, verification and communication are important considerations in the implementation of characterisation protocols, as they are in the implementation of management options (Bjerregard and Towler, 2009).

Materials arising from decommissioning at nuclear licensed sites will not necessarily be subject to regulatory control as radioactive substances. For example, much of the material arisings may be classed as 'clean' in the sense that they are not activated above background levels. Moreover, the activity of slightly radioactive items and materials at such sites may fall below the lower threshold for control as VLLW, into the exempt SoLA category. A key aspect to the acceptability of different uses, or otherwise, of the materials will be the procedures used in assessing the level of activity so that transparency and confidence can be achieved in the segregation and characterisation processes.

2 CONTEXT

2.1 Materials arising from Decommissioning of Nuclear Sites

Miller and Tooley (2005) have provided broad estimates of the volumes of wastes expected to arise from the decommissioning of nuclear licensed sites in the UK, being in the region of:

- 1.5 million m^3 of radiologically clean, and SoLA exempt and excluded wastes; and
- 1.5 million m^3 of 'slightly radioactive' wastes

It should be recognised that there are differing views concerning what can be regarded as 'radiologically clean' and it is important to acknowledge stakeholder concerns regarding potential re-use and recycling of such materials outside a controlled nuclear site.

'Slightly radioactive' waste was previously considered to comprise the lowest of the five orders of magnitude activity range covered by the classification of LLW, now corresponding to high volume VLLW, with total activity in the range 0.4 to 4.0 MBq/te (Defra et al., 2007; Environment Agency, 2008).

The 2007 UK Radioactive Waste Inventory (RWI) (Pöyry, 2008) provides an estimate of future LLW arisings from nuclear licensed sites of about 3,000,000 m^3. More than half of this volume comprises either waste that falls into the VLLW sub-category (1,390,000m^3) or mixed VLLW/LLW waste from Springfields (385,000m^3). This supports the estimate by Miller and Tooley (2005) for slightly radioactive wastes. As noted in the 2007 RWI:

"The greatest uncertainty rests with future arisings of waste from facilities decommissioning and site clean up. This is particularly the case for wastes at the lower end of the LLW activity range, where uncertainty about regulatory requirements and disposal routes, lack of definition of site decommissioning and clean up plans, and the fact that much characterisation work remains to be carried out, all make estimation of waste volumes somewhat speculative. Furthermore the benefit of decontamination that might allow waste volume to be below the lower threshold level for LLW must be considered against the cost.

The 2007 Inventory includes some High Volume VLLW from facilities decommissioning and site clean up, but only where the waste has been sufficiently well characterised. It is recognised that the total quantity of such waste could be significantly higher than that in the 2007 Inventory. Thus the additional volume of potentially contaminated ground for remediation is reported to be about 13,000,000 m^3."

As the RWI does not provide estimates of waste volumes for materials below the SoLA exemption threshold, the uncertainty on future arisings for these wastes is expected to be even greater.

Excluding potentially contaminated ground, it is apparent that materials arising from decommissioning that are contaminated at levels below the SoLA exemption threshold will, volumetrically, be at least as large as for the slightly radioactive material. They will also, inevitably, contain some hazardous wastes such as asbestos, polychlorinated biphenyls (PCBs) and hydrocarbon contaminated materials that will need to be subject to specific controls. In general, however, this category of materials will tend to provide greater opportunities for material re-use and recycling compared to radioactive wastes above the SoLA exemption threshold. Effective management of the arisings from decommissioning at nuclear licensed sites will require an ability to manage the established procedures and guidance for the characterisation of these two primary material streams.

It is concluded from the 2007 RWI that adequate inventories currently do not exist of materials arising from future decommissioning works, particularly of VLLW, potentially contaminated ground and the non-radioactive materials. The management of the arisings from the decommissioning of a nuclear site

cannot effectively be undertaken without an inventory of the items and materials, both radioactive and non-radioactive, that will have to be dealt with at that site.

