Radioactive Waste Management

WPSGD no. WPS/923/01

Geological Disposal:

Guidance on the application of safeguards during the packaging of higher activity waste

February 2015

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WASTE PACKAGE SPECIFICATION AND GUIDANCE DOCUMENTATION

WPS/923 GUIDANCE ON THE APPLICATION OF SAFEGUARDS DURING THE PACKAGING OF HIGHER ACTIVITY WASTE

1 Executive Summary

This document forms part of the *Waste Package Specification and Guidance Documentation* (WPSGD), a suite of documents prepared and issued by Radioactive Waste Management Ltd (RWM), a subsidiary of the Nuclear Decommissioning Authority (NDA). The WPSGD are intended to provide a 'user-level' interpretation of the RWM packaging specifications, and other aspects of geological disposal, to assist UK waste producers in the development of plans for the packaging of higher activity waste in a manner suitable for geological disposal.

Key documents in the WPSGD are the *Waste Package Specifications* which define the requirements for the transport and geological disposal of waste packages manufactured using standardised designs of waste container. The WPS are based on the high level requirements for all waste packages as defined by the *Generic Waste Package Specification* and are derived from the bounding requirements for waste packages containing a specific category of waste, as defined by the relevant *Generic Specification*.

This document provides guidance on the application of safeguards during the packaging of higher activity waste. Its aim is to make waste packagers aware of the safeguards obligations during the packaging of waste containing nuclear material and to suggest strategies for the discharge of those obligations.

The documents that make up the WPSGD will be subject to periodic revision which may lead to significant changes in packaging requirements. Users are therefore advised to contact RWM, or refer to the RWM website, to confirm that they are in possession of the latest version of any documentation used.

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List of Contents

Abbreviations and acronyms used in this document

BTC	Basic Technical Characteristics
DECC	Department of Energy and Climate Change
Euratom	The European Atomic Energy Community
GDF	geological disposal facility
GWPS	Generic Waste Package Specification
HEU	high enriched uranium
HLW	high level waste
HSE	Health & Safety Executive
IAEA	International Atomic Energy Agency
ICR	Inventory Change Report
ILW	intermediate level waste
INFCIRC	IAEA Information Circular to member states
LLW	low level waste
LLWR	Low Level Waste Repository
LoC	Letter of Compliance
MBA	Material Balance Area
NDA	Nuclear Decommissioning Authority
NM	nuclear material
NMA	nuclear materials accountancy
NPT	Treaty on the Non-Proliferation of Nuclear Weapons
NWS	Nuclear Weapons State
ONR	Office for Nuclear Regulation
PIV	Physical Inventory Verification
RWM	Radioactive Waste Management Ltd
TU	Termination of use
UKRWI	UK Radioactive Waste Inventory
WPS	Waste Package Specification
WPSGD	Waste Package Specification and Guidance Documentation

2 Introduction

The Nuclear Decommissioning Authority (NDA), through Radioactive Waste Management Ltd (RWM), is responsible for implementing UK Government policy for long-term management of higher activity radioactive wastes, as set out in the *Implementing Geological Disposal* White Paper [1]. The White Paper outlines a framework for managing higher activity radioactive waste in the long term through geological disposal, which will be implemented alongside the ongoing interim storage of waste packages and supporting research.

RWM produces packaging specifications as a means of providing a baseline against which the suitability of plans to package higher activity waste for geological disposal can be assessed. In this way we assist the holders of radioactive waste in the development and implementation of such plans, by defining the requirements for waste packages which would be compatible with the anticipated needs for transport to and disposal in a geological disposal facility (GDF).

The packaging specifications form a hierarchy which comprises three levels:

- The *Generic Waste Package Specification* (GWPS) [2]; which defines the requirements for all waste packages which are destined for geological disposal.
- *Generic Specifications;* which apply the high-level packaging requirements defined by the GWPS to waste packages containing a specific type of waste.
- *Waste Package Specifications* (WPS); which apply the general requirements defined by a Generic Specification to waste packages manufactured using standardised designs of waste container.

As a means of making the full range of packaging specifications available to waste producers and other stakeholders, RWM produces and maintains for a suite of documents known as the *Waste Package Specification and Guidance Documentation* (WPSGD). The WPSGD, which can be accessed via the RWM website, includes a range of WPS for different waste package types together with explanatory material and guidance that users will find helpful when it comes to application of the WPS to practical packaging projects. For further information on the extent and the role of the WPSGD, reference should be made to the *Introduction to the RWM Waste Package Specification and Guidance Documentation* [3].

The requirements for waste packages containing intermediate waste (ILW), and wastes with similar radiological properties, are defined by the *Generic specification for waste packages containing low heat generating waste* [4]. These requirements are applied to the waste packages that can be manufactured using the current range of standardised waste containers (as identified in the *Disposal System Technical Specification* (DSTS) [5]) in the WPS that make up the WPS/300 Series of documents that form part of the WPSGD.

The purpose of this guidance is to provide waste packagers with a basic guide to the safeguards obligations pertaining to higher activity waste[1] which contains 'nuclear material' (NM) and how those obligations should be discharged during the packaging of such waste for geological disposal. The guidance discusses the application of safeguards at waste processing and interim storage facilities, and during transport, and identifies the main

[1] Whilst this guidance is mainly aimed at the safeguards implications of the packaging of such wastes, i.e. ILW and high level waste (HLW), it contains much information that is relevant to other radioactive materials that could be the subject of geological disposal.

stages involved in allowing for safeguards to be terminated on waste that is to be consigned to a GDF.

The guidance details the appropriate safeguards obligations for waste containing NM, along with an explanation of how these should be applied in practise, including the requirements for nuclear materials accountancy (NMA) during waste packaging. Consideration is also given as to how waste packagers should provide RWM with evidence that safeguards obligations and NMA have been fully considered during the development of plans to package specific waste streams, such that the adequacy of these arrangements can be evaluated by way of the Disposability Assessments Process.

Users of this guidance are advised to read it in conjunction with *Guidance on International Safeguards and Nuclear Material Accountancy at Nuclear sites in the UK, produced by the safeguards section of the* Office for Nuclear Regulation (ONR-Safeguards) [6].

The remainder of this document is structured in the following manner:

- Section 2 provides background information on geological disposal in general and the manner in which RWM assess the suitability of proposed waste packages for geological disposal.
- Section 3 outlines the aims of nuclear safeguards and their practical application.
- Section 4 reviews current safeguards legislation, policy and guidance.
- Section 5 provided guidance on how safeguards apply to the packaging of waste containing NM.
- Section 6 discusses the implementation of safeguards during the actual packaging of waste and the needs of the RWM Disposability Assessment process in that regard.
- Glossaries of important terms and phrases, and information from EC Recommendation (2006/40/Euratom), are provided at the end of the document.

3 Background

3.1 The concept of geological disposal

Whilst the precise manner in which geological disposal would be implemented in the UK is not yet defined we envisage that any approach to long-term management of waste (including disposal) would comprise a number of distinct stages which could include:

- the manufacture of passively safe and disposable waste packages;
- a period of interim surface storage, usually at the site of waste arising or packaging;
- transport of the waste packages to a GDF;
- transfer of waste packages underground and emplacement in the disposal facility;
- back-filling of the disposal areas; and
- eventual sealing and closure of the facility.

The exact nature, timing and duration of each stage would depend on a number of criteria, including the geographical location and host geology of a GDF, as well as the disposal concept selected for implementation for each distinct category of waste.

3.2 The role of the waste package in geological disposal

The waste package provides the most immediate barrier to the release of radionuclides and other hazardous materials from the waste it contains both during interim storage, transport and when it forms part of a multiple barrier geological disposal system. It can also play a role in protecting individuals from the radiation emitted by the radionuclides it contains during interim storage, transport and the GDF operational period.

The barrier provided by a waste package can be considered to comprise two components, each of which can act as a barrier in its own right:

- The waste container, which provides a physical barrier and also enables the waste to be handled safely during and following waste package manufacture. Containers can be manufactured from a range of materials with designs selected to suit the requirements for the packaging, transport and disposal of the wastes they contain.
- The wasteform, which can be designed to provide a significant degree of physical and/or chemical containment of the radionuclides and other hazardous materials associated with the waste. The wasteform may comprise waste which has been 'immobilised' (e.g. by the use of an encapsulating medium such as cement) or that which may have received more limited pre-treatment prior to packaging (e.g. size reduction and/or drying).

It is the performance of the barrier(s) provided by the waste package that packaging specifications seek to address by defining requirements for waste packages which have been derived from the needs of their long-term management.

3.3 Types of waste package

A variety of waste container designs have been proposed for the packaging of low heat generating waste (i.e. LLW and ILW) for geological disposal. These designs can be grouped into three basic types, on the basis of the general nature of the waste packages that they can be used to produce:

- For use with ILW and LLW with low specific activity, such as would not generally require the extensive use of remote handling techniques, waste containers incorporating integral radiation shielding[2] can be used to create *shielded waste packages.*

- For higher activity ILW, such as would generally require the use of remote handling techniques, relatively thin-walled (i.e. a few mm) metal containers can be used to create *unshielded waste packages.* Because of their high external radiation dose rate, or requirements for the containment of their contents, such waste packages would be expected to be transported through the public domain in reusable shielded transport containers.

- For all types of ILW, thick-walled (i.e. many 10's of mm thick) waste containers can be used to provide both radiation shielding and physical containment of their contents, and to create *robust shielded waste packages.* Such waste packages are capable of being stored, transported and disposed of without the need for remote handling techniques or for additional shielding or containment.

For wastes with higher heat generation (e.g. HLW) specific designs of waste container have not been identified but it is likely that these would generally be fabricated from low corrosion metal (e.g. stainless steel, copper etc.) and have walls thicknesses of several 10's of mm.

