INTERNATIONAL HARMONISATION OF THE DEFINITIONS FOR RADIOACTIVE WASTES – THE CURRENT DIFFERENCES, THE PROBLEMS THIS PRESENTS AND THE ACHIEVABILITY OF HARMONISATION

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Abstract

The paper will examine the legal definitions for radioactive waste types in different jurisdictions focusing on:-

- Joint Convention on the Safety of Spent Fuel Management and on Radioactive Waste Management 1997 and relevant IAEA guidance;
- Euratom Treaty and Euratom Directive on Spent Fuel and Radioactive Waste 2011 and relevant European Commission guidance;
- Relevant UK legislation;
- Relevant French legislation; and
- Relevant Belgium legislation.

It will consider the concepts out-of-scope wastes, exempted wastes, the introduction of the waste hierarchy to radioactive waste management and the point at which radioactive wastes are no longer legally considered to be a waste.

It will explore the reasons why there is currently no international harmonisation of definitions and the problems that a lack of harmonisation may be causing – for example, the impacts on the decommissioning of nuclear facilities and the management of radioactive waste management (including opportunities for resource, recovery, and recycling).

DISCLAIMER

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INTRODUCTION

Various classification schemes have evolved for radioactive wastes according to the physical, chemical and radiological properties that are of relevance to particular facilities or circumstances in which radioactive waste is managed. These schemes have led to a variety of different terminologies, which differ from country to country and even between facilities in the same country.

This can give rise to challenges in developing consistent and coherent national waste management policies and implementing strategies. It also makes communication on waste management practices difficult nationally and internationally, particularly in the context of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management.

International bodies, national authorities and waste operators have established radioactive waste classification systems. The first standard of classification was published by the International Atomic Energy Agency (IAEA) in 1970[2] and revisions were published in 1981, 1994 and more recently in 2009[3]. Directive (2011/70/Euratom) establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste includes a requirement for Members States to have a national radioactive waste classification scheme.

The difficulty is that the classification schemes have been developed independently and for different purposes and therefore vary widely in approach and application. For example, some are based on activity concentration and others on origins/source of the waste or disposal route.

This paper looks at the different international classification schemes for radioactive waste and sets out why harmonisation – setting out a common language in defining the different radioactive waste categories – might bring improvements to international radioactive waste management. It also considers whether international law should introduce the concept of the waste hierarchy, sustainability and a life-cycle approach into radioactive waste management.

WHY IS THE CLASSIFICATION OF RADIOACTIVE WASTE REQUIRED?

The principal function of a radioactive waste classification scheme is communication. It facilitates the development and implementation of waste management strategies and information exchange within and across international boundaries.

Waste classifications do not necessarily replace the waste acceptance criteria required for accepting waste at licensed facilities. In fact, the waste acceptance criteria of facilities can be decoupled from a classification scheme.

The main consideration for defining and categorising waste is the long term safety of its disposal. Wastes are classified according to potential hazard and this determines the containment and isolation requirements. The physical, chemical and radiological properties will affect how the waste is handled, stored and ultimately disposed of or recycled.

[2] International Atomic Energy Agency, Standardisation of Radioactive Waste Categories, Technical Reports Series No 101, IAEA, Vienna (1970)
[3] IAEA Safety Standards "Classification of Radioactive Waste" General Safety Guide No. GSG-1 dated 2009

It is possible to break down the approaches to radioactive waste classification into three types primarily based on[4]:-

- the **application of radiological (activity, half-life) boundaries** as recommended by the IAEA and the European Commission and used in Finland, France and the UK;
- consideration of the **safety of disposing of wastes** at particular national disposal sites as set out in facility specific safety cases, as used in Belgium, Spain and Sweden; and
- the overall characteristics of wastes as determined by their **origin**, as used in Japan and the US.

Classification schemes are used by waste producers and regulators to determine the level of regulation that applies to a particular waste, thereby removing the need to assess waste on a case by case basis to decide how the radioactive waste should be regulated.

INTERNATIONAL APPROACHES TO RADIOACTIVE WASTE CLASSIFICATION

THE JOINT CONVENTION ON THE SAFETY OF SPENT FUEL MANAGEMENT AND ON THE SAFETY OF RADIOACTIVE WASTE MANAGEMENT (THE "JOINT CONVENTION")[5]

The Joint Convention is the first legally binding international treaty on the safety of spent fuel management and radioactive waste management. Obligations of the Contracting Parties[6] to the Joint Convention include, for example, the need to take the appropriate legislative, regulatory and administrative measures to ensure that at all stages of spent fuel management and radioactive waste management, individuals, society and the environment are adequately protected against radiological hazards in the siting, design and construction, assessment of facilities, operations and closure.

The Joint Convention defines radioactive waste as:

> – *'radioactive material in gaseous, liquid or solid form for which no further use is foreseen by the Contracting Party or by a natural or legal person whose decision is accepted by the Contracting Party, and which is controlled as radioactive waste by a regulatory body under the legislative and regulatory framework of the Contracting Party'*[7]

This definition does not cover wastes from military or defence programmes (unless declared as radioactive waste for the purposes of the Joint Convention or transferred permanently to an exclusively civilian facility). Nor does the definition include NORM waste. The definition does not specifically exclude 'out of scope' or 'exempt' wastes.

There is no mention in the Joint Convention of waste classifications other than in relation to the reporting obligation in Article 30. Article 30 requires that each Contracting Party shall submit a national report for review which includes the criteria used to define and categorise radioactive waste.

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[4] LLW Repository Ltd October 2016 report entitled "International Approaches to Radioactive Waste Management" - https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/697667/NWP-REP-134-International-Approaches-to-RW-Classification-Oct-2016.pdf
[5] https://www.iaea.org/sites/default/files/infcirc546.pdf
[6] There are currently 78 Contracting Parties to the Joint Convention.
[7] Article 2(h) of the Joint Convention

Although Contracting Parties are required to report on the criteria they have in place to define and categorise radioactive waste, the Joint Convention does not require or set out the need for each Contracting Party to use a uniform and consistent approach to radioactive waste classification.

INTERNATIONAL ATOMIC ENERGY AGENCY (IAEA) CLASSIFICATION SCHEME

The first standard of classification was published by the IAEA in 1970[8] and revisions were published in 1981, 1994 and more recently in 2009 – the IAEA Safety Standards "Classification of Radioactive Waste" General Safety Guide No. GSG-1 dated 2009 (the "IAEA Classification Scheme")[9].

The IAEA Classification Scheme is based primarily on considerations of long term safety, and by implication, disposal of the waste (as set out in Figure 1 below). Two major variables are used: activity (concentration) and radionuclide half-life. A third variable, rate of heat generation, is also noted in the description of high level waste. The origin of the waste is not considered.

