British Nuclear Group

Management Services

# Treatment of Plutonium Contaminated Material at Sellafield

## Best Practicable Environmental Option Study

Stakeholder Consultation Information Document

British Nuclear Group Sellafield Ltd, which operates the Sellafield site on behalf of the Nuclear Decommissioning Authority, is carrying out a strategic review of current treatment processes for Plutonium Contaminated Material (otherwise known as PCM). A key part of this review is to consult with stakeholders on strategic issues surrounding the identification of a preferred management approach.

This Information Document provides detailed background information relating to PCM, how it is generated on the Sellafield site and how it is currently managed. This information is included to provide a comprehensive basis for discussion with stakeholders. This Information Document also includes a general discussion of the consultation and decision-making processes that are being followed by British Nuclear Group Sellafield Ltd. Lastly, the Information Document outlines the specific issues of concern regarding management of PCM which may assist stakeholders in examining the issues.

This Information Document has been prepared as background information for a workshop to review management and treatment of Plutonium Contaminated Material (PCM) at the Sellafield site. To aid in obtaining feedback, the document has been structured around a number of key questions. British Nuclear Group Sellafield Limited would welcome the views of stakeholders regarding these questions as well as any other relevant concerns regarding the management of PCM.

For the reader's reference, a glossary section is provided in the Appendix of this document.

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## 1. Introduction

Plutonium Contaminated Materials, otherwise known as PCM, are generated through the primary mission of reprocessing on the Sellafield Site. The decades of operations at the Sellafield site have resulted in the largest store of PCM in the United Kingdom. As advances are made in engineering together with increases in regulator and public expectations, British Nuclear Group Sellafield Ltd has periodically reviewed PCM operations to ensure best management controls are being applied. Past reviews have resulted in the decision to recover PCM from the Low Level Waste Repository and to construct the Waste Treatment Complex (WTC).

The WTC compacts PCM and grouts the compacted waste into a drum. Whilst the WTC has made tremendous progress in transforming large volumes of PCM into safer, more manageable wasteforms, there are several drivers for reviewing the current treatment options. It is known that there are significant volumes of PCM at Sellafield that are unsuitable for treatment at the WTC. Moreover, there are more recent concerns suggesting that changes to the conditioned wasteform might be considered necessary in order to account for performance factors that are more relevant now than at the time the product was originally endorsed. Lastly, the historical throughput of the WTC suggests that it is unlikely to be able to process existing stocks of PCM at Sellafield rapidly enough to meet current regulator requirements for dealing with the legacy of past operations at the site. One of the most pertinent regulator requirements is one placed by the Nuclear Installations Inspectorate (NII) that states:

> *"In respect of the facilities within the Sellafield nuclear licensed site, at least 90% of the total volume of all Plutonium Contaminated Material originating from operation prior to 1 August 2000 and which has been accumulated as radioactive waste shall be stored in a safe passive form by 1 August 2020."*

Based on this requirement as well as the other listed concerns, British Nuclear Group Sellafield Ltd is carrying out a review of treatment processes for PCM with the aim of selecting a preferred strategy for the longer term. This strategy may comprise one or a number of treatment and conditioning processes.

The primary focus of the study is on treatment options for PCM at Sellafield. It is recognised, however, that similar PCM exist at two other UK public sector civil nuclear sites, Harwell and Dounreay, both operated by the United Kingdom Atomic Energy Authority (UKAEA). UKAEA are also utilising the Best Practicable Environmental Option (BPEO) process, including local stakeholder consultations, to identify preferred strategies for Harwell and Dounreay. From a national perspective, the question arises as to whether the most effective solution is to treat all such wastes on a site-by-site basis, or if a more co-ordinated approach might be preferred. As part of the current options study, British Nuclear Group Sellafield Ltd is therefore seeking stakeholder opinions on the possible impact of transfer of PCM from Harwell and/or Dounreay for the treatment options that are established at Sellafield. This includes reviewing whether the favoured option for treating Sellafield PCM would change if the volume or nature of PCM were to change as a result of transfer of PCM from other sites.