3.4 The assessment of packaging proposals

RWM has established the Letter of Compliance (LoC) Disposability Assessment process [7] to support waste producers in the development of plans to package higher activity wastes. Specifically the Disposability Assessment process is used by RWM to demonstrate that proposals to package waste would, if implemented, result in 'disposable' waste packages. In this context a disposable waste package is one that is compliant with all of the relevant regulations and safety cases for transport to and disposal in a GDF, and in line with regulatory expectations for the long term management of the waste [8].

The Disposability Assessment process also plays an important role in underpinning the generic *Disposal System Safety Case* (DSSC) [9] by providing confidence that the safety cases, which are based on generic assumptions regarding the wastes that are anticipated to be accommodated by a GDF, are compatible with the 'real' waste packages that are being manufactured. The performance of disposability assessments also helps us to show that the disposal concepts considered within the generic Disposal System Safely Case will be appropriate for the wastes they will be expected to cover as well as identifying wastes that could challenge current disposal concepts and allow early consideration of what changes may be required to these concepts to permit these wastes to be accommodated.

Guidance is available on the manner by which waste packagers should prepare submissions for the disposability assessment of packaging proposals [10].

[2] If needed, to ensure that external radiation dose rates do not exceed the regulatory limits for transport.

4 Nuclear safeguards

4.1 Definition of Nuclear Material

The term 'nuclear materials' is defined in Article 2.4 of EC Regulation (Euratom) 302/2005 as [12]:

> *'"Nuclear materials" means ores, source material or special fissile material as defined in Article 197 of the Euratom Treaty'.*

In summary, Article 197 defines these materials as:

'Special fissile materials':	Plutonium-239, uranium-233, uranium enriched[3] in uranium-235 or uranium-233.
'Source materials':	Natural uranium depleted uranium, thorium
'Ores':	Materials from which source materials can be extracted by chemical or physical processing.

Article 18.2(b) of the Regulation specifies six categories of nuclear material for which NMA reporting is required:

- Plutonium;
- High enriched uranium (20% enrichment or greater);
- Low enriched uranium (higher than natural, less than 20% enrichment);
- Natural uranium;
- Depleted uranium; and
- Thorium.

4.2 The aim of nuclear safeguards

The aim of nuclear safeguards is to detect, and therefore deter, the diversion of NM from peaceful uses to nuclear weapons. It is the means by which the international community limits the spread of nuclear weapons, through verifying that nuclear activities established for peaceful, civilian, purposes, such as power generation, medical and research applications, are not diverted to military use.

Safeguards are a fundamental aspect of the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) and one which is implemented on behalf of the international community by the International Atomic Energy Agency (IAEA). In the case of countries within the European Union (EU), the safeguards inspectorate of the Energy Directorate of the European Commission also has regulatory responsibilities. The UK's status as a Nuclear Weapons State (NWS) under the NPT means that the majority of safeguards implementation in the UK is by Euratom

A wide array of techniques, physical and administrative, have been developed over the past half century and are now well established for the safeguarding of NM at civil nuclear facilities across the world. The issues surrounding the application of safeguards to nuclear waste have been under development for several decades. At this time some clear

[3] In this context 'enriched' uranium is that in which the abundance ratio of the sum of uranium-233 and uranium-235 to uranium-238 is greater than the ratio of uranium-235 to uranium-238 in natural uranium (i.e. 0.7%w/w).

principles and generic safeguards approaches have now emerged. The application of safeguards to geological disposal facilities is less mature but is of direct relevance to the procedures being adopted in relation to existing and newly generated waste materials.

This guidance considers the general legal, regulatory and policy basis of safeguards and how to apply this to waste materials. It then considers the underlying principles which drive safeguards and their application to the various waste-streams in the context of UK facilities. There is an examination of the safeguards practices which are being adopted by the safeguards regulatory authorities and the practical and conceptual arrangements which should be applied by UK facilities processing and storing waste containing NM for which the ultimate destination is intended to be a GDF. This document is therefore relevant to all operators of nuclear facilities that produce and subsequently package waste containing NM.

4.3 Conditions for the application of safeguards to waste

It is known that many of the higher activity wastes that are destined for eventual geological disposal contain NM, sometimes in significant quantities. As the eventual operator of a GDF, RWM will, at some point in the future, assume the ownership of such materials, together with the safeguards obligations they attract. RWM therefore require that the presence of NM in waste packages, and its safeguards status, is well known and that the possibility for uncertainty in this aspect of the disposal of the waste is minimised.

In considering the conditions for the application of safeguards to NM contained within waste there are two key issues that need to be considered. The first of these is the actual definition of what constitutes ‘waste’ for the purposes of safeguards , the second being at what point safeguards can be ‘terminated’ on the NM associated with that waste. In the latter case it should be noted that termination does not necessarily have to involve discard to the environment, but could involve emplacement in a long-term storage facility or a GDF.

For safeguards purposes, ‘waste’ is defined as NM in concentrations or chemical forms considered as irrecoverable for practical or economic reasons and which may be disposed of. In practice waste is subcategorised into either ‘retained waste’ or ‘conditioned waste’ depending on the physical form of the waste. It should be noted that for NM in the form of conditioned waste, agreement can be sought from the relevant Safeguards Inspectorate for the termination of safeguards.

Whilst formal guidelines for the treatment of the safeguards status of the NM content of waste intended for geological disposal are still under development, it is considered good practise for safeguards to be terminated for such material. This would be achieved by agreement with the relevant Safeguards Inspectorate, in advance of the packaging of the material. Such an approach would allow agreement to be obtained for an entire wastestream, rather on a package by package or batch by batch basis. However, it should be noted that the safeguards status of the NM in a wastestream, and particularly whether termination has been effected, would not be expected to dictate the viability or otherwise of a proposed approach to the packaging of the waste.

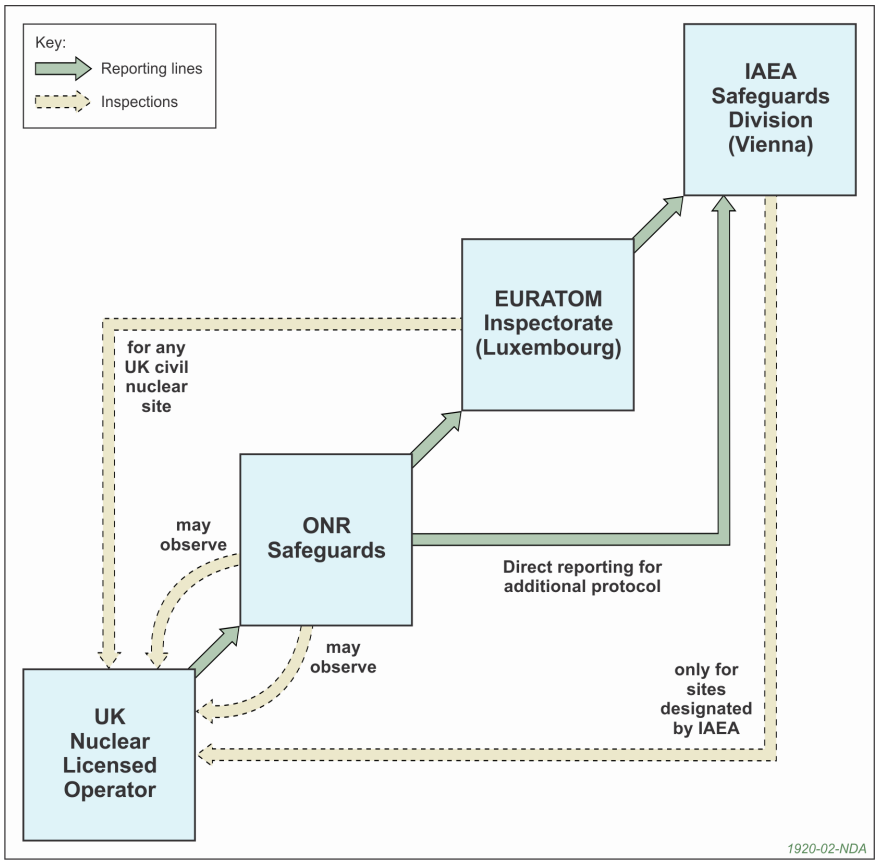
5 Review of safeguards legislation, policy and guidance

5.1 Current legislation and the application of safeguards

In terms of international regulation for safeguards, it is the obligations of the government on behalf of the State which are being verified, with the safeguards inspectorate ('regulator') being independent of any national government control. Whilst nuclear activities in the UK are fully regulated through various forms of legislation, these are primarily concerned with the safe and effective operation of facilities where NM is processed or stored. This includes provisions for NMA, but no mandate for the implementation of domestic safeguards-type verification activities.

The safeguards reporting structure, as practiced in the UK is illustrated in Figure 1 which shows, as explained above, at the global level it is the IAEA that has the responsibility for the application of safeguards. All such safeguards, with the exception of those applied in the three states that have not signed the treaty, are driven by the NPT, which entered into force on 5 March 1970. As a NWS under the terms of the treaty, the UK has entered into a voluntary offer in connection with the NPT, this means that IAEA is not obliged to implement safeguards within the UK and as a result the extent of such implementation is fairly limited[4].

Figure 1 UK safeguards reporting structure



Additionally, within the EU, safeguards are also implemented by the Safeguards Inspectorate of the Energy Directorate of the EC, colloquially referred to as "Euratom", after

[4] Currently the IAEA allocates a total of ~160 man days to on-site inspections at UK licensed sites.

the treaty of the same name. The key documents are the Euratom Treaty itself (Chapter VII) and Commission Regulation (Euratom) No. 302/2005 on the application of Euratom safeguards [12]. This was subsequently complemented by EC Recommendation (2006/40/Euratom) which provides practical guidance on aspects of the implementation of Regulation 302/2005 and the Commission Recommendation of 11 February 2009 on the implementation of a nuclear material accountancy and control system by operators of nuclear installations [11].

The nature of safeguards obligations means that countries usually designate a 'State Authority' to act as the official link with the regulators/inspectorates; in the UK this role is undertaken by ONR-Safeguards.