Associated with characterisation will be the estimation of material quantities. Information gathered during inventory preparation can then be used to categorise materials and wastes, defining management options for item or site area disposition, including the selection of decommissioning and recycling alternatives, where these are considered appropriate. The objective would be to provide direction for a compliant, consistent, systematic and auditable approach to site characterisation, as well as to support the planning and implementation of the decommissioning work.

A Site Waste Management Plan (SWMP) should be prepared for wastes arising from decommissioning a nuclear licensed site in accordance with the Site Waste Management Plans Regulations 2008, although where a nuclear licensed site has an Integrated Waste Strategy (IWS) in place that includes waste from construction activities, a separate SWMP is not required, provided that all the obligations set out in the SWMP Regulations are included in the strategy and its supporting documents (Defra, 2008). The proper characterisation, forming part of an IWS or SWMP, of items and materials will provide the basis for their subsequent management, be that disposal to landfill, re-use on the nuclear site or at locations off-site, as considered appropriate for the different categories of material.

2.2 Regulatory and Guidance Context

The context in which guidance on the characterisation of items, materials and wastes arising from the decommissioning of nuclear sites would be prepared is an extensive framework of existing legislation and guidance covering both radioactive and non-radioactive wastes. For non-radioactive materials, the legislation and guidance deal exclusively with these types of materials, as a result of European directives including the original Waste Framework Directive (75/442/EEC), the recent Directive on Wastes (2008/98/EC) and the Landfill Directive (1999/31/EC). Radioactive wastes are specifically excluded from the remit of all these directives. The legislation and guidance dealing with materials and wastes arising from the decommissioning of nuclear sites are strongly focussed towards the issues associated with the management of radioactive materials and wastes but sometimes also do address, but only to a relatively cursory level, radiologically clean materials and wastes.

The policies, procedures and guidance contained in these documents have effectively been developed separately with little integration or co-ordination, with the result that the level of understanding on nuclear sites of waste management practices for radiologically clean materials is not always complete.

The disparity between the management of the two waste streams can be seen at several levels, an initial one being that the definition of waste is different. In 2008, the way this definition is interpreted for non-radioactive materials in various circumstances changed, so that material that may previously have been categorised as waste, is no longer considered as waste. These changes came about with the publication by CL:AIRE of *The Definition of Waste: Development Industry Code of Practice* (2008) and the associated Environment Agency Position Statement, as well as by clarifications on the interpretation of the definition of waste (but no change to the actual definition) contained in the EU Directive on Waste (2008/98/EC) published in November 2008 (but yet to be the subject of guidance tools from the UK government or agencies). These recent changes in regulatory practice add to the

potential for a lack of understanding to occur on nuclear licensed sites regarding methods of categorising non-radioactive materials arising from demolition activities. Where material can be categorised as a non-waste by virtue of its lack of contamination (radioactive and non-radioactive) and its defined after-use on site, then this material can avoid regulation under the waste regime.

A major challenge in the characterisation process, which includes measurement of activity and the methods of segregation of materials as the decommissioning proceeds, is the ability, reliably and demonstrably, to separate the arisings into the slightly radioactive and radiologically clean categories.

The Clearance and Exemption Code of Practice (CEWG, 2006) (also known as the Nuclear Industry Code of Practice) was produced to identify and facilitate the consistent application of good practice within the nuclear industry regarding the clearance and sentencing of items, materials and wastes which may be clean, or radioactive at levels below the thresholds for regulatory control. The level of confidence within stakeholders of the sufficiency of the Code of Practice, the procedures set out therein and the ability of the decommissioning team to adhere to the procedures, are key issues in the acceptance of the subsequent management of the decommissioning wastes and materials.