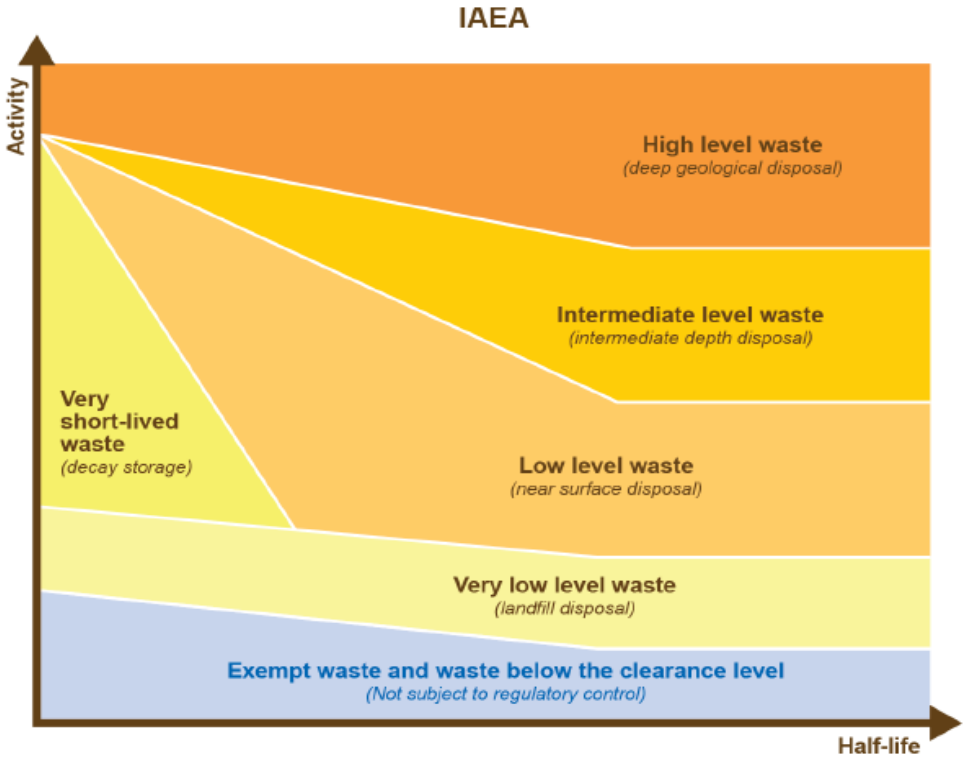

Figure 1: Schematic diagram indicating the IAEA's recommended approach to waste classification, and link to disposal routes[10].

Six classes of waste are used as the basis for the IAEA Classification Scheme (as set out in Table 1 below). This covers the whole range of radioactive waste: from spent nuclear fuel (when it is considered radioactive waste), to waste having such low levels

[8] International Atomic Energy Agency, Standardisation of Radioactive Waste Categories, Technical Reports Series No 101, IAEA, Vienna (1970)
[9] International Atomic Energy Agency, Classification of Radioactive Waste: Safety Guide, IAEA, Vienna (2009)
[10] Source: Figure 2 page 23 of the LLWR Report (based on Figure 1 page 7 in the IAEA's *Classification of Radioactive Waste*, General Safety Guide No. GSG-1)

of activity concentration that it is not required to be managed or regulated as radioactive waste.

Table 1: IAEA Classification Scheme

	Class of Waste	**Description**
1.	Exempt Waste (EW)	Waste that meets the criteria for clearance, exemption or exclusion from regulatory control for radiation protection purposes. *See application of the concepts of exclusion, exemption and clearance IAEA No. RS-G-1.7, IAEA, Vienna 2004.*
2.	Very Short Lived Waste (VSLW)	Waste that can be stored for decay over a limited period of up to a few years and subsequently cleared from regulatory control according to arrangements approved by the regulatory body, for uncontrolled disposal, use or discharge. This class includes waste containing primarily radionuclides with very short half-lives often used for research and medical purposes.
3.	Very Low Level Waste (VLLW)	Waste that does not necessarily meet the criteria of EW, but that does need a high level of containment and isolation and, therefore, is suitable for disposal in near surface landfill type facilities with limited regulatory control. Concentrations of longer lived radionuclides in VLLW are generally very limited.
4.	Low Level Waste (LLW)	Waste that is above clearance levels, but with limited amounts of long lived radionuclides. Such waste requires robust isolation and containment for periods of up to a few hundred years and is suitable for disposal in engineered near surface facilities. This class covers a very broad range of waste. LLW may include short lived radionuclides and also long lived radionuclides, but only at relatively low levels of concentration.
5.	Intermediate Level Waste (ILW)	Waste that, because of its content, particularly of long lived radionuclides, requires a greater degree of containment and isolation than that provided by near surface disposal. However, ILW needs no provision, or only limited provision, for heat dissipation during its storage and disposal. ILW may contain long lived radionuclides, in particular, alpha emitting radionuclides that will not decay to a level of activity concentration acceptable for near surface disposal during the time for which institutional controls can be relied upon.

6.	High Level Waste (HLW)	Waste with levels of activity concentration high enough to generate significant quantities of heat by the radioactive decay process or waste with large amounts of long lived radionuclides that need to be considered in the design of a disposal facility for such waste. Disposal in deep, stable geological formations usually several hundred metres or more below the surface is the generally recognised option for disposal of HLW.

Although the scheme addresses the generic linkage between the different classes of waste and disposal options, the suitability of waste for disposal in a particular disposal facility is still required to be demonstrated by the safety case and supporting safety assessment for the facility.

The IAEA Classification Scheme is not a legal requirement but a general safety guide and part of the IAEA Safety Standards. Contracting Parties are therefore not required to adopt this classification, although it is required to be used when reporting to the IAEA.

The report prepared by LLW Repository Ltd entitled "International Approaches to Radioactive Waste Classification" (NWP-REP-134-October 2016)[11] (the "LLWR Report") sets out three points to note on the IAEA Classification Scheme, being:-

- there are no numerical values assigned to the boundaries between categories;
- the boundaries between waste categories are not at constant values of activity of half-life, but are a function of the two variables. The UK, Franceand Belgium do not use the non-constant thresholds illustrated in the IAEA Classification Scheme; and
- there is a category of very short-lived waste (decay over a few years), but not a short-lived waste category (half-lives are less than about 30 years).

Quantitative values of allowable activity content for each significant radionuclide will be specified on the basis of safety assessments for individual disposal sites (outside the scope of the IAEA Classification Scheme). The IAEA Classification Scheme includes the use of storage for decay. The main criteria are the half-lives of predominant radionuclides and acceptability of amounts of longer half-life radionuclides.

For VSLW, the intent of storage for decay is to allow activity levels to fall beneath the level for clearance, allowing the waste once cleared to be managed as conventional waste. The boundary for half-lives is not specified generically as it depends on the planned duration of storage and initial activity concentration. However, the storage of half-lives is in the order of 100 days or less.