5.2 Policy and guidance

In the UK, the lead organisation in the area of International Safeguards policy and its development is the Department of Energy and Climate Change (DECC). As already explained the two main international regulators are the IAEA and Euratom, with ONR-Safeguards acting as the official UK Government link with those inspectorates.

Due to the UK's status as a NWS, the implementation of safeguards by IAEA is limited and the prime safeguards interface for nuclear operators is with Euratom.

Euratom Regulation 3002/2005 [12] introduced a major revision to the requirements for Member States and operators in meeting their safeguards responsibilities under the Euratom Treaty. This revision contained specific provisions dealing with the categorisation, and reporting relating to nuclear waste material during processing, storage and subsequent transfers, and guidance on how the provisions in respect of waste would be applied was included in EC Recommendation (2006/40/Euratom) [13] which accompanied the new regulation.

Practical experience with the implementation of the new regulations has since developed and discussions between ONR Safeguards and Euratom have improved mutual understanding of the extent of the safeguards challenges posed by the range of waste materials that are subject to the Euratom Treaty. Current indications are that Euratom will adopt a pragmatic approach to the application of criteria for termination of safeguards and to the kind of verification activities applied for material categorised as waste for safeguards purposes or otherwise destined for disposal (ie even if not categorised as waste), and that safeguards for waste streams will be considered on a case by case basis. This is discussed in further detail later in this document.

6 Basic guidance for the application of safeguards to waste

This guidance provides those responsible for the development of proposals to package higher activity waste for eventual geological disposal and the considerations that must be given to international safeguards obligations and nuclear materials accountancy in the performance of waste management activities, including waste processing, packaging, interim storage, transport and geological disposal.

NM in other forms, such as depleted, natural and low enriched uranium (DNLEU), separated plutonium and spent fuel, are also materials that could be declared as wastes and consigned for disposal in a UK GDF. Where it is the intention to dispose of these materials in "non-waste" forms, then the safeguards requirements are not covered by this guidance. However, should processing of these materials into waste forms be anticipated, then the requirements of this guidance will apply.

6.1 Requirements of the RWM packaging specifications relating to safeguards

Some aspects of international safeguards requirements are already covered by existing RWM documentation, notably the packaging specifications. The GWPS defines a high-level requirement for all waste packages which are to the subject of geological disposal [2]:

> *'The management of waste packages containing NM shall comply with all relevant safeguards obligations… …for their transport and disposal.'*

For waste packages containing low heat generating wastes, the relevant Generic Specification is more prescriptive [4], i.e.:

> *'The safeguards status of any NM contained within the waste package shall be ascertained and recorded.'*

The application of this requirement forms part of the Disposability Assessment process which includes a 'safeguards evaluation' which aims to ensure that waste producers are aware of the safeguards consequences of the conditioning and packaging of the waste, and that RWM are aware of the ongoing requirements for safeguards obligations for the packaged waste. Safeguards classification of nuclear material in waste-streams

In many ways the key factor in the application of correct safeguards to NM contained in a waste stream is the initial consideration of the safeguards status of the NM as it exists before the retrieval of the wastes (i.e. prior to packaging) and whether this status may be changed by the proposed conditioning and packaging processes. Such NM may be under full safeguards coverage by the relevant authorities, could be under limited coverage due to it being declared as waste or may have already have had safeguards terminated due to its concentration within the waste stream being below the relevant value identified by Euratom guidance (see below).

6.1.1 Euratom safeguards

As discussed above, for Euratom safeguards purposes, 'waste' is defined as NM in concentrations or chemical forms considered as irrecoverable for practical or economic reasons and which may be disposed of. The two categories of waste are:

- Retained waste (transaction code RW); generated from processing or from an operational accident, measured or estimated on the basis of measurements, which has been transferred to a specific location within the material balance area (MBA) from which it can be retrieved.

- Conditioned waste (transaction code CW); measured or estimated on the basis of measurements, which has been conditioned in such a way (for example, in glass, cement, concrete or bitumen) that it is not suitable for further nuclear use.

The transfer of material to either of these waste forms from fully safeguarded NM (i.e. that deemed 'on inventory') has potentially significant impact as it is accompanied by a significant reduction in the intensity of safeguards coverage on that material. Retained or conditioned waste is not part of the main safeguards inventory and, as such, routine (i.e. monthly) safeguards reporting and associated inspections are not applicable. Instead operators are only required to keep appropriate local operating records, which may be subject to audit. The limited formal procedures/requirements are detailed in Euratom Regulation No. 302/2005 and are explained in more detail below.

Euratom safeguards also recognises a 'Termination of Use' (TU) transaction code that allows NM to be removed completely from a site's inventory of nuclear material subject to safeguards, including all reporting requirements. It is important to note however that Euratom safeguards can only be terminated with the prior agreement of Euratom.

More specifically, Section 2.5.2.1 of EC Recommendation (2006/40/Euratom) [14] provides guidance as to how Euratom safeguards can be terminated, following their agreement, on waste containing very low separate or combined[5] concentrations of NM as indicated in the Table 1.

Table 1 Limiting NM concentrations for potential termination of safeguards

NM category	Concentration
Depleted and natural uranium	1,000g/tonne (0.1%w/w)
Low enriched uranium	200g/tonne (0.02%w/w)
High enriched uranium	10g/tonne (10ppm w/w)
Plutonium	4g/tonne (4ppm w/w)

6.1.2 Interpretation of the safeguards regulations regarding NM in waste

The definition of both retained and conditioned waste in the regulations is by no means precise and even the 'termination levels' presented in Table 1 are defined for guidance only. What is evident is that some degree of negotiation will be required with the regulators (chiefly Euratom) to agree what they will accept as waste on a case by case basis. Similar negotiations should also be expected in terms of reaching agreement for the application of the final termination of safeguards on waste materials.

Euratom Guidance in Commission Recommendation (2006/40/Euratom) makes it clear that there should be flexibility in the application of its guidance levels for termination. The Euratom guidance on this matter is explicit about such flexibility*: 'Termination of Euratom safeguards on waste containing concentrations of nuclear material which are higher than those given in the table below may be granted on a case by case basis when properly*

[5] This meaning that more than one limit can apply to a wastestream, i.e. waste with <1000g/tonne depleted or natural uranium and <4g/tonne plutonium is just as eligible for termination as waste containing only <4g/tonne plutonium.

justified.' [14]. For example this flexibility may extend to a waste stream where on average the material falls below the guidance limits, but where inhomogeneity of the NM in the waste stream could result in some individual waste packages with NM concentrations above the values stated in Table 1. In such cases termination could be applied to all of the waste packages produced from the conditioning of the waste stream.

The wording of the guidance does however imply that the NM is assumed to be dispersed throughout the waste stream and issues could arise where the NM exists in other forms. For example, a wasteform containing NM as a small number of discrete components within a matrix, as opposed to a homogeneous dispersion, may raise issues with respect to termination, even if the mean concentration of the NM within the wasteform is less than the values given in Table 1. In such cases it may not be the overall average concentration of NM that influences the Euratom decision, but the size and nature of the discrete items. Addressing such and similar issues and achieving termination will always be a matter for consultation and negotiation with Euratom, via ONR-Safeguards, on a case by case basis using the TU process as explained in the relevant regulations (i.e. [12]) and its supporting guidance [14]).

6.1.3 Safeguards status of existing waste material

There is currently a large amount of waste material for which safeguards has already been terminated. For the avoidance of doubt, all such material should remain as such and there should be no process of retrospectively analysing these pre-existing materials to verify that it meets the current Euratom definition of waste. Information on NM concentrations and form (i.e. degree of dispersion within a waste) should be readily available to substantiate the assertion that the materials concerned must remain completely free of safeguards.

Similarly, material that is already classified as either retained or conditioned waste should remain as such; there is no need for retrospective analysis to confirm its current status. Compliance with existing 'reduced' safeguards requirements for such material means that information on the quantities/forms involved should already be available.

6.1.4 Waste material arising from decommissioning activities

Many nuclear facilities in the UK are currently undergoing decommissioning activities having ceased their mainstream operations and activities. The process of entering the decommissioning phase is usually preceded by a period of post-operational clean out (often referred to as POCO). The aim of the POCO stage is to clean out all areas and items of equipment that processed and previously contained radioactive materials to remove contamination and thereby simplify subsequent decommissioning operations. This will generally include the removal of all discrete items of NM and, as a result, by the end of the POCO stage, the NM inventory of the facility can usually be declared as zero. However, during POCO activities safeguards obligations will continue to be applied and any NM arising will be subject to regular safeguards classification as described above.

Following POCO operations further decommissioning activities may still generate wastes containing NM, primarily as a result of the decontamination of dismantled equipment. It would be expected that such NM would be at concentrations lower than the levels for the termination of safeguards set out in Table 1, but adequate NMA processes will need to be established and records maintained to support any case for termination. However, the preferred approach would be for non-application of safeguards in the first place, on the grounds that the NM content of waste arising from decontamination activities is assessed as below the TU thresholds, and safeguards are not applied.

If it is foreseen that some wastes may arise that would not meet the requirements for termination, advice must be sought initially from ONR-Safeguards. This should include early identification, ideally before operations commence, of such wastes in order to give the

maximum opportunity for advance consultation with Euratom, in order to determine the optimum safeguards solution for the NM.

6.1.5 Identification of potential problematic wastes

During both POCO and subsequent decommissioning activities it is possible that certain waste streams may be identified as being particularly problematic from the viewpoint of safeguards. This may arise due to the overall NM content, the proposed manner of packaging or difficulty in making an accurate measurement of the NM content or the waste arisings.

While such streams will be covered by the principles set out in the preceding Sections, it is strongly advised that such waste streams are identified as early as possible and discussions on possible approaches initiated with ONR- Safeguards and Euratom Safeguards on an early timescale. Early engagement has proven to be the most effective way to deal with these problem waste streams and agree an appropriate proportionate safeguards approach.