In this context it is relevant to underline that wastes below the activity limit specified in the Substances of Low Activity (SoLA) Exemption Order remain defined as radioactive wastes; it is simply that their low activity does not warrant them being subject to controls under the Radioactive Substances Act RSA 93. It is also appropriate to note that Government is currently reviewing the system of Exemption Orders (EOs) made under RSA93[1]. This is based on general agreement that the existing EOs do not reflect the types of radioactive materials currently arising, as they were drawn up many decades ago. Specifically, they relate mainly to those materials and wastes at the lower activity end of the classification scale, which is the same range as that generally associated with SD:SPUR guidance.

The Government review is intended to result in a more relevant system of exemption, specifying criteria and procedures that more accurately reflect the specific hazards associated with particular radionuclides. At this stage, details of the new EOs remain unclear; however, it is not expected that Government's work will extend to providing detailed guidance on practical matters relating to waste characterisation. The SD:SPUR project will need to take account of the outcome of the review in due course, as will the Nuclear Industry Code of Practice.

Regulatory controls and guidance that affect the characterisation and management of decommissioning materials continue to be developed and issued, and existing regulations and good practice tools are updated and revised at intervals to take into account policy, regulatory and technical developments, as the case may be, and experience in using the documents. A few examples include the Agencies' Guidance on Hazardous Waste (WM2) which was first published in 2003, with the second edition coming out in 2005. This was then further updated in 2006 and 2008. The Environment Agency published new guidance on *Disposing of Radioactive Waste to Landfill* (Environment Agency, 2008) in response to policy changes on LLW introduced by government in March 2007 (Defra et al., 2007). The Institution of Civil Engineers updated its *Demolition Protocol* in 2008, while the Site Waste Management Plans Regulations 2008 came into force in April of that year.

[1] See http://www.defra.gov.uk/environment/radioactivity/government/legislation/exemption.htm

The more recent tools have provided improved and often more applicable guidance for the decommissioning of nuclear sites, but the focus remains essentially separate for radioactive and non-radioactive wastes.

New guidance on waste characterisation produced by SD:SPUR cannot have the goal of determining industry best practice as the necessary procedures are already set out in detail in guidance issued and updated by the relevant regulatory agencies and other bodies. Instead, it is seen that the new guidance would have a wider remit to bridge the gap between the non-radioactive and radioactive guidance and to identify and address the key issues of concern to stakeholders.

3 NEED

3.1 Crossover Guidance

The largely separate development of guidance and good practice tools for the characterisation of nuclear sites assigned for decommissioning noted above leads to the conclusion that "crossover" guidance bridging the gap between radioactive and non-radioactive materials and wastes would be of direct benefit to all stakeholders who will have to deal with both regulatory regimes in the management of the material arisings. This is particularly important given the need to demonstrate consistent control of potentially substantial volumes of radioactive wastes that are contaminated at levels below the SoLA threshold for exemption from regulatory control as radioactive material.

As well as separating the two basic waste streams, the guidance and good practice tools on material, item and waste characterisation and classification that are currently available tend to focus on the development of policies and strategies. It would be useful to develop guidance and tools to support more detailed waste management planning and procedures for site decommissioning, leading to a compliant, consistent and transparent process.

The guidance should also be beneficial to other stakeholders to facilitate their understanding of the specific procedures involved, leading to greater confidence in the decommissioning process, and in the characterisation, handling and appropriate use or disposal of the items and material arisings.

3.2 Characterisation

Characterisation is the process of identifying the physical, chemical and/or radiological hazards associated with a site, with the initial objective of preparing an outline inventory of materials and items according to different categories (see Section 3.3). It is on the basis of the data in the inventory that rational management of material, items and wastes can be achieved. The characterisation and sentencing of solid material is complex for several reasons, including the non-uniformity of materials and contamination, the potential for radioactivity to be concealed and the large number of options for monitoring and sampling.

Characterisation is not a one-time event but a process conducted during the life of a project, such as at the onset of a project; during de-planting and decontamination; and prior to demolition. It will normally comprise several phases, for example the following five phases may be used to establish the inventory of materials, items and wastes:

- Scoping Characterisation;
- Reconnaissance Level Characterisation;
- In-Process Characterisation;
- Pre-Demolition Survey; and,
- Post-Demolition Survey (including residual wastes).