The precise criteria according to which waste is assigned to a particular waste class will depend on the specific situation in each country in relation to the nature of the waste and the disposal options available or under consideration.

The IAEA Classification Scheme has not been adopted in its entirety by many countries, including for example, the UK, France, Belgium or the USA. The IAEA has commented that, in some instances, the evolution of the various schemes for

[11] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/697667/NWP-REP-134-International-Approaches-to-RW-Classification-Oct-2016.pdf

classifying radioactive wastes has given rise to difficulties in establishing consistent and coherent national waste management policies and implementing strategies and can lead to less than optimal levels of safety[12]. It further noted that this also makes communication on waste management practices difficult nationally and internationally, particularly in the context of the Joint Convention. Comparison of data published in the scientific literature is not straightforward, and difficulties can arise in trying to understand waste management programmes and practices both within and between States.

EURATOM TREATY[13]

The Euratom Treaty established the European Atomic Energy Community (Euratom) and was signed on 25 March 1957 and covers activities involving radioactive substances. Article 30 of the Euratom Treaty establishes European basic safety standards for the protection of the health of workers and the general public against the dangers arising from ionising radiation, including from radioactive waste. The Euratom Treaty does not contain a classification scheme for radioactive waste.

Article 31 of the Euratom Treaty calls for uniform basic safety standards to be established by Member States. In order to meet this requirement, basic standards for the protection of workers and the public have been set out in various Directives since 1959, the most recent being the Basic Safety Standards Directive 2013[14] (the "BSSD 2013"). The BSSD 2013 consolidates and updates existing European legislation in line with guidance and advice prepared by International Commission on Radiological Protection and International Basic Safety Standards published by the IAEA. In particular, the BSSD 2013 further develops of the concepts of "exclusion", "clearance" and "exemption" levels introduced by the IAEA. The IAEA definitions of the terms "exclusion", "clearance"' and ‘exemption’ (set out in the IAEA Safety Glossary, 2007[15] Edition) are:-.

- **Exclusion** is defined as: "The deliberate exclusion of a particular category of exposure from the scope of an instrument of regulatory control on the grounds that is it not considered amenable to control through the regulatory instrument in question";
- **Clearance** is defined as: "The removal of radioactive materials or radioactive objects within the authorised practices from any further regulatory control"; and
- **Exemption** is defined as: "The determination by a regulatory body that a source or practice need not be subject to some or all aspects of regulatory control on the basis that the exposure due to the source or practice is too small to warrant the application of those aspects".

Euratom has developed these concepts further to derive numerical values for both clearance and exemption. Clearance values/exemption values for bulk solid amounts are set out in Annex VII Table A of the BSSD 2013. Exemption levels for moderate amounts for any type of material (solids, liquids, gases), are set out in Annex VII Table B of the BSSD 2013. The general criteria for the exemption of practices or clearance of authorised practices are set out in Annex VII of the BSSD 2013.

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[12] Paragraph 1.3 of the General Safety Guide No.GSG-1, IAEA Safety Standards: Classification of Radioactive Waste

[13] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:12012A/TXT&from=EN

[14] Council Directive 2013/59/Euratom of 5 December 2013 laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation, and repealing Directives 89/618/Euratom, 90/641/Euratom, 96/29/Euratom, 97/43/Euratom and 2003/122/Euratom

[15] International Atomic Energy Agency, IAEA Safety Glossary, Terminology Used in Nuclear Safety and Radiation Protection 2007 Edition, IAEA, Vienna (2007)

Different European countries apply different approaches and terminology to apply these concepts which can result in confusion and also prevent the efficient application of the waste hierarchy e.g. when a radioactive waste is considered to be "cleared" from regulatory control and can be managed as conventional non-radioactive waste. This is discussed further in the context of the UK and France below.

SPENT FUEL AND RADIOACTIVE WASTE DIRECTIVE 2011/70/EURATOM[16]

The Directive 2011/70/Euratom sets out a framework for the responsible and safe management of spent fuel and radioactive waste, so as not to impose excessive restraints on future generations.

It defines spent fuel as 'nuclear fuel that has been irradiated in and permanently removed from a reactor core'[17]. Spent fuel can either be reprocessed, or if regarded as radioactive waste then disposed. Radioactive waste is "radioactive material in gaseous, liquid or solid form for which no further use is foreseen"[18]. It does not however include a radioactive waste classification scheme.

Article 14 requires Member States to report to the Commission their inventory of all radioactive waste and spent fuel, clearly indicating the location and amount in accordance with an appropriate classification. Moreover, Member States' reports should include estimates of future quantities, including those from decommissioning, and they should provide an update of their inventory and projections every three years. On the basis of the information provided by the Member States, the Commission is required to submit an inventory of radioactive waste and spent fuel present in the Community's territory to the European Parliament and the Council.

EUROPEAN COMMISSION CLASSIFICATION SCHEME

In 1999 the European Commission recommended[19] that each Member State should adopt a common classification scheme for national and international communication purposes (which has been updated in 2008) (the "EC Classification Scheme"[20]). The EC Classification Scheme is based on the IAEA Classification Scheme, with some changes to take into account views and experiences of European national experts (see Figure 2 below for the schematic of the approach to classification).

The EC Classification Scheme is a qualitative waste classification scheme (see Table 2 below). It does not replace national technical criteria for specific safety considerations (as these are based on specific safety considerations e.g. licensing of facilities or other operations) and only deals with materials which contain or are contaminated by radionuclides and for which no further use is foreseen.

[16] Council Directive 2011/70/Euratom of 19 July 2011 establishing a Community Framework for the responsible and safe management of spent fuel and radioactive waste
[17] Article 3(11) 2011/70/Euratom
[18] Article 3(7) 2011/70/Euratom
[19] Commission Recommendation 99/669/EC Euratom of 15 September 1999 on a classification system for solid radioactive waste (SEC (1999) 1302 final)
[20] Regulation (EC) No 1272/2008 of the European Parliament and of the Council of 16 December 2008 on classification, labelling and packaging of substances and mixtures, amending and repealing Directives 67/548/EEC and 1999/45/EC and amending Regulation (EC) No 1907/2006

Table 2: EC Classification Scheme

	Waste Class	Description
1.	**Transition Radioactive Waste**	Type of radioactive waste (mainly from medical origin) which will decay within the period of temporary storage and may then be suitable for management outside of the regulatory control system subject to compliance with clearance levels.
2.	**Very Low Level Waste (VLLW)**	Introduced in an amendment to the original scheme. Management requires consideration from the perspective of radiation protection, but the extent of the provisions necessary is limited in comparison to those required for waste in higher classes.
3.	**Short-lived low level and intermediate level waste (LILW-SL)**	Short-lived wastes include those with half-lives less than or equal to around 30 years with a restricted alpha long-lived radionuclide concentration (limitation of long-lived alpha-emitting radionuclides to 4000 Bq/g (4GBq/te) in individual waste packages and to an overall average of 400 Bq/g (0.4 Gb/te) in the total waste volume).
4.	**Long-lived low level and intermediate level waste (LILW-LL)**	Wastes containing long-lived radionuclides and alpha emitters whose concentration exceeds the limits for short-lived waste.
5.	**High Level Waste (HLW)**	Waste with such a concentration of radionuclides that generation of thermal power shall be considering during its storage and disposal.