6.1.6 Consideration of issues relating to non-safeguarded NM

'Non-safeguarded' NM is that for which the UK has exercised its right as a NWS to exclude from the safeguards regime for reasons of national security. The presence of such NM in a wastestream may raise additional issues during its conditioning and packaging. In such cases the first responsibility of the waste packager is to identify the presence of non-safeguarded NM and to reach agreement with the owner of that material as to how processing and reporting should be carried out.

The preferred approach may be to bring non-safeguarded material under safeguards, but this can only be done with the prior agreement of the owner of the material. In addition there is a requirement to provide Euratom with advance notification of the intention to bring previously non-safeguarded material into safeguards, such that they have the opportunity to physically verify the material. It should be noted that such notification is not a requirement of the Euratom regulations, but it is however longstanding good practice in the UK.

6.2 Nuclear materials accountancy and record keeping

The operators of facilities where NM is handled are responsible for all aspects of compliance with the requirements of Euratom Regulation 302/2005 [12]. It is not the intention of this guidance to list these requirements and their application in detail, but this section serves to identify where the safeguards requirements for the handling and processing of wastes containing NM are set down.

The definition of the different classes of waste material (i.e. retained waste and conditioned waste) is set out in Section 5.1.1, as has the principle of the termination of safeguards. Section 2.5.2[6] of EC Recommendation (2006/40/Euratom) [14] is titled 'Provision for nuclear material contained in waste' and provides specific guidance relating to the implementation of Articles 30 to 32, and Annexes XII to XV of Euratom Regulation 302/2005 [12].

Section 2.5.2.1 provides the definitions of NM, retained waste, conditioned waste and the provisions for the termination of safeguards. Section 2.5.2.2 provides specific guidance on the accountancy requirements to be employed for facilities where NM is either processed or stored. In particular Section 2.5.2.2 details the protocols for transactions relating to transfers of NM to retained waste (TW), transfers to conditioned waste (TC) and

[6] Section 2.5.2 is included in full with this guidance as Appendix C.

termination of safeguards (TU). It also provides specific guidance for facility operators in terms of the expectations for the maintenance of inventory lists, operating records and supporting documentation and also details what verification measures may be employed.

For transfers of either class of waste between locations or conversion from retained to conditioned waste Articles 32(a) and (b) of Euratom Regulation 302/2005 [12] require that shipments/exports and receipts/imports of conditioned waste must be reported using Annexes XIII and XIV respectively, but such transfers are not subject to 'full' Annex III ICR reporting.

In addition to Euratom safeguards requirements, there are other reporting requirements that are incumbent on facilities handling and processing nuclear waste materials. These obligations relate to the Additional Protocol to the UK/IAEA/Euratom safeguards agreement [15]).

Specific advice on Additional Protocol reporting can be sought from ONR-Safeguards who are responsible for the submission of UK reporting required by the protocol to the IAEA

7 The implementation of safeguards during the packaging of waste

This section deals with the practical implementation of safeguards during the retrieval and packaging of wastes. This includes both the requirements of Euratom safeguards and those requirements of the RWM packaging specifications which are identified in Section 5.1. Issues regarding the practical implementation of the termination of safeguards on NM in waste are also considered.

7.1 Safeguards at waste producing facilities

7.1.1 Facility safeguards obligations

Existing nuclear facilities will already be covered by the requirements of international safeguards and as such will be reporting under the auspices of Euratom Regulation 302/2005 [12] and will be subject to appropriate inspection by Euratom inspectors.

Each facility will have submitted a Basic Technical Characteristics (BTC) Document to Euratom and will be covered by one or more MBA codes. The requirements of the BTCs are different for different facility types. Annex 1 of 302/2005 contains BTC questionnaires for the following facility types:

- I-A Reactors
- I-B Critical and zero energy installations
- I-C Conversion fabrication and reprocessing installations
- I-D Storage installations
- I-E Isotope separation
- I-F Installations using NM in quantities exceeding one effective kg
- I-G Installations candidate members of the catch all MBA
- I-H Waste treatment or waste storage installations
- I-J Other

It is important that BTCs are kept up to date for all facilities where NM is handled, including those where this may be limited to NM in waste. This is particularly important where the main purpose of an installation changes as the site ceases normal operations and ultimately enters the decommissioning stage, when resubmission of the site/installation BTCs in the Annex I-H format for a waste installation should be discussed with the safeguards authorities. As with other aspects of successful and efficient safeguards implementation, the more significant the proposed change, the more important it is to engage early with the safeguards authorities before formal presentation of proposals.

Agreement that a facility can be categorised as that which is involved in the treatment or storage of wastes (Annex I-H) should result in a relaxation in the overall safeguards approach to the facility. This will be both in terms of the routine NMA reporting required (see section 5.3. above) and also the number and frequency of inspections that are carried out. In this context the Euratom guidance is that, for NM in retained waste or conditioned waste, *'safeguards activities would normally be limited to the verification of the BTCs, operating and accounting records. The objective of the verification of the BTCs is the confirmation that the installation is operating as declared. Physical verifications would normally not be done on conditioned waste. Euratom safeguards however maintains the right to request for some physical checks to help to resolve discrepancies'* [14] – see section 6.1.3 below. Current practice for such installations at Sellafield is yearly inspection

by Euratom, although whether such frequency would apply to a facility such as a GDF has not yet been agreed.

7.1.2 Application of safeguards to waste streams

All waste streams that contain NM should be identified and assessed with regard for the case for on-going safeguards coverage, irrespective of the quantity or concentration of the NM. The only exception is waste containing NM for which safeguards have already been terminated and which is assumed to remain so.

NM in waste for which safeguards are required will have to be accounted for in terms of the relevant Euratom Inventory Change Report (ICR) transaction codes. The codes most relevant to waste, as set out in Euratom Regulation 302/2005, are given in Table 2.

Table 2 Euratom ICR transaction codes for waste material

Description	Code	Explanation
Transfer to conditioned waste	TC	NM contained in waste that is measured or estimated on the basis of measurements, and which has been conditioned in such a way (e.g. in glass, cement, concrete or bitumen) that it is not suitable for further nuclear use. The quantity of NM involved is to be subtracted from the inventory of the MBA. Separate records must be kept for this type of material.
Discards to the environment	TE	NM contained in waste that is measured or estimated on the basis of measurements, and which has been irrevocably discarded to the environment as the result of a planned discharge. The quantity of NM involved is to be subtracted from the inventory of the MBA.
Transfer to retained waste	TW	NM generated from processing or from an operational accident contained in waste that is measured or estimated on the basis of measurements, and which has been transferred to a specific location within the MBA from which it could be retrieved. The quantity of NM involved is to be subtracted from the inventory of the MBA. Separate records must be kept for this type of material.
Retransfer from conditioned waste	FC	Retransfer of conditioned waste to the inventory of the MBA. This applies whenever conditioned waste undergoes processing.
Retransfer from retained waste	FW	Retransfer of retained waste to the inventory of the MBA. This applies whenever retained waste is retrieved from the specific location within the MBA, either for any processing involving the separation of elements in the MBA or for any shipment from the MBA.

The three T codes are for reporting transfer off the 'full' safeguards account of the NM content of what is accepted as waste. The F codes are for

- bringing retained waste back onto the full inventory if it is to be transferred out of the MBA (note though that the Euratom guidance is clear that 'any processing of retained waste that does not involve the separation of elements can be conducted off the main inventory'), or
- processing of a previously conditioned waste.

There is no ICR (i.e. routine) reporting on NM in waste other than in these particular circumstances – but operating and accounting records should be available on site for Euratom safeguards inspection, including to substantiate the 'stock list' for the NM content of the waste, as updated by the operator on the basis of an annual PIT (which updates do not though need to be reported to Euratom).

Table 3 Euratom ICR transaction codes applicable to different waste types

Description of the material	Transaction Codes
Spent fuel in ponds	NM on inventory (NMI)
Spent fuel in dry storage casks	NMI
Spent fuel pieces in storage silos	NMI
Spent fuel in final repositories	NMI
Solution containing fission products in reprocessing plants	Normally TW upon storage
Fuel pieces and residues from post irradiation examination dispersed in cement matrix	TC upon conditioning
Leached hulls in reprocessing plants dispersed in cement matrix	TC upon conditioning
Decanned swarf with associated carry over of NM from reprocessing plant dispersed in cement matrix	TC upon conditioning
Undissolved fines in reprocessing plants	TW upon storage, or TC upon conditioning
Liquid effluents from various activities	TW upon storage, or TC upon conditioning
Vitrified waste from reprocessing plants	TC upon conditioning normally
Cemented waste from reprocessing plants	TC upon conditioning
Radioactive waste stores often contain various amounts of uranium and thorium	Case by case
Other plutonium contaminated material	TW upon storage, or TC upon conditioning
NM found during decommissioning and clean out of old plants	Take on books as GA or FW then TW upon storage, or TC upon conditioning
Waste at uranium processing plants	Case by case

Section 2.5.2.3 of EC Recommendation (2006/40/Euratom) provides examples of reporting under Regulation (Euratom) No 302/2005 for NM contained in different material forms, as listed in Table 3. Whilst not an exhaustive list of all possible waste streams, since it is

mainly dominated by reprocessing facility waste streams, Table 3 provides an insight into the use of the appropriate NMA codes for a wide variety of waste materials generated within nuclear facilities, and thus also an indication of Euratom thinking on the forms of material that could be categorised as waste for safeguards purposes (e.g. plutonium contaminated material) and those which would need to be the subject of negotiation (e.g. spent fuel in any form).

7.1.3 Safeguards verification activities

Section 2.5.2.4 of EC Recommendation (2006/40/Euratom) [14] makes reference to the safeguards verification activities which would normally be applied to NM contained in waste. This states that activities would generally be limited to the verification of the BTCs, operating records and accounting records, whilst physical verification activities would not normally be appropriate unless required to resolve an anomaly.