## 2. Waste and Current Facilities

**What is Plutonium?**

Plutonium is a radioactive, metallic element. Plutonium is produced when the uranium$^{238}$ in a fuel rod is bombarded by neutrons in a nuclear reactor. When fuel rods are transferred to Sellafield, the plutonium is extracted from irradiated nuclear fuel by chemical reprocessing. At Sellafield, a portion of the recovered plutonium is re-used to make new reactor fuel called MOx for Mixed Oxide Fuel Reactors.

Plutonium is of concern at Sellafield for several reasons, including:

- Some plutonium isotopes have very long half-lives (Pu$^{239}$ has a half life of 24,100 years) meaning that plutonium and plutonium contaminated materials will stay radioactive for a very long time and therefore must be packaged and managed to allow for long-term safety.
- Plutonium emits alpha radiation and can cause cancer if ingested or inhaled.
- As plutonium decays, it produces Americium$^{241}$ an isotope which emits penetrating gamma radiation which can pose a health hazard for nearby persons.
- Plutonium contains fissile isotopes meaning that it has the potential for an uncontrolled radiation release called a criticality if not handled properly.

### Sellafield Site PCM Wastes

The primary mission at the Sellafield site has been nuclear fuel reprocessing. During reprocessing, plutonium is separated from the fuel. A portion of the recovered plutonium is used in fabricating new nuclear fuel rods known as Mixed Oxide Fuel. The remainder of Plutonium on the Sellafield site is stored. During fuel reprocessing, fuel fabrication, refurbishment, decommissioning and other site operations, tools and equipment come in contact with plutonium and thus become contaminated. These wastes are classified as 'plutonium contaminated material' or PCM. Due to the toxicity of plutonium, PCM is subject to a higher level of control than other radioactive wastes such as those wastes disposed at the Low Level Waste Repository.

PCM waste stored at Sellafield is classified into a number of generic categories, according to their type and the form in which they have been packaged for storage prior to treatment.

The majority of PCM waste stored at Sellafield may be classified into several generic groups, according to their type and how they are packaged for storage.

**Mixed PCM waste**, which predominantly consists of a combination of the following items: PVC gloves, PVC protective suits, polythene, glass, filters, paper towels, small items of plant, hand tools, laboratory equipment and packaging cans. The wastes are double-bagged in heat-sealed PVC linings within mild steel 200-Litre drums. Such drums represent the majority of existing PCM wastes by total volume.

**Whole Equipment and Dismantled items**, consists of items such as PCM-contaminated gloveboxes and machinery, some dating as far back as the late 1950s. Gloveboxes may in turn contain smaller items of equipment. These items are packaged in crates. The crates are made from timber, stainless steel or fibreglass and in some cases are covered in 'driclad' (a type of PVC) on steel supports.

**Filters** are used throughout the site to remove particulate material, including plutonium containing dust, from air in building ventilation systems. Older types of filters used on the Sellafield site are generally steel (sometimes wood) framed. Upon removal from the ventilation system, the filters are double-wrapped in heat-sealed PVC sheeting. More recently removed filters have been packaged in metal 'tins' for better physical protection and containment during interim storage. Filters used in newer facilities at Sellafield are cylindrical and designed to fit directly into a 200 litre drum.

In addition to these wastes, current stocks of PCM at Sellafield include 500 litre drums of encapsulated product from the existing waste treatment process.

Ongoing reprocessing and fuel fabrication operations will continue to produce 'mixed PCM waste'. As decommissioning progresses, however, the wastes produced will include more dismantled plant and equipment, service pipe work and parts of building fabric that have come into contact with plutonium. While the equipment will be decontaminated where possible and opportunities for waste minimisation will be exploited, there will be an increase in volume. Estimates of future arisings continue to be developed, but the current planning basis is that future arisings at Sellafield are approximately the same as the quantity of current Sellafield PCM waste.

**PCM Management at Sellafield in the Context of Sellafield Site Restoration**

The long-term vision for the Sellafield site is to make the land occupied by the existing PCM storage facilities available for other possible future uses, consistent with the proposed site End State. This includes activities that are undertaken systematically and progressively to reduce hazard levels, consistent with the overall 'As Low as Reasonably Practicable' (ALARP) objective. The process is likely to involve several stages, spread over a number of years; however, there are two essential elements PCM management and decommissioning (including demolition).