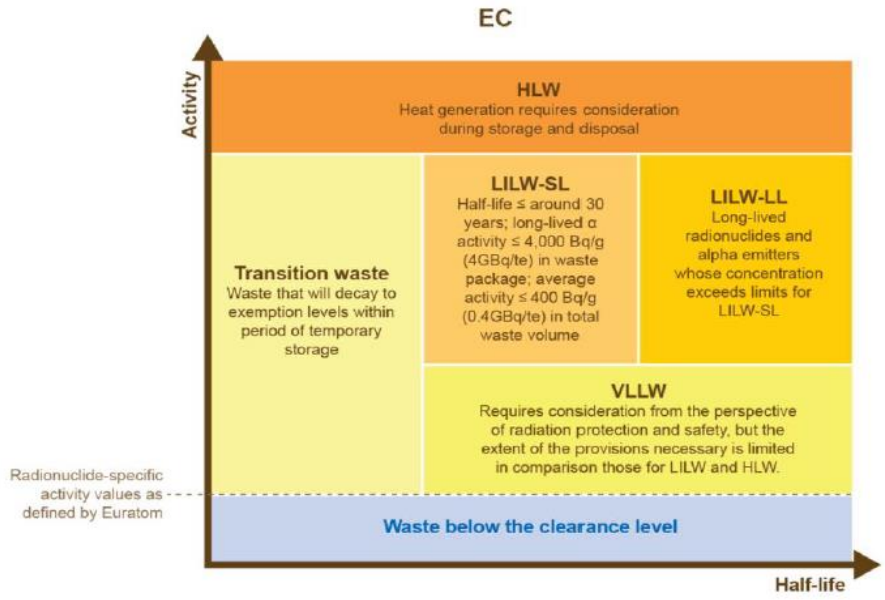

Figure 2 Schematic diagram indicating EC's recommended approach to waste classification[21]

Although the EC Classification Scheme is based on the IAEA Classification Scheme, there is no indication that the boundaries between waste categories are at constant values of activity and half-life. The EC Classification Scheme also has a different division of low level and intermediate level wastes (i.e. LLW and ILW in the IAEA Classification Scheme and LILW-SL and LILW-LL in the EC Classification Scheme).

[21]Source: Figure 3 page 25 of LLWR Report

There is no link between classification and disposal route in the EC Classification Scheme, other than the implication that transition wastes should be decay-stored. Apart from decay diversion, neither the IAEA nor the EC Classification Scheme makes any explicit reference to diversion of wastes from disposal or application of the waste management hierarchy.

The EC Classification Scheme has also not been adopted in full by many countries, including the UK and France. As the EC Classification Scheme is a European Commission recommendation, there is no legal requirement to implement it into a Member States domestic law.

RADIOACTIVE WASTE CLASSIFICATION IN THE UNITED KINGDOM

The UK Classification Scheme for Radioactive Waste is mainly based on the activity of the waste. There are three basic categories of radioactive waste: Low Level Waste (LLW), Intermediate Level Waste (ILW) and High Level Waste (HLW).

The most recent national classification scheme for LLW is that set out in the Government's Policy for the Long Term Management of Solid Low Level Radioactive Waste in the United Kingdom dated 26 March 2007[22].

Table 3 National Definition of LLW in the UK (from the Low Level Waste Policy 2007)

Waste category	Description
LLW	Radioactive waste having a radioactive content not exceeding 4 GBq/te alpha activity or 12 GBq/te beta/gamma activity. LLW includes two sub-categories of VLLW (see below).
VLLW sub-category of LLW 1: *Low volumes ('dustbin loads')*	Radioactive waste that can be safely disposed of to an *unspecified* destination with municipal, commercial or industrial waste ("dustbin" disposal), each 0.1 m^3 of waste containing less than 400 kBq of total activity or single items containing less than 40 kBq of total activity. For wastes containing C-14 or tritium, in each 0.1 m^3, the activity limit is 4,000 kBq for C-14 and tritium taken together, and for any single item the activity limit is 400 kBq for C-14 and tritium taken together. Controls on disposal of this material, after removal from the premises where wastes arose, are not necessary.
VLLW sub-category of LLW 2: *Bulk disposals – High-Volume VLLW*	Radioactive waste with a maximum concentration of 4 MBq/te (0.004 GBq/te) of total activity, which can be disposed of to *specified* landfill sites. For waste containing tritium, the concentration limit for tritium is 40 MBq/te (0.04 GBq/te). Controls on disposal of this material, after removal from premises where the wastes arose, will be necessary in a manner specified by the environmental regulators.

[22] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/254393/Low_level_waste_policy.pdf

The Government's Low Level Waste Policy 2007 also introduced the LLW sub-category of Very Low Level Waste (VLLW). In addition, certain waste disposal organisations in the UK have developed their own sub criteria for LLW at the lower end of the activity spectrum for disposal of waste at particular facilities, for example:

- for disposal at the Dounreay Nuclear Low Level Waste Facility ("NLLWF") - "Demolition LLW" has been defined as a sub-category of LLW. The upper activity limits are 10 MBq/te (0.01 GBq/te) alpha activity or 400 MBq/te (0.4 GBq/te) beta/gamma activity; and

- for disposal at appropriately permitted commercial landfills the Low Level Waste Repository Ltd in Cumbria has defined "Low Activity LLW" as waste containing less than 0.2 GBq/te total activity.[23]

Intermediate Level Waste (ILW) is defined by reference to LLW, being waste which exceeds the upper boundaries for LLW but which does not require heat to be taken into account in the design of storage or disposal facilities.

High Level Waste (HLW) is defined in the UK as waste in which the temperature may rise significantly as a result of its radioactivity, so this factor has to be taken into account in the design of storage or disposal facilities.

The term Higher Activity Waste (HAW) is used in the UK to refer collectively to all waste that has historically been assumed to require geological disposal. This is HLW and ILW but also includes some LLW that is not suitable for disposal in existing LLW facilities. This illustrates the separation between the UK's classification scheme and the disposal routes in the UK for its different classes of radioactive wastes.

The distinction between radioactive and non-radioactive waste in the UK is defined by the "out-of-scope" concept. Out-of-scope wastes correspond to wastes containing amounts of activity below the clearance levels set out in the BSSD 2013.