7.2 Termination of safeguards

The preferred option for all waste packages containing higher activity wastes is the formal termination of all safeguards obligations prior to the receipt of waste packages at the GDF, where this can be achieved. Details of the TU code relevant to the termination of safeguards on waste materials, and the basic circumstances under which termination may be possible as set out in Euratom Regulation 302/2005, is given in Table 4.

Table 4 Euratom Termination of Use transaction code

Description	Code	Explanation
Termination of use	TU	Quantity of NM considered as irrecoverable for practical or economic reasons which is: i.) incorporated in end products used for non-nuclear purposes; or ii.) contained in waste in very low concentrations measured, or estimated on the basis of measurements, even if these materials are not discarded to the environment. The quantity of NM involved is to be subtracted from the inventory of the MBA.

It is important to note that the termination of the safeguards obligations for any NM can only be carried out following agreement with Euratom. This will generally require the waste holder to make their arguments for termination to Euratom, via ONR-Safeguards, on a case-by-case basis. This issue is discussed in Section 5, which also provides details of the expected interpretation of the categories of waste by the safeguards authorities.

As part of consultations with ONR-Safeguards and Euratom the waste owner will be required to produce a proposed approach for termination which would include the definition of the quantities and form of the NM in a proposed wasteform, a ‘wasteform specification’ outlining the arguments for termination. Any application for termination should also cover aspects of the measurements that will be required to demonstrate that the waste packages meet the required levels for termination. This will normally form part of the Waste Product Specification (WPrS) [16] produced by the waste packager and endorsed by RWM as part of the disposability assessment of the packaging proposal. The WPrS would also define the information that would be obtained and recorded regarding the NM inventory of individual waste packages.

Whilst the termination could be applied for upon receipt of conditioned waste at the GDF, the preferred option would be for termination to be applied for at the time of planning the packaging of the waste. Such an approach would mean that all safeguards obligations could be fully removed from the waste prior to retrieval and packaging, and certainly before the emplacement of the waste packages into interim storage. The latter would help reduce safeguards requirements for the storage facilities as well as minimising them for the GDF.

7.3 Safeguards evaluation of packaging proposals by RWM

As described in Section 5.1, RWM will carry out an evaluation of the manner in which a waste packager intends to address their safeguards obligations during the packaging of each waste stream. The main aim of this evaluation is to satisfy RWM that such obligations are fully addressed at the time of packaging and that, as a consequence, any uncertainty regarding the safeguards status of any NM in waste packages is removed well in advance of the arrival of the waste packages at the GDF, and that the safeguards status of all material arriving at the GDF will be clear. Addressing such issues at the time of packaging will also have benefits for the waste owner during the interim storage of the waste packages prior to their export to the GDF.

7.4 The safeguards implementation plan[7]

The knowledge that RWM will perform a safeguards evaluation is also intended to encourage the waste packager in the definition of a *safeguards implementation plan* for each waste stream that is to be packaged for disposal at the GDF. Such a plan will cover all aspects of safeguards for waste materials from the point of waste stream generation through processing, storage, retrieval, packaging, interim storage of the waste packages and ultimate export to the GDF. As such the following issues will need to be addressed:

- Technical details of the proposed waste form
- NM content of the waste form
- Safeguards reporting requirements for the NM
- Agreement of safeguards regulators regarding change of safeguards status (i.e. to conditioned waste or for termination)
- Documentation/records package to satisfy ongoing safeguards obligations (if any) and any GDF requirements for the same.

Figure 2 illustrates the stages that should make up a safeguards implementation plan. It shows that the actual stages of a plan for a specific waste will depend upon a number of criteria including:

i.) whether the NM in the waste is safeguards or unsafeguarded;

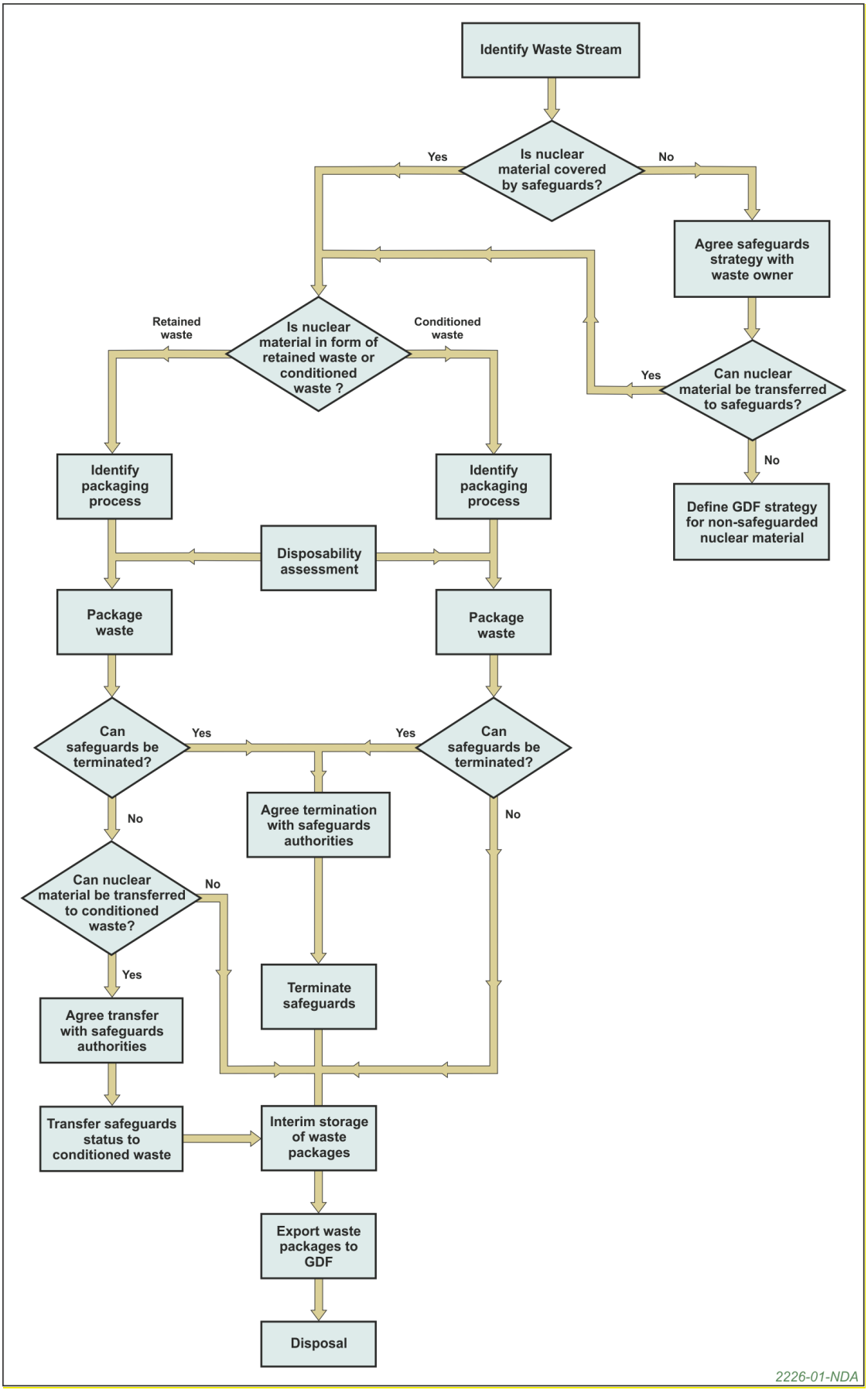
ii.) whether the (safeguarded) NM is in the form of retained waste or conditioned waste; and

iii.) whether termination of safeguards can be justified.

The ensuing sub-sections discuss the requirements of the key stages of the safeguards implementation plan.

[7] This section pre-supposes agreement that the NM is in a form that can be categorised as waste for safeguards purposes. There may however be some materials containing NM (e.g. spent fuel, see Table 3) destined for the GDF which are not categorised as waste for safeguards purposes.

Figure 2 The main stages in a safeguards implementation plan



7.4.1 Identification of NM content of the waste stream

Much of the information pertaining to the nature, technical detail and NM content of the waste stream should already be in existence, as part of the submission for the disposability assessment of a packaging proposal, or from information generated during the conduct of the assessment. As well as information on the total quantity of NM in the waste, its form (notably the degree of dispersal within the waste), concentration and the variability of concentration within the waste stream will be of relevance.

7.4.2 Safeguards status of the NM in the waste stream

Information on the safeguards status of the NM in the wastestream should be identified in the submission for the disposability assessment of a packaging proposal. Examples of the data that may be required are safeguards waste category (i.e. conditioned or retained waste), MBA location, safeguards material code, obligation code etc.

This information will be required to ascertain the precise facility specific safeguards coverage of the NM in the waste stream at that particular point in time. If the waste stream is under safeguards coverage then this will also determine whether the NM is on-inventory, consigned to either retained or conditioned waste or has already had safeguards terminated.

7.4.3 Agreement with safeguards regulators regarding termination

As discussed in Section 5, current Euratom Safeguards regulation and guidance indicates that prior agreement is required on a case by case basis before the safeguards obligations for any NM can be terminated.

Whilst the grounds for termination will generally be based on showing that the concentration of NM in a waste is less than the relevant limiting value in Table 1, Euratom guidance is that termination of safeguards on waste containing concentrations of NM which are higher than those limits may be granted on a case by case basis and when properly justified [14]. Waste packagers who wish to obtain termination for such waste streams should, in the first instance, contact ONR-Safeguards for advice as to how such an application for termination should be progressed.