*PCM Management*

PCM management relates to the set of actions that are necessary to manage the existing legacy and ongoing arisings of PCM, as well as to prepare existing PCM storage facilities for future decommissioning. PCM management has several major component parts, with related objectives, as described in the following table.

| Management Component | Objective |
|---|---|
| PCM Retrieval | Retrieval of PCM from older PCM stores for storage in modern standards facilities. These operations have been safely conducted over recent years and are continuing. |
| PCM Storage | Safe storage of PCM in modern standards facilities prior to treatment. (Note: For this BPEO study, consideration of storage is limited to storage prior to waste treatment. The storage of treated waste prior to final disposal is considered as part of the wider Sellafield strategy.) |
| PCM Treatment | Treatment of existing and future arisings, including those from decommissioning, of PCM to make a safe, passive and secure waste package that it is suitable for temporary on-site storage and ultimate disposal (Note that the NDA has instructed British Nuclear Group Sellafield Ltd that a deep geological repository opening in 2040 should be used as a basis for planning purposes). |
| Effluents and Secondary Waste Management | Management of aerial discharge, liquid effluent and secondary wastes resulting from PCM management to minimise environmental detriment. This includes consideration of avoidance, recycle and re-use and other management tools to minimise discharges. At this stage, the focus is primarily on radioactive effluents and secondary wastes. As plans mature, the focus will include non-radioactive effluents and secondary wastes. |

*Decommissioning (including Demolition)*

Decommissioning typically involves the removal of plant and equipment and, wherever possible, a reduction in the facility footprint. This is followed by demolition of the out-of-service facility to allow the site to be redeveloped for alternative uses consistent with the proposed site End State. Facilities that have been decommissioned will be out of service with adequate regard for the health and safety of workers and the public, and for protection of the environment.

The focus of the current study is on PCM management. Decommissioning and eventual demolition will be addressed as part of the wider Sellafield site activities.

PCM management is a major step along the path to facilities decommissioning and site restoration. It will essentially result in the removal of existing untreated wastes from PCM stores and an agreed treatment route for future PCM arisings from ongoing site operations. PCM management will conform to the current Sellafield Site Licence Conditions and, in particular, to those that pertain to the control and containment of radioactive material and radioactive waste.

**Current PCM Treatment at Sellafield**

Treatment of PCM at the Sellafield site is currently conducted in the Waste Treatment Complex (WTC). The WTC was originally designed and built in the early 1980s to segregate PCM by plutonium content and into hard and soft waste for further treatment. Due to a nuclear industry change of focus to geological disposal, the project was never commissioned.

In the early 1990's, a new process (WTC1A) was developed for drummed PCM. The WTC plant was modified to supercompact 200 litre drums (without sorting) and to grout the resulting pucks in stacks contained within 500 litre stainless steel drums. The intention was that this final conditioned wasteform should be suitable for disposal within a deep geological waste repository.

As the WTC has a single operating line there has been concerns regarding treatment capacity and availability. An important factor that limits the availability of WTC is liquid management. During the supercompaction process, liquid, known as 'squeezate', is squeezed out of the drums. The WTC plant has only a small capacity for collection of squeezate and, once the capacity is exhausted, the compaction process must be stopped. The operation cannot be resumed until the squeezate has been removed for treatment. An additional constraint is the time required to take measurements of the fissile content of the waste to be fed into the process.

**What is a Geological Land Repository?**

In 1980's, UK Nirex Limited was formed by the nuclear industry to provide radioactive disposal advice. There was particular emphasis on those nuclear wastes ineligible for disposal at the Low Level Waste Repository due to their levels of radioactivity or the radioisotopes present. By 1987, the focus was on the feasibility of a Deep Geological Land Repository for long term management. This would be a facility located deep underground below the groundwater table designed to safely store nuclear wastes. Recently, the Committee of Radioactive Waste Management (CoRWM) has endorsed the concept of a Deep Geological Land Repository.