In addition to the clearance regime, there is an exemption system where substances which are legally considered to be radioactive (i.e. not "out of scope") may be exempt from the need for a radioactive substances regulation environmental permit[24]. A second set of numerical exemption levels are set out in the legislation and are generally given as concentrations of radionuclides in a substance or article, but there are also rules for total quantities of any substance held on any particular premises. If an activity is exempt it is still subject to certain exemption conditions set out in legislation.

Radioactive waste disposals in the UK may also be exempt from the environmental permitting regime in certain situations, depending on criteria relating to concentration or mass limits, disposal methods and conditions relating to disposal. These disposal criteria are based to a large extent on the Government's Low Level Waste Policy 2007 and are supported by radiological impact assessments carried out by the Health Protection Agency and in particular HPA-RPD-020.

In 2018, new guidance was published by the UK Government on the scope of and exemptions from the radioactive substances legislation in England, Wales and

[23] See Section 3 page 17 and 18 of the LLWR Report
[24] Or a consent under the Radioactive Substances Act 1983 in Scotland

Northern Ireland[25]. The legislation together with Government policy in England, Wales and Northern. Ireland achieves broadly the same result as set out in the BSSD 2013.

The UK's policy for waste diversion and the application of the waste hierarchy is influenced by the current UK classification scheme. The independence of the UK's classification scheme from treatment/disposal routes does allow waste producers to classify wastes without reference to waste acceptance criteria set by disposal facilities. Nevertheless, the classification scheme is not without its challenges. The LLWR Report sets out a number of disadvantages of the current system, including for example:-

- it is not obviously risk-based - i.e. the UK classification scheme is not always in line with the regulator's guidance and potential barriers to risk-based disposal (e.g. waste acceptance criteria/planning permissions/permits may specify LLW even where some ILW would be within the safety case envelope);

- there is no category for short-lived ILW (SL-ILW e.g. tritiated wastes) presenting a barrier to optimal waste management;

- the historical link between classification and disposal route means that many wastes are being packaged for disposal in a future GDF or near surface facility in Scotland - this is disproportionate to the hazard of SL-ILW;

- there is no category for very short-lived waste;

- the LLW-ILW boundary is outdated - it does not fit in well with the industry view that waste acceptance criteria should be based on a facility's safety case;

- opportunities for optimised management of boundary waste are potential missed; and

- broad categories do not reflect underlying complexities – the complexities are well understood within industry but communicating this to the public can be challenging. The current UK Classification Scheme may not indicate the scale of hazard which may be misleading/undermine public understanding of risk-based disposal.

The Nuclear Decommissioning Authority ("NDA"), in its 2016 Strategy[26], acknowledges that the boundary between different waste categories and associated management routes needs careful management. Due to the nature of the wastes, geological disposal may be more appropriate for some LLW, while for some HAW, particularly those containing short-lived radionuclides – a more appropriate management route could be in a near surface environment. The NDA concludes that the management approach for such boundary wastes should be closely aligned with the lifecycle approach to radioactive waste management to ensure optimal waste management decisions while making best use of capacity and capability within the industry.

[25] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/731733/RSL_Guidance_update_BEIS_format_v5_180803.pdf

[26] Nuclear Decommissioning Authority, Strategy: Effective from April 2016, United Kingdom (2016)

RADIOACTIVE WASTE CLASSIFICATION SCHEME IN FRANCE

The French radioactive classification scheme[27] is similar to the EC Classification Scheme with waste categories based on both activity and half-life with boundaries at constant values (prescribed for half-life, indicative for activity) (see Figure 3 below).

With regard to the radioactive half-life, a distinction is made between very short-lived waste (for which the half-life is less than 100 days), short-lived waste (for which the radioactivity stems mainly from radionuclides with a half-life of 31 years or less), and long-lived waste (which contains a significant quantity of radionuclides with a half-life of greater than 31 years).

Depending on the radioactive half-life and taking account of the activity level, six main waste categories are defined:

- **high level waste (HLW)** mainly consists of vitrified packages of waste from spent fuels after processing. These waste packages contain the vast majority of the radioactivity contained in all the waste produced in France, whether fission products or minor actinides. The activity level of the vitrified waste is several billion Bq/g. Owing to their high level of radioactivity, this waste gives off heat;

- **intermediate level, long-lived waste (ILW-LL)** comes mainly from spent fuels after processing and from the maintenance and operation of the processing plants. This primarily consists of structural waste from nuclear fuels, that is the hulls (cladding sections) and end-pieces, packaged in cement-encapsulated or compacted waste packages, as well as technological waste (used tools, equipment, etc.), or even waste resulting from the treatment of effluents such as certain sludge. The activity of those residues ranges between 1 million and 1 billion Bq/g. There is either no or negligible heat release;

- **low-level long-lived waste (LL-LL)** mainly consists of graphite and radium-bearing waste. The graphite waste comes mainly from the former gas-cooled reactor (GCR) technology. The graphite waste (graphite sleeves of the fuels stored and the stacks still in place) mainly contains long-lived beta radionuclides such as carbon 14 and chlorine 36. Their activity level is from ten thousand to a hundred thousand Bq per gram. The radium-bearing waste, most of which comes from non-NPP activities (such as the processing of ores containing rare earths), mainly contains long-lived alpha emitter radionuclides, with an activity of between several tens of Bq par gram and several thousand Bq per gram;

- **low-level and intermediate-level short-lived waste (LIL-SL)** results mainly from the operation, maintenance and dismantling of nuclear power plants fuel-cycle facilities and research establishments, as well as, for a slight share, from activities relating to medical studies;

- **very-low-level waste (VLL)** is mostly due to dismantling of nuclear power plants, fuel-cycle facilities, research establishments and, to a lesser extent, from the operation and maintenance of this type of nuclear installations. The

[27] https://www.andra.fr/download/andra-international-en/document/351va.pdf

activity level of this waste is generally below one hundred Bq per gram. Its activity level is generally lower than 100 Bq/g; and

- **very-short-lived waste** comes mainly from the medical and non-NPP research sector.

There are benefits to the French Classification Scheme, for example:

- the LLW/LW-SL category allows proportionate (i.e. surface) and prompt disposal of short-lived wastes;
- options for surface, near-surface and geological disposal – allows optimised management and proportionate disposal; and
- bulk activity levels are straightforward to apply.