The following points are recommended as key in the process of securing permission for termination by the most efficient means:

- Permission sought on as earlier timescale as possible;
- All approaches to Euratom made in conjunction with ONR-Safeguards. This will ensure access to most current information relating to interpretation of safeguards regulations and precedents/best practice for termination;
- Generic permission sought for whole waste streams rather than specific batches;
- Complete data set of information pertaining to waste stream:
    - Technical description of waste form;
    - Technically justifiable method for measurement/assessment of NM content;
    - Location, number of items, safeguards status; and
    - Description of available records package.
- Development of a NMA and safeguards reporting plan;
- Assessment of the safeguards significance of the proposed waste packages, including potential recoverability of the NM from the conditioned waste into a form that would increase a proliferation threat;
- Agreement to terminate includes requirements for records package;

- Once permission to terminate safeguards is granted, termination should be actioned as quickly as possible, in order to make the most of the benefits arising from the reduced safeguards requirements; and
- Safeguards terminated before transfer to a GDF

7.5 Requirements for the disposability assessment of a packaging proposal

As discussed in Section 2.4, all proposals for the packaging of waste for geological disposal will be subject to a disposability assessment. Each assessment will include a 'safeguards evaluation' the purpose of which is to ensure that the safeguards status of any NM in the waste to be packaged is known and any future changes to that status (e.g. termination) is to be managed by the waste producer in accordance with regulatory requirements.

Ultimately RWM require that the requirements of the packaging specifications (as discussed in Section 5.1) are satisfied and that '*The safeguards status of any NM contained within the waste package shall be ascertained and recorded.'*

To this end the main objectives of the safeguards evaluation are to ensure that:

- Arrangements are in place to ensure effective NMA during the retrieval and packaging of the waste, and that the information obtained is suitable for transmission to a future GDF operator.
- The obligations of the waste packager with regard to international safeguards will be maintained up to the time that waste packages are despatched to a GDF.

To achieve this, the safeguards evaluation will:

- Identify the waste to be packaged and outline the proposed approach to packaging;
- Determine the expected NM content of the proposed waste packages and its physical form[8].
- Consider the significance of the quantity and form of the NM in the proposed waste packages from the point of view of NMA and safeguards.
- Ensure that the pre-packaging safeguards status of the NM is known and that any proposed changes to this status have been agreed with the relevant safeguards authorities[9].
- Ensure that adequate NMA procedures will be in place at the time of waste retrieval and packaging.

As described in [7] the Disposability Assessment process is staged to reflect the degree of development (and implementation) of a proposal to package a specific waste. The requirements of the safeguards evaluation at each stage are defined as:

- At the *Conceptual stage* the safeguards evaluation should confirm that the waste packager is aware of the requirements for NMA that will be necessary during waste retrieval and packaging and that the existing (i.e. pre-packaging) safeguards status of any NM in the waste has been ascertained.

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[8] Notably whether, and how, the NM is dispersed within a wasteform, or, if it is present as discrete items. Also whether the wastform is encapsulated to form a monolithic solid or comprises loose non-encapsulated waste.

[9] This will be led by site safeguards, through ONR Safeguards and to the Euratom inspectorate.

- At the *Interim stage* the evaluation should confirm the adequacy of the proposed approach to NMA and that the relevant safeguards authorities (i.e. the site safeguards controller) has been informed about plans to package the waste and that suitable arrangements are in place to ensure that all safeguards obligations will be maintained during the packaging of the waste and interim storage of the waste packages. The evaluation should also give confidence that adequate information will be available when the responsibility for the NM is passed to the GDF operator.
- By the *Final stage*, all matters regarding safeguards should have already have been addressed and a formal evaluation will not normally take place. Work at this stage will generally be limited to closing out any issues identified at the Interim stage including agreement with all the relevant safeguards authorities on the post-packaging safeguards status of the NM and the associated reporting and verification measures.

In order for RWM to have confidence that the declared status of any NM in a waste packages is correct, the waste producer will be required provide certain, very specific information. Table 5 provides a checklist which details the extent of the safeguards information that a waste packager would need to provide as part of a packaging submission, such as would permit the safeguards evaluation to be carried out in an adequate manner.

Table 5 Packaging proposal safeguards checklist

Item	Information required
Waste stream identifier and description	From current UKRWI (e.g. [17] etc.) Summary of NM form in waste stream, waste form matrix, waste package details, number of waste packages Details of plants/processes producing waste
Waste stream NM inventory	Waste inventory and current waste location(s) Total and average NM content of waste stream. ideally expressed in terms of concentration on NM in the waste by weight Form of NM (e.g. homogeneous/heterogeneous) Any details of known variability of NM within the waste stream N.B.: This must include quantities of each category of NM (depleted, natural uranium, LEU, HEU, plutonium and thorium)
Safeguards status and ICR designation	Safeguarded/non-safeguarded/previously non-safeguarded? Applicable safeguards ICR code for NM (Table 2, Table 3) If appropriate reference to waste owner's documents giving agreement for transfer into safeguards. Safeguards terminated? (Yes/No)
Where relevant, details of termination of safeguards	Statement whether termination was before or after change in Euratom Safeguards Regulations Summary of timescales for when formal termination was applied. Reference to ONR and/or Euratom documents giving agreement to termination. Summary of conditions stipulated for termination Summary of and reference to records proving material meets conditions for termination
Details of safeguards status for materials where safeguards has not been terminated	Anticipated safeguards status on delivery to GDF Details of/reference to safeguards approach agreed with ONR/Euratom prior to delivery Details of NMA and ongoing safeguards plan for the material Details of plans (if any) and timescales for future termination of safeguards
Details for non-safeguarded materials	Reference to waste owner's documents giving agreement of plans for acceptance at GDF

8 Summary

As the operator of a future GDF, RWM will be responsible for ensuring the discharge of the safeguards obligations for all NM accepted for disposal at such a facility. To assist in carrying out of this responsibility, RWM require a good knowledge of the presence of NM in waste package destined for disposal in the GDF, its quantity and its safeguards status. This is achieved by way of the performance of a 'safeguards evaluation' which is carried out as part of the disposability assessment of each proposal by waste producers for the packaging of wastes for disposal. In order that a safeguards evaluation can be effectively carried out, the waste producer will have to provide sufficient information of the NM contained within a waste stream, notably its nature, quantity and safeguards status.

Advice from ONR-Safeguards to RWM is that the *termination* of the safeguards obligations on NM in packaged waste may offer benefits in the application of safeguards at a GDF. It is therefore RWM's preferred option that waste producers should, where possible, agree with the relevant regulator that safeguards can be terminated on NM in packaged waste.

Any decision to change the safeguards status of NM ultimately resides with Euratom to whom applications for such changes should be made. However, waste packagers are urged to progress such applications through ONR-Safeguards who will be able to provide guidance. As a means of ensuring a successful and efficient safeguards implementation, the more significant the proposed change, the more important it is to engage early with the safeguards authorities before formal presentation of proposals.

References

1 DECC, *Implementing Geological Disposal, A Framework for the long-term management of higher activity radioactive waste,* Department of Energy and Climate Change, URN 14D/235, 2014.

2 NDA, *Geological Disposal: Generic Waste Package Specification,* NDA Report No. NDA/RWM/067, 2012.

3 NDA, *Geological Disposal: Introduction to the RWM Waste Package Specification and Guidance Documentation,* WPS/100/04, 2014.

4 NDA, *Geological Disposal: Generic specification for waste packages containing low heat generating waste,* NDA Report No. NDA/RWM/068, 2012.

5 NDA, *Geological Disposal: Generic Disposal System Technical Specification,* NDA Report No. NDA/RWM/044, 2010.

6 UKSO, *Guidance on International Safeguards and Nuclear Material Accountancy at Nuclear sites in the UK,* 2010 Edition, Revision 1.

7 NDA, *Geological Disposal: An overview of the RWM Disposability Assessment Process,* WPS/650/03, 2014.

8 HSE/EA/SEPA, *The management of higher activity radioactive waste on nuclear licensed sites. Joint guidance from the Health and Safety Executive, the Environment Agency and the Scottish Environment Protection Agency to nuclear licensees*, 2010.

9 NDA, *Geological Disposal: An overview of the generic Disposal System Safety Case,* NDA/RWM/010, 2010.

10 NDA, *Geological Disposal: Guidance on the preparation of submissions for the disposability assessment of waste packages*, WPS/908/04, 2014.

11 EC, *Commission Recommendation of 11 February 2009 on the implementation of a nuclear material accountancy and control system by operators of nuclear installations*, 2009/120/Euratom:2009-02-11.

12 EC, *Commission Regulation (Euratom) on the application of Euratom safeguards*, Regulation No. 302/2005, 2005.

13 IAEA, *Model Protocol Additional to the Agreement(s) between state(s) and the International Atomic Energy Agency for the Application of Safeguards*, INFCIRC/540 (corrected) 1997.

14 EC, *Commission Recommendation (2006/40/Euratom) of 15 December 2005 on guidelines for the application of Regulation (Euratom) No 302/2005 on the application of Euratom safeguards,* Official Journal of the European Union, L 28/1, 2005.

15 IAEA, *Protocol Additional to the agreement between the United Kingdom of Great Britain and Northern Ireland, the European Atomic Energy Community and the International Atomic Energy Agency for the application of safeguards in the United Kingdom of Great Britain and Northern Ireland in connection with the Treaty on the Non-Proliferation of Nuclear Weapons*, Information Circular 263/Add1, 2005.

16 NDA, *Guidance on the Structure and Format of Waste Product Specifications*, WPS/620/02, 2008.

17 NDA/DECC, *UKRWI Radioactive Wastes in the UK: A Summary of the 2013 Inventory,* 2014. http://www.nda.gov.uk/wp-content/uploads/sites/2/2014/02/14D039-NDASTSTY140006-UKRWI-2013-High-Level-Summary.pdf

Appendix A Glossary of terms of specific reference to safeguards[10]

Basic Technical Characteristics (BTCs)

Design information on nuclear installations as provided for Euratom Safeguards. The BTCs include a description of the installation, the form, quantity, location and flow of NM being used, the layout of the installation, containment features and procedures for NM accountancy and control. The information is used, inter alia, to prepare the safeguards approach to the installation.

book inventory

A record of all the NM held at a site and its location on the site. The book inventory consists of the results of the most recent physical inventory and of all the inventory changes that have occurred since that physical inventory was taken.

conditioned waste

NM, measured or estimated on the basis of measurements, which has been conditioned in such a way (for example, in glass, cement, concrete or bitumen) that it is not suitable for further nuclear use;

design information

Information which is declared to the IAEA/Euratom to allow them to understand the purpose of the nuclear facility and through which they can develop a safeguards approach to verify that it is only being used for peaceful purposes.

effective kg

A special unit used in the safeguarding of NM, and reflecting its strategic value. A quantity in effective kilograms is obtained by taking:

- for plutonium, its weight in kilograms;
- for uranium with a uranium-235 enrichment of 1% and above, its weight in kilograms multiplied by the square of its enrichment (expressed as a fraction);
- for uranium with an enrichment below 1% and above 0.5%, its weight in kilograms multiplied by 0.0001; and
- for uranium with an enrichment of 0.5% or below, and for thorium, its weight in kilograms multiplied by 0.00005.