This will allow development of the understanding of the potential for contamination, determine the unknowns, assess decontamination efforts and ensure project readiness for final disposition, usually demolition. The classification of materials can be documented, the recycling of materials tracked, the sentencing of wastes recorded and a transparent QA and audit trail is provided throughout the whole process (see also Bjerregard and Towler (2009)). The sentencing decision will rely to a considerable extent on the characterisation process.

The difficulties in characterising and segregating materials and items at very low levels of radioactive contamination need to be addressed. If these activities are not done reliably and consistently, then the options for the subsequent re-use of materials, especially offsite, become much more limited as there is likely to be resistance to the offsite use wastes of even very low levels of radioactive contamination. Wastes and materials falling below the upper SoLA criterion, and those classified as clean, will be regulated as non-radioactive controlled wastes in accordance with the Landfill Regulations 2002 and other relevant legislation, together with the agencies' WM2 guidance.

The new guidance should focus on dealing with uncertainties associated with measuring low levels of activity and the sampling regimes necessary to provide adequate characterisation of heterogeneously contaminated arisings. Consideration should also be given to the statistical tools that should be applied to the sampling, measurement and analysis procedures with the purpose of increasing confidence and transparency in the characterisation and subsequent sentencing. In addition, the acceptability to all stakeholders of exempt and clean wastes being considered together under the same regulatory control for either disposal or potential re-use or recycling (on-site and off-site) should be addressed. One factor previously identified as being relevant to such acceptability is the perceived potential for synergistic harmful effects in situations where there can be combined low-level radiation and other hazardous material exposures (Miller and Tooley, 2005).

Data and document management is an essential activity when undertaking site characterisation and sentencing activities for decommissioning and demolition. It is fundamental to the development of the management strategy and selection of management options for wastes and items, and for the implementation of management options. Large amounts of data will be generated and documents created or reviewed throughout these processes that will need to be stored in a robust system that may require access over a period of many decades. Currently, substantial amounts of characterisation and other relevant information are available at nuclear sites, but are held at numerous different places and in many different formats, making it difficult to collate, compare or summarise the information. A single database for information management is necessary to avoid gaps and duplication, and to enable data validation and auditing to be carried out. This is an essential element in building confidence in stakeholders in the categorisation process.

A further aspect that should receive attention is the materials management practices of the organisations that direct or undertake decommissioning. There currently appear to be challenges in achieving sustainable practices in planning and undertaking decommissioning, such as material segregation and taking advantage of recycling opportunities. In terms of overall attention to site restoration, priorities can be focused strongly to a single aspect, for example hazard reduction, with the result that other concerns including the implementation of sustainable decommissioning practices can receive less than adequate consideration. This can result in a preference for 'contained demolition' where the focus is on demolition and disposal of all VLLW and cleaner arisings in a suitable landfill, rather than the detailed characterisation, segregation and sentencing necessary to support recycling and re-use. The limited capacity of the LLWR precludes the disposal of such high volume low activity wastes there, except to substitute for non-radioactive inert materials as infill. Landfill facilities for such wastes may need to be located on-site or at another nuclear decommissioning site that is more suitable for the development of an on-site engineered disposal facility. This approach seeks to minimise hazard but maximises the quantities of wastes for disposal, and can lead to large numbers of transport movements if the landfill is at a distant site.