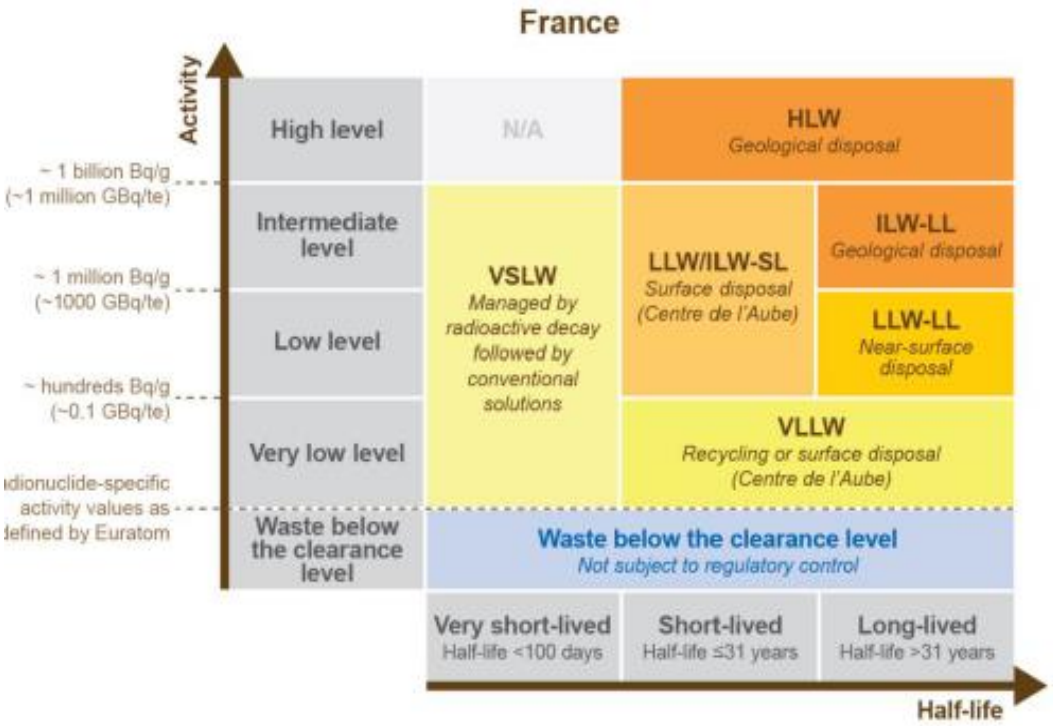

Figure 3 Schematic diagram indicating the French approach to waste classification[28]

However, there are a number of challenges with the French classification system[29], for example:-

- there is no single classification criterion for determining the category of waste and numerous criteria are required to determine the acceptability of a given waste in a given route; and
- the regulatory framework exempts processes and not substances. A substance which falls within the scope of the regulations applicable to the uses of radioactivity for Basic Nuclear Installations (BNIs) or from the small-scale

[28] Source: Figure 6 page 29 of the LLWR Report
[29] See République Française, Fifth National Report on Compliance with the Joint Convention Obligations, September 2014

nuclear sector, requires specific management if it has been in contact with radioactive contamination or has been activated by radiation.

Further, the French regulatory framework does not provide for clearance of VLLW although recycling of VLLW is possible if waste is reused in the nuclear sector[30]. Any substance which falls within the scope of the regulations applicable to the uses of radioactivity for Basic Nuclear Installations (BNIs) or from the small-scale nuclear sector, requires specific management if it has been in contact with radioactive contamination or has been activated by radiation. This entails management of radioactive waste, including processing and/or disposal, in duly authorised facilities.

France therefore has a dedicated disposal facility in the Aube *département* for the long-term management of very low level (VLL) waste, where in the UK such wastes can be disposed of in commercial non-nuclear landfills (provided they have the appropriate permit).

The French approach to clearance is more restrictive than the BSSD 2013 which introduces clearance levels for solid materials. However Member States are free to adopt or maintain more stringent measures. Nevertheless, the BSSD 2013 states that protection against natural radiation sources, rather than being addressed separately in a specific title, should be fully integrated within the overall requirements. In particular, industries processing materials containing NORM should be managed within the same regulatory framework as other practices. Consequently, France plans to introduce clearance levels for NORM. France has confirmed it will continue to apply its restrictive approach to clearance levels for artificial radionuclides[31].

It is understood that the management of VLLW coming from decommissioning and the issue of clearance levels will probably be part of the discussions in France with the national debate that is scheduled in the second half of 2018 for the future national plan for waste management.

RADIOACTIVE WASTE CLASSIFICATION IN BELGIUM[32]

The Belgian approach to radioactive waste classification is based on a "facility-specific safety case approach". ONDRAF/NIRAS (the Belgian waste management organisation) has developed a hierarchical classification system for conditioned radioactive waste, directed towards the long-term management of the waste, and a hierarchical classification for unconditioned waste, directed at the waste processing routes (See Figure 4 below for the schematic of the approach to classification).

At the top of the classification two groups are defined based on the potentially suitable disposal methods, being:-

- **The open group** - *"conditioned radioactive waste with radiological characteristics, i.e. the concentration of activity of the radioisotopes which they contain and the half-life of those radioisotopes, are sufficiently low and short-lived for alternative solutions to geological disposal to be considered. Their radioactive decay must allow them to attain a radiological level that is viewed as*

[30] For example, after the decontamination of contaminated lead, it has been sent to a conventional facility to then produce equipment for nuclear facilities such as shielding under a derogation of the Public Health Code is obtained (article R.1333-4).
[31] http://www-ns.iaea.org/downloads/rw/conventions/sixth-review-meeting/Questions%20Posted%20To%20France%20in%202018.pdf
[32] This summary is based on the information contained in the LLWR Report.

insignificant over a period of time that is compatible with the options for monitoring that decay"; and

- **The geological group**- *"conditioned radioactive waste whose radiological characteristics, i.e. the concentration of activity of the radioisotopes which they contain and the half-life of those radioisotopes, are such that their permanent isolation from the biosphere is imperative, and that this therefore constitutes the only ultimate solution. This permanent isolation is currently regarded as being achievable by burial in deep and stable geological formations"*.

Conditioned waste is then assigned to one of three categories, being:-

- **Category A Wastes** - belong to the open group and is defined by whether they can be safely disposed of to the national surface facility at Dessel. The determination of suitability is based on a safety calculation. A set of radionuclide-specific maximum activity concentrations (in Bq/m3) have been developed for twenty radionuclides and the presence of these radionuclides in conditioned waste must be quantified. These activity concentrations are used in the calculation to determine the acceptability of individual waste streams. The scheme assumes *in situ* decay post disposal, up to the point the site is released from institutional control, a period of 300 years. As a result, radionuclide-specific limits need only be developed for a relatively small number of radionuclides. However, there are also facility-specific waste acceptance criteria that limit the amount of short-lived radionuclides in accepted wastes for operational reasons. This is similar to the IAEA LLW category; and

- **Category B and C Wastes** - belong to the geological group and are defined as wastes that cannot be safely disposed of in the facility at Dessel, whether because of their activity level or half-life, and require higher levels of isolation and containment than can be provided by geological disposal. Category B and Category C wastes are separated based on heat generation.