Inventory Change Report (ICR)

A report that describes changes in inventory of NM in a material balance area. ICRs are usually provided on a monthly basis.

Material Balance Area (MBA)

An area such that, for the purpose of establishing the material balance: The quantity of NM in each transfer into or out of each material balance area can be determined; The physical inventory of NM in each material balance area can be determined when necessary in accordance with specified procedures

Non-Nuclear Weapon State (NNWS)

[10] See also http://www.onr.org.uk/safeguards/glossary.htm and Section 2 of Annex 3 to the Guidance on International Safeguards and Nuclear Material Accountancy at Nuclear sites in the UK [6]

Other than the five recognised Nuclear Weapon States, all other signatories to the Nuclear Non-Proliferation Treaty are non-nuclear weapons states.

Nuclear Materials Accountancy (NMA)

A system to register material quantities and locations, track items and quantities through transfers and processes, record measurement data, and provide information for reporting and analysis. Accounts of NM are kept for security, safety, environmental and international safeguards reasons.

Nuclear Weapon State (NWS)

The Nuclear Non-Proliferations Treaty (NPT) defines a NWS is '*one which has manufactured and exploded a nuclear weapon or other nuclear explosive device prior to 1 January 1967'.* Five States are so defined by the NPT, namely China, France, Russia, the UK and the United States of America.

ONR-Safeguards

Part of the Office for Nuclear Regulation, responsible for working with UK organisations subject to safeguards requirements and the safeguards inspectorates of Euratom and the IAEA to ensure that safeguards obligations for the UK are met in a proportionate manner.

Physical Inventory Listing (PIL)

A report listing all batches of NM separately and specifying material identification and batch data for each batch.

plutonium (Pu)

A radioactive element occurring in very small quantities in uranium ores but mainly produced artificially by the neutron irradiation of uranium. Of its several nuclides two in particular (i.e. plutonium-239 and plutonium-241) are fissile.

Plutonium is considered special fissile/fissionable material from the point of view of safeguards, irrespective of its isotopic concentration.

retained waste

Generated from processing or from an operational accident, measured or estimated on the basis of measurements, which has been transferred to a specific location within the material balance area from which it can be retrieved

safeguards

The procedures used to monitor civil nuclear activities to detect diversion of NM for possible use in nuclear weapons

significant quantity

The amount of material, the diversion of which the safeguards regulators seek to detect. It approximates to the amount of special fissile/fissionable material required in the manufacture of a nuclear explosive device.

source material

Defined at Article 197 of the Euratom Treaty as *'uranium containing the mixture of isotopes occurring in nature; uranium whose content in uranium-235 is less than the normal; thorium; any of the foregoing in the form of metal, alloy, chemical compound or concentrate; any other substance containing one or more of the foregoing in such a concentration as shall be specified by the Council, acting by a qualified majority on a proposal from the Commission.'*

Source material can be transformed into special fissile/fissionable material by neutron irradiation (i.e. in a nuclear reactor) or, in the case of uranium, by enrichment of the proportion of uranium-235 it contains.

Source material is subject to safeguards.

special fissile/fissionable[11] material

Defined at Article 197 of the Euratom Treaty as 'plutonium-239; uranium-233; uranium enriched in uranium-235 or uranium-233[12]; and any substance containing one or more of the foregoing isotopes and such other fissile materials as may be specified by the Council, acting by a qualified majority on a proposal from the Commission; the expression special fissile materials' does not, however, include source materials.'

termination of use

An ICR code used to remove the NM content of waste from safeguards.

thorium (Th)

A heavy, naturally occurring and weakly radioactive element. Whilst not capable of sustaining a nuclear chain reaction in its own right, the most predominant nuclide of thorium (i.e. thorium-232) can be converted to fissile uranium-233 by neutron irradiation. As such, thorium is considered source material from the point of view of safeguards.

uranium (U)

A heavy, naturally occurring and weakly radioactive element, commercially extracted from uranium ores. It possesses one naturally occurring nuclide (i.e. uranium-235) which is fissile and its most predominant nuclide (i.e. uranium-238), whilst not fissile, can be converted to fissile plutonium nuclides (i.e. plutonium-239 and plutonium-241) by neutron irradiation.

Uranium is often categorised by way of the proportion of the radionuclide uranium-235 it contains. The categories generally used in this guidance are:

- depleted uranium: <0.71% uranium-235;
- natural uranium: ~0.71% uranium-235;
- low enriched uranium: Up to ~5% uranium-235; and
- high enriched uranium: >5% uranium-235.

Uranium is considered a special fissile/fissionable material if the combined concentration of uranium-233 and uranium-235 is higher than that of uranium-235 in natural uranium, or source material if the concentration is equal to or less than that of uranium-235 in natural uranium.

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[11] The term 'fissile' is used in the Euratom Treaty whereas 'fissionable' is used in Article XX of the IAEA Statute. The definition of each term is effectively identical.

[12] Uranium containing uranium-235 or uranium-233 or both in an amount such that the abundance ratio of the sum of these isotopes to nature

Appendix B Glossary of general terms used in this document

activity

The number of atoms of a radioactive substance which decay by nuclear disintegration each second. The SI unit of activity is the becquerel (Bq) equal to one radioactive decay per second.

disposability assessment

The process by which the disposability of proposed waste packages is assessed. The outcome of a disposability assessment may be a Letter of Compliance endorsing the disposability of the proposed waste packages.

disposal

In the context of solid waste, disposal is the emplacement of waste in a suitable facility without intent to retrieve it at a later date; retrieval may be possible but, if intended, the appropriate term is storage.

fissile material

A material capable of sustaining a nuclear chain reaction.

geological disposal

A long term management option involving the emplacement of radioactive waste in an engineered underground geological disposal facility or repository, where the geology (rock structure) provides a barrier against the escape of radioactivity and there is no intention to retrieve the waste once the facility is closed.

geological disposal facility (GDF)

An engineered underground facility for the disposal of solid radioactive wastes.

Health and Safety Executive (HSE)

The HSE is a statutory body whose role is the enforcement of work-related health and safety law.

intermediate level waste (ILW)

Radioactive wastes exceeding the upper activity boundaries for LLW but which do not need heat to be taken into account in the design of storage or disposal facilities.

International Atomic Energy Agency (IAEA)

The IAEA is the world's centre of cooperation in the nuclear field. It was set up as the world's 'Atoms for Peace' organization in 1957 within the United Nations family. The Agency works with its Member States and multiple partners worldwide to promote safe, secure and peaceful nuclear technologies.

Letter of Compliance (LoC)

A document, prepared by RWM, that indicates to a waste packager that a proposed approach to the packaging of waste would result in waste packages that are compliant with the requirements defined by relevant packaging specifications, and the safety assessments for transport to and disposal in a GDF, and are therefore deemed 'disposable'.

Nuclear Decommissioning Authority (NDA)

The NDA is the implementing organisation, responsible for planning and delivering the GDF. The NDA was set up on 1 April 2005, under the Energy Act 2004. It is a non-departmental public body with designated responsibility for managing the liabilities at

specific sites. These sites are operated under contract by site licensee companies (initially British Nuclear Group Sellafield Limited, Magnox Electric Limited, Springfields Fuels Limited and UK Atomic Energy Authority). The NDA has a statutory requirement under the Energy Act 2004, to publish and consult on its Strategy and Annual Plans, which have to be agreed by the Secretary of State (currently the Secretary of State for Trade and Industry) and Scottish Ministers.

Office for Nuclear Regulation (ONR)

ONR was established as a statutory Public Corporation on 1 April 2014 under the Energy Act 2013, which provides the framework of responsibilities and the powers of the organisation (http://www.onr.org.uk/legal-framework-and-regulations.htm). ONR's mission is to provide efficient and effective regulation of the nuclear industry, holding it to account on behalf of the public

Radioactive Waste Management Ltd (RWM)

A wholly owned subsidiary of the NDA, established to design and build an effective delivery organisation to implement a safe, sustainable, publicly acceptable geological disposal programme. Ultimately, it will evolve under the NDA into the organisation responsible for the delivery of the GDF. Ownership of this organisation can then be opened up to competition, in due course, in line with other NDA sites.

waste container

Any vessel used to contain a wasteform for disposal.

wasteform

The waste in the physical and chemical form in which it will be disposed of, including any conditioning media and container furniture (i.e. in-drum mixing devices, dewatering tubes etc) but not including the waste container itself or any added inactive capping material.

waste package

The product of conditioning that includes the wasteform and any container(s) and internal barriers (e.g. absorbing materials and liner), as prepared in accordance with requirements for handling, transport, storage and/or disposal.

waste packager

An organisation responsible for the packaging of radioactive waste in a form suitable for transport and disposal.

Appendix C Section 2.5.2 of EC Recommendation (2006/40/Euratom)

2.5.2. Provision for nuclear material contained in waste (Articles 30 to 32, and Annexes XII to XV)

2.5.2.1. Definitions relevant to nuclear material contained in waste

(1) Nuclear material on inventory

Nuclear material contained in waste will normally originate from a 'waste stream' from an activity that processes nuclear material. These 'waste streams' are properly accounted for in the installation that produces the waste and reported as any other nuclear material on the inventory.