3.3 Waste Classification

Where materials and items are identified as waste (or waste once demolished), then they can be classified into the appropriate waste class:

- Radioactive and regulated under the RSA 1993
  - Higher activity than high volume VLLW (outside the remit of this project)
  - VLLW
- Radioactive but of very low activity such that it can be regulated under non-radioactive waste legislation:
  - Radioactive but exempt
  - Excluded
- Non-radioactive (clean)
  - Hazardous
    - ♦ Sub-class of stable non-reactive hazardous waste (SNRHW)
  - Non-hazardous
  - Inert

The process of classification is defined in current guidance including the Guidance on Hazardous Waste (WM2) and the Clearance and Exemption Code of Practice (CEWG, 2006). These are large and detailed documents demanding considerable study to gain an adequate understanding of the procedures and then to apply correctly to a particular case. Incorrect application of the procedures set out in WM2 and associated documents for the classification of non-radioactive wastes and their acceptance for disposal are frequently observed. Hence, it is considered that more accessible guidance on material categorisation on waste classification written specifically for nuclear site decommissioning would be helpful to decommissioning managers as well as to other stakeholders.

The items and materials should be characterised and sentenced so that they are identified into their waste category as above should they subsequently be classed as waste. Materials that may then be suitable for re-use or recycling, as appropriate to their category, can be identified. Segregation of these materials will be a key activity where a focus on sustainable practices can be implemented and the

materials properly allocated so far as the classification of the segregated material allows. Materials that are unsuitable for re-use or recycling, for example because they are of inappropriate composition or have too high levels of activity or are classed as hazardous waste, would be assigned for appropriate disposal.

It is important to identify the extent of the information necessary to enable materials to be determined and sentenced appropriately, to ensure satisfactory hazard reduction and the implementation of sustainable practices, where these are suitable. This will be important to all stakeholders in the development of confidence in the characterisation process.

4 RELEVANCE

Along with the other scoping documents, guidance produced on site characterisation is of immediate relevance to the industry and stakeholders because of the current and upcoming work on decommissioning of the Magnox sites as well as the emphasis on sustainable demolition that has grown rapidly over the last five years. In addition, the problem of limited remaining capacity at the LLWR has led to studies on finding alternatives to the LLWR, which may also lead to greater efforts to improve the sustainability of nuclear licensed site decommissioning.

The status of current materials management practices employed at decommissioning sites was raised in Section 3.2 above. The emphasis on hazard reduction can be described as a short-term objective while sustainable decommissioning is a longer term objective, and the potential for integration and for conflict between these two objectives is of immediate relevance. Better resolution of the conflicts and wider acceptance of the benefits of sustainability by the organisations that direct and plan decommissioning will be required to enable the introduction of sustainable practices that are acceptable to all, or at least most, stakeholders.

Decommissioning managers must work within the extant statutory legislation and regulatory guidance and codes of practice. The current focus at nuclear licensed sites has been on radioactive items, materials and wastes. As noted, a substantial proportion of the arisings will either be clean or exempt which then demands that the extensive regulatory and guidance regime that applies to non-radioactive materials needs to be fully accommodated, including the priority placed on waste minimisation and materials re-use or recycling. There are differing views on the use of waste material from nuclear sites being used off-site and the emphasis on waste minimisation needs to address these concerns. These issues are of immediate as well as long term relevance to decommissioning managers as well as to the wider group of stakeholders.

Guidance on waste characterisation following on from this scoping document will need to be accessible to and usable by all stakeholders to improve the ability of wider stakeholders to interact with decision makers. The guidance should have a practical emphasis on categorisation, classification and segregation during the different phases of the characterisation and sentencing processes.

5 FORMAT

The guidance should be presented to emphasise the relationship between characterisation and waste classification, which in turn is closely linked to the development of management strategy. It should

also be structured so as to highlight the fact that characterisation is not a one-time event, but a process conducted though the life of the site restoration programme.

Key objectives in relation to specific materials and their characteristics should be incorporated, with specific attention to areas of uncertainty (e.g. in relation to measurements of low activity concentration and the heterogeneous distribution of contamination). As far as possible, the guidance should be practically oriented, based on a step-by-step approach. Note that there are strong links to the 'implementation' document (Bjerregard and Towler, 2009), which is expected to discuss quality management issues relating to the management of characterisation information.

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