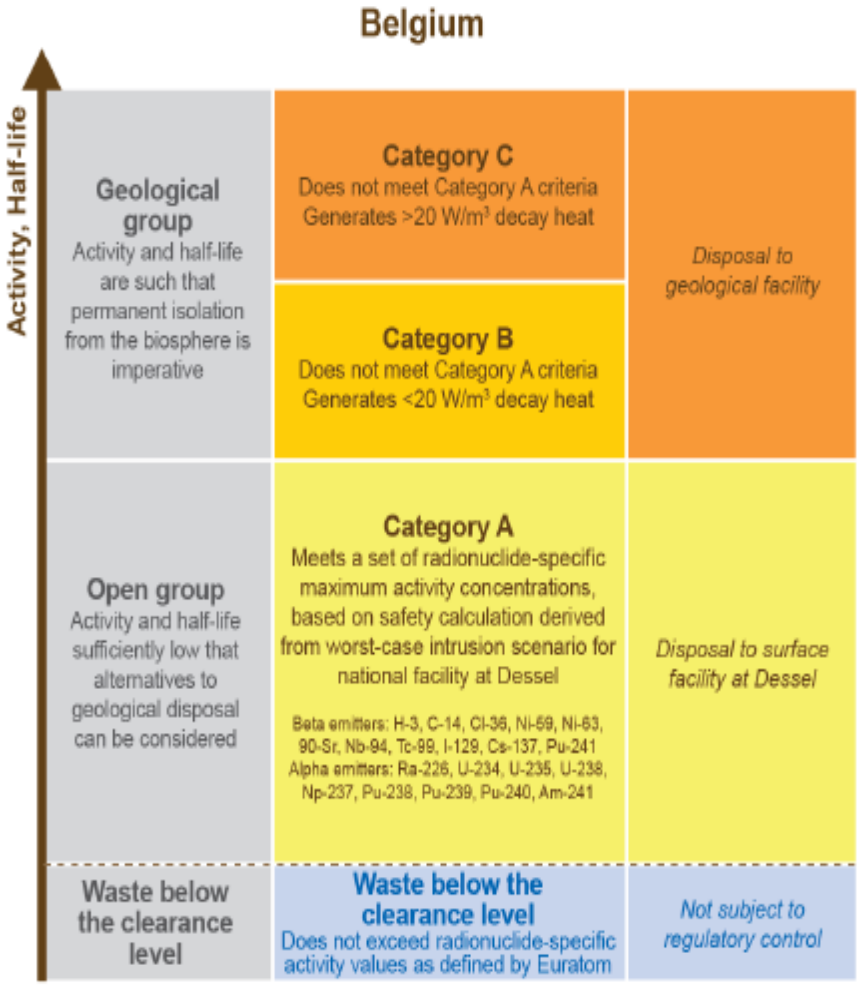

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Figure 4 Schematic diagram indicating Belgium's recommended approach to waste classification[33]

An advantage of the Belgian classification system is that it is based on a small number of categories and is therefore easy to understand and apply. The system is also a risk based system, focused on the safety of disposal at a specific facility (Dessel). This allows existing facilities to be used effectively and the system could be easily adapted to apply to new facilities. The system also assists in the identification of any gaps in suitable disposal routes for certain radioactive waste streams and could be used to drive investment and market research into the development of new facilities.

However, there are also disadvantages to the Belgium classification system, including, for example[34]:-

- it could result in a complex system of disposal routes;
- difficulties in explaining the hazards and risks of each of the three categories of conditioned radioactive waste to stakeholders and the public;

[33]Source: Figure 4 page 27 of LLWR Report
[34] See LLWR Report for further detail

- there are no explicit provisions for decay storage and it is unclear when wastes should be classified;

- the system is directed at ensuring safe disposal at specific facilities. However, this does not address the need to classify the waste for transport purposes. In addition, it means that wastes cannot be classified until a facility is permitted and operational i.e. has WAC in place.

THE WASTE HIERARCHY AND SUSTAINABILITY

The European Union Waste Framework Directive 2008/98/EC[35] sets out a basic framework for managing wastes (not radioactive wastes) including:-

- definitions of waste, recycling and recovery;

- when waste ceases to be a waste and becomes a secondary raw material (the-end-of-waste concept); and

- application of the waste hierarchy (see figure 5 below for a schematic diagram of the waste hierarchy).

In the UK, the Low Level Waste Policy of 2007 expressly provides that "*to ensure that arisings of LLW and the requirements for its disposal are minimised, LLW managers should plan to manage their waste in accordance with the waste management hierarchy principles...*.". For LLW this means:-

- not creating waste where practicable ("avoidance");

- reducing waste arisings (both by activity and mass) to the minimum through the appropriate design and operation of processes and equipment and making effective use of techniques such as waste characterisation, sorting and segregation, volume reduction and surface contamination removal;

- otherwise minimising quantities of LLW requiring disposal through decay storage, re-use and/or recycling, and incineration (under appropriately regulated circumstances); and

- disposal (which may, for some waste forms, include incineration).

The waste hierarchy is a key driver and an integral part of the development of integrated waste strategies at nuclear and non-nuclear sites in the UK. For example, one requirement of the UK's Low Level Waste Policy 2007 was for the Nuclear Decommissioning Authority to produce a UK Strategy for the management of solid LLW from the nuclear industry, to establish treatment and disposal routes to support past, present and future decommissioning and remediation activities and manage operational LLW that continues to be created by the nuclear industry.

[35] Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives

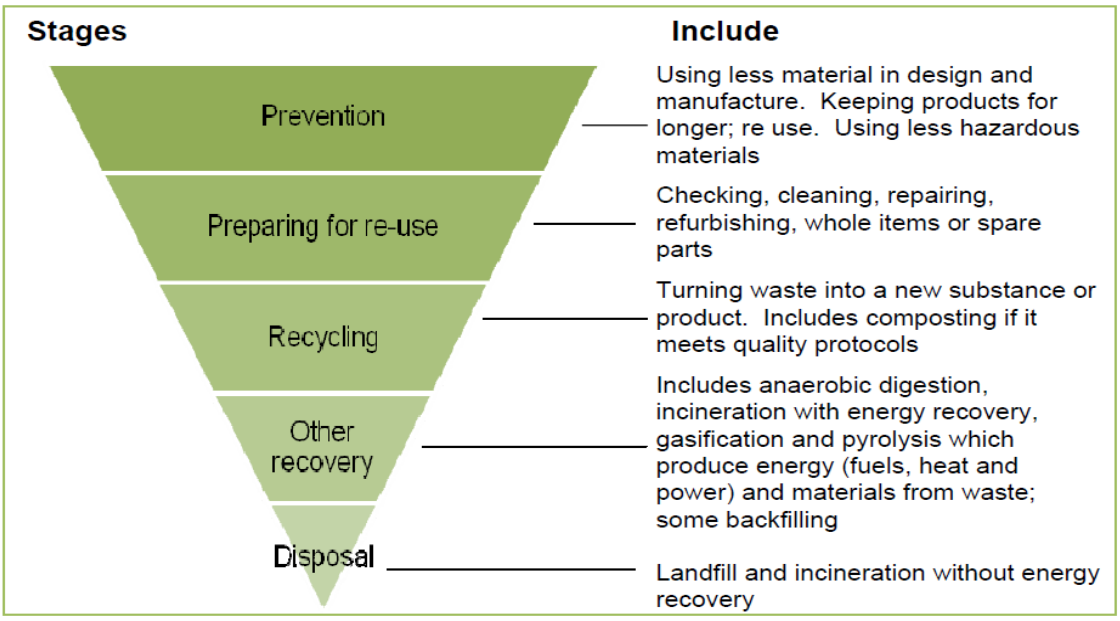

Figure 5 – Schematic diagram of the waste hierarchy[36]