(2) Retained waste

'Retained waste' is nuclear material generated from processing or from an operational accident, which is deemed to be unrecoverable for the time being but which is stored. The actual inventory change used in accounting records and reports is termed 'transfer to retained waste' (TW). Material transferred to retained waste is stored at the material balance area (MBA) and continues to be subject to IAEA safeguards (Safeguards Agreement), but is not included in the inventory of the MBA.

It refers to nuclear material contained in waste that is measured or estimated on the basis of measurements and has been transferred to a specific location within the material balance area from which it could be retrieved. Waste belonging to this category has normally not yet been conditioned and is regarded as economically irrecoverable by current technology.

(3) Conditioned Waste

'Conditioned waste' is nuclear material contained in waste that is measured or estimated on the basis of measurements and has been conditioned in such a way (for example, in glass, cement, concrete or bitumen) that it is not suitable for further nuclear use. The actual inventory change used in accounting records and reports is termed 'transfer to conditioned waste' (TC). This material is normally not subject anymore to IAEA safeguards under the Safeguards Agreements [terminated pursuant to paragraph 11 and 35 of INFCIRC/193, INFCIRC/263 or INFCIRC/290]. This category could also apply to some specific cases where IAEA safeguards are terminated on nuclear material in waste, which is not fully condition

However, information regarding the location or further processing of intermediate or high-level 'conditioned waste' containing plutonium, high enriched uranium or uranium-233 on which safeguards have been terminated pursuant to paragraph 11 of INFCIRC/193, INFCIRC/263 or INFCIRC/290 has to be reported to the IAEA under article 2a(viii) of the additional protocol. In this context, 'further processing' does not include repackaging of the waste or its further conditioning not involving the separation of elements, for storage or disposal.

(4) Termination of Euratom safeguards

Euratom safeguards are terminated on nuclear material that is irrevocably discarded to the environment as the result of a planned discharge. The nuclear material contained in such discharge is measured or estimated on the basis of measurements.

Euratom safeguards (and IAEA safeguards) are terminated on these materials at the point of discharge.

(5) Termination of Euratom safeguards on waste containing low concentrations of nuclear material

Euratom safeguards can also be terminated on waste containing very low concentrations of nuclear material as indicated in the table below, which are considered practically irrecoverable - even if they are not discarded to the environment. Termination of Euratom safeguards on waste containing concentrations of nuclear material which are higher than those given in Table 1 *may be granted on a case by case basis when properly justified.*

2.5.2.2. Accountancy requirements for nuclear material contained in waste

(6) Nuclear material on inventory

Nuclear material contained in waste that is not yet declared as retained waste, conditioned waste or waste discarded to the environment is accounted for and reported as any other nuclear material on inventory.

(7) Nuclear material contained in retained waste (Article 30)

Installations producing, handling, processing or storing retained waste provide BTCs, on the basis of which PSPs are prepared. BTCs are prepared following Annex I-H to Regulation (Euratom) No 302/2005 if it consists of an installation only involving nuclear materials contained in waste, or alternatively, the relevant activities are included in the BTCs of the installation that generates the retained waste. Each installation is also required to provide an annual programme of activities covering, if possible, the following two years. In the case of an installation that generates retained waste, this annual programme shall be included in the same programme of activities to be provided under Article 5.

Material is transferred from the main inventory to retained waste using the inventory change code TW (transfer to retained waste). It is subtracted form the inventory of third country-obligated material and will be normally kept under the obligation code P. Retained waste is brought back onto the main inventory, using code FW (transfer from retained waste), for any processing involving the separation of elements or for any shipment.

Any processing of retained waste that does not involve the separation of elements can be conducted off the main inventory. The operator advises Euratom of such processing in the programme of activities, records for which (including the quantities of material involved) are to be available at the installation.

In order to establish a starting point an initial stock list is to be established, where applicable, of the nuclear material contained in retained waste. It shall include the estimated stock (e.g. using the form of the PIL or the LII), normally with obligation code P based on best available values. The initial stock list should provide details of the total amounts of nuclear material for each MBA, by category (Pu, HEU, LEU, N, D, and T) and broken down at the level of storage areas and type of waste. This list will be updated annually following the PIT. Operator documentation in support of the figures will be made available on site as requested during Euratom safeguards inspections.

Upon shipment the installation declares the inventory change code FW followed by SD or SF, normally with obligation code P.

Upon receipt of material that qualifies for retained waste, the operator declares the transaction code RD or RF followed by TW, normally with obligation code P.

Operating and accounting records, including all movements, are to be kept and made available on site as requested during Euratom safeguards inspections.

Advance notifications (Articles 20 and 21) of retained waste receipts and shipments are not required.

Operators are required to undertake an annual PIT. The PIT for retained waste does not involve remeasurement of the nuclear material but is established based upon the best available values. The stock list is updated yearly after the PIT.

No PIL (Annex V to Regulation (Euratom) No 302/2005) and no MBR (Annex IV to Regulation (Euratom) No 302/2005) are required for material previously declared as retained waste. Any TW or FW transaction will be included in the ICRs (Annex III to Regulation (Euratom) No 302/2005) of the MBA generating the retained waste.

(8) Nuclear material contained in conditioned waste (Article 30)

Installations producing, handling, processing or storing conditioned waste provide BTCs, on the basis of which PSPs are prepared. BTCs are prepared following Annex I-H to Regulation (Euratom) No 302/2005 if it consists of an installation only involving nuclear materials contained in waste, or alternatively, the relevant activities are included in the BTCs of the installation that generates the conditioned waste. Each installation is also required to provide an annual programme of activities covering if possible the following two years.

Material is transferred from the main inventory to conditioned waste using the inventory change code TC (transfer to conditioned waste). It is subtracted from the inventory of third country-obligated material and will be normally kept under obligation code P. Where applicable, IAEA safeguards are terminated on this material following Articles 11 and 35 of the Safeguards Agreements.

In order to establish a starting point, an initial stock list of the nuclear material contained in conditioned waste is to be established, where applicable. It shall include the estimated stock (e.g. using the form of the PIL or the LII (list of inventory items)), normally with obligation code P based on best available values. The initial stock list should provide detail of the total amounts of nuclear material for each MBA, by category (Pu, HEU, LEU, N, D, and T) and broken down at the level of storage areas and type of waste. This list will be updated annually following the PIT. Operator documentation in support of the figures will be made available on site as requested during Euratom safeguards inspections.

Shipments of conditioned waste from the installation are communicated to Euratom using the form in Annex XIII. Receipts of conditioned waste from outside the EU (or from within the EU if the shipper does not have an MBA code) are communicated using the form in Annex XIV. Annexes XIII and XIV communications can be grouped per year and do not require information on the obligation code. Communications are not required if no transactions took place.

Advance notifications (Articles 20 and 21) of conditioned waste receipts and shipments are not required.

In order to fulfil the obligations under the additional protocol, advance notification (Article 31) is to be given to the Commission of any waste-processing campaign involving intermediate and high level waste containing plutonium or high enriched uranium or uranium-233, but excluding repackaging or further conditioning without separation of elements (using the form in Annex XII). For processing campaigns of low-level wastes no notifications are required. In addition, according to Article 32c, each year an annual report of changes in location of conditioned waste containing plutonium, high-enriched uranium or uranium-233, using the form in Annex XV, has to be made. It is understood that the above refers mainly to waste.

Operating and accounting records, including all movements, are to be kept and made available on site as requested during Euratom safeguards inspections.

Operators are required to undertake an annual PIT. The PIT for conditioned waste does not involve a remeasurement of the nuclear material but is established based upon the best available values. The stock list is updated yearly after the PIT.

No ICR (Annex III to Regulation (Euratom) No 302/2005), no PIL (Annex V to Regulation (Euratom) No 302/2005) and no MBR (Annex IV to Regulation (Euratom) No 302/2005) are required for material previously declared as conditioned waste.

(9) Nuclear material on which Euratom Safeguards can be terminated

Material is discarded from the main inventory to the environment using the transaction code TE (discard to the environment) and subtracted form the inventory of third country-obligated material. Euratom safeguards terminate on this material.

Material on which Euratom safeguards is to be terminated, but which will not be discarded to the environment is subtracted from the main inventory using the transaction code TU (termination of use) and subtracted form the relevant obligation code account.

2.5.2.3. Examples of various types of 'waste' and their reporting

Table 3 *provides some examples of typical waste streams encountered in the European nuclear fuel cycle and their possible reporting mechanisms.*

In order for material to qualify for 'Conditioned Waste' (TC), the material has to be dispersed in a glass, cement, concrete or bitumen matrix is such a way that that it is not suitable for further nuclear use. The operator and the Commission may agree reporting arrangements on a case-by-case basis. The guidelines on the concentrations provisionally implemented by Euratom safeguards (and by the IAEA where applicable) are as recommended by the IAEA Member States' experts and included in the IAEA policy paper 14 on waste.

2.5.2.4. Verification Activities

1. Nuclear material on inventory

As long as the nuclear material is still on inventory and has not been transferred to any of the 'waste' categories, all measures as established in the installation's safeguards approach apply. They include normally the verification of the BTCs, physical verification of inventories, receipts and shipments, the verification of the accountancy system, operating and accounting records and reports.

2. Nuclear material contained in retained waste

Safeguards activities would normally be limited to the verification of the BTCs, operating and accounting records. The objective of the verification of the BTCs is the confirmation that the installation is operating as declared. Physical verifications would normally not be done on retained waste. Euratom safeguards however maintains the right to request for some physical checks to help to resolve discrepancies.

3. Nuclear material contained in conditioned waste

Safeguards activities would normally be limited to the verification of the BTCs, operating and accounting records. The objective of the verification of the BTCs is the confirmation that the installation is operating as declared. Physical verifications would normally not be done on conditioned waste. Euratom safeguards however maintains the right to request for some physical checks to help to resolve discrepancies.

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