The NDA Strategy was published in 2016[37] and makes compliance with the waste hierarchy for LLW waste a requirement. Implementation of the strategy has been successful across the NDA estate and has resulted in the development of a number of alternative waste management routes and diverted significant volumes of LLW away from the Low Level Waste Repository in Cumbria.

It is worth considering whether the introduction of the waste hierarchy into the international nuclear legal framework for managing radioactive waste could bring the same benefits as have been seen across the non radioactive waste sector after its introduction in the Waste Framework Directive. At present the Joint Convention includes a requirement to ensure generation of radioactive waste is kept to a minimum practicable (Article 11) but does not include any reference to any other aspects of the waste hierarchy, such as recycling and recovery.

IS THERE INTERNATIONAL CONSENSUS TO MOVE TOWARDS A MORE HARMONISED APPROACH?

The Sixth Review Meeting of the Joint Convention took place on the 21 May 2018 to the 1 June 2018 at the IAEA's headquarters in Vienna. Key points to note from the summary report of the meeting include[38]:-

- the possibility of shared or regional radioactive waste disposal facilities is still under consideration by some Contracting Parties;
- clearance mechanisms are being put in place by some Contracting Parties. These are being based on international safety standards and are giving focus to implementing procedures to assure compliance with clearance levels in place;

[36] Source: Figure 1 Page 3 of Defra, Guidance on applying the Waste Hierarchy, June 2011
[37] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/497114/NI_LLW_Strategy_Final.pdf
[38] http://www-ns.iaea.org/downloads/rw/conventions/sixth-review-meeting/summary-report-sixth-review-meeting-e.pdf

- as existing radioactive waste storage and disposal facilities receive waste and the difficulties in developing new facilities remain, there is a need to ensure adequate capacity will be available and to put in place efforts to reduce the volumes of waste generated. Use of clearance, reuse and recycling programmes can contribute as can efforts to optimise national radioactive waste management and disposal programmes;

- the linking of radioactive waste classes with disposal options is an important part of national radioactive waste management policy and strategy and a clear and defined approach to classification is considered important. **International standards for radioactive waste classification and clearance criteria exist and work has been undertaken by a number of international organisations in this area to assist reporting to different national conventions and regional legal instruments. Some Contracting Parties indicated further harmonisation in this area would be beneficial though the IAEA's existing processes**.

It is clear from the national reports of the Contracting Parties to the Joint Convention and the Summary Report of the Sixth Review Meeting of the Joint Convention that:-

- different Contracting Parties have very different radioactive waste classification schemes. This makes it difficult to compare data and waste management options and routes for different radioactive waste streams. This in turn will have impacts on the co-operation of different States in developing and sharing radioactive waste treatment and disposal options; and

- the Contracting Parties are aware of the difficulties and the need for greater harmonisation at the international level however given the different approaches in existence achieving mandatory harmonisation of waste classification would be extremely difficult.

Further the Report from the European Commission to the Council and the European Parliament on progress of the implementation of the Council Directive 2011/70/Euratom and an inventory of radioactive waste and spent fuel present in the Community's territory and future prospects (COM (2017) 236 Final)(the "Report"[39]) stated the following:

> *"Decommissioning of nuclear power plants will become an increasingly important activity for the European nuclear industry in the coming years due to the ageing of the reactor fleet, and investments are also needed to replace existing nuclear plants...This will have an important impact on the amounts of radioactive waste generated, especially very low level waste and low level waste, and should thus, need to be taken into account when planning disposal and storage facilities….*
>
> *The development of a comprehensive and up-to-date Member State's inventory is the basis for national programming, cost estimation and related concepts and plans for the safe and responsible management of spent fuel and radioactive waste.* ***Currently, the estimation and presentation of a reliable EU wide inventory is challenging as most Member States use their own classification systems and a harmonised approach is not***

[39] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52017DC0236&from=EN

addressed explicitly in the Directive. *In addition, a number of Member States have not reported on all types of radioactive waste, particularly radioactive waste originating from decommissioning and new builds, future forecasts and institutional waste. Therefore, in the next reporting cycle (i.e. in 2018)…the Commission intends to support the Member States in (i)* ***further improving reporting of radioactive waste inventory data****, providing e.g. a clear definition of the different sources of radioactive waste and their origins; and (ii) carrying out additional work on detailed and reliable projections".*

CONCLUSIONS

Approaches to radioactive waste classification varies from country to country and in some cases, even within countries. This results in problems with international communication and comparison of practices (e.g. data collection on inventories and projections of waste streams). There is also the risk of inaccuracies and confusion resulting from the conversion of data from national systems to the IAEA Classification Scheme (e.g. for the purposes of reporting under the Joint Convention and the Spent Fuel and Radioactive Waste Directive 2011).

The challenges arising from a lack of a harmonised radioactive waste classification scheme have already been recognised at the international level. A common classification system would bring benefits and could assist with co-operation between countries (including with the development of shared disposal facilities).

Further, using a common language in international dialogue and reporting is important, and clear communication with the public and stakeholders is essential to ensure openness and transparency as well as assisting with public participation.

As more nuclear power stations are built and the number of nuclear power plants in decommissioning increases, the challenge of the safe management of radioactive waste gets greater (including the need for increased capacity at storage and disposal facilities as well as the development of new facilities to treat, re-use and recover radioactive waste). There is a real need for Contracting Parties to consider the effectiveness of the reporting requirements under the Joint Convention and whether now is the time to seek to bring a common and harmonised radioactive waste classification system along with other potential changes to waste management.

Harmonisation will not be easy but the IAEA classification system has not been adopted by many countries and in the opinion of the author will not be unless harmonisation is made mandatory.

The benefits of amending the Joint Convention to require a harmonised approach to waste classification may not bring sufficient benefits to justify the change[40]. However, it is the opinion of the author that this is worth further consideration as well as a review of other general waste law concepts such as the application of the waste hierarchy and the concept of end of waste to all radioactive waste streams.

Helen Peters
November 2018

[40] The author has not carried out an analysis of benefits to reach a fully informed opinion.