British Nuclear Group Sellafield Limited requested a 'Letter of Comfort' from Nirex for the PCM treated in the WTC. A 'Letter of Comfort' was granted by Nirex in 1996 for the grouted 500 litre drum product from the WTC1A process with certain caveats and conditions. Any changes to the product or new product will require a 'Letter of Compliance'.

**What is Fissile Material?**

Nuclear Fission is a process in which a large nucleus, for example the nucleus of a uranium atom, splits into two or more smaller nuclei releasing energy and radiation. Fissile materials are composed of atoms that can be split by neutrons in a chain-reaction. An unplanned self-sustaining chain reaction is called a criticality. As Plutonium-239 is a classified as a fissile material, PCM must be carefully managed and stored with adequate controls to ensure that a criticality is not initiated.

Accurate measurements of the amount of fissile material present in the PCM entering into the WTC are critical. Until early 2006, due to concerns regarding measurement accuracy, regulator controls restricted feed to the compaction process to 200 litre drums containing less than 50g fissile material (expressed as equivalent mass of Pu-239). The compacted 200 litre drums are combined into a final grouted 500 litre stainless steel drum which is also limited to a maximum inventory of 50g. As the documented confidence in the assay measurements has improved, there will be a demonstration of operations with feed drums containing up to 230g and product drums loaded with up to 260g equivalent mass of Pu-239.

### PCM Wastes with No Current Treatment Options at Sellafield

While the WTC treats a significant quantity of Sellafield PCM, there are waste packages that are unsuitable for supercompaction. These wastes are not acceptable for a variety of reasons including:

- Drums and packages that will not fit in the supercompactor without re-work, owing to their size and shape;
- Drums containing dense waste that may compromise fissile material assay results;
- Drums exceeding the fissile control limits; and
- Drums containing vent filters and fluoride slags, owing to concerns regarding the immobilisation of particulate material in the compacted product.

Because the waste is not sorted prior to compaction, there are additional concerns that drums destined for treatment at the WTC may contain any of the following which may impact either the supercompactor or the generated wasteform:

- flammable, pyrophoric and brittle items within the wastes, all of which have the potential to cause damage to the plant through fire or shock;
- non-compactable wastes, which prevent the drums from being crushed into pucks smaller than the required height of 500 mm;
- wood, rubber and PVC components of the raw waste, which may reassert their shape following supercompaction, causing deformation of the puck;

### PCM Wastes at other NDA Sites

British Nuclear Group Sellafield Ltd's primary responsibility is the management of the existing and future arisings of PCM at Sellafield and is thus the primary focus of this study. From a national perspective, however, there is a level of interest in investigating the possibility to achieve economies of scale by coordinating PCM treatment at Sellafield for similar types of waste originating at Harwell and Dounreay. The wider implications of any co-ordinated strategy would be a matter for broader consultation, most likely with more direct involvement from the NDA.

#### NDA PCM Waste at UKAEA Sites

The categorisation of plutonium contaminated material on UKAEA sites is slightly different from that followed at Sellafield. So-called 'contact-handled' intermediate level waste (CHILW) has a radioactivity content that is predominantly associated with radioactive materials that emit alpha-radiation. This includes materials that would be classified as PCM at Sellafield, but also potentially includes other types of wastes (e.g. those with a significant uranium content) arising from research activities

Total PCM quantities at the UKAEA sites (including projected volumes from decommissioning these sites) are about 10 to 15% of the current stored Sellafield inventory

#### Harwell Wastes

- Miscellaneous drummed waste including general laboratory trash, sludges, cemented liquors and incinerator ash
- 200 Litre drummed active cell and glovebox facilities wastes with mixtures of shredded soft materials (swabs, gloves, plastic, etc.) and hard materials (small HEPA filters, tools, scrap equipment, size-reduced glove boxes)

#### Dounreay Wastes

- Waste from fume-cupboard and glovebox operations, comprising filters, glass, metal, concrete, process residues, tins, etc. as well as general wastes (tissues, swabs, bags and gloves). The majority has been sorted into combustible and non-combustible waste streams.
- Waste is packed in either high density polythene or fibre drums overpacked in 200 litre galvanised mild steel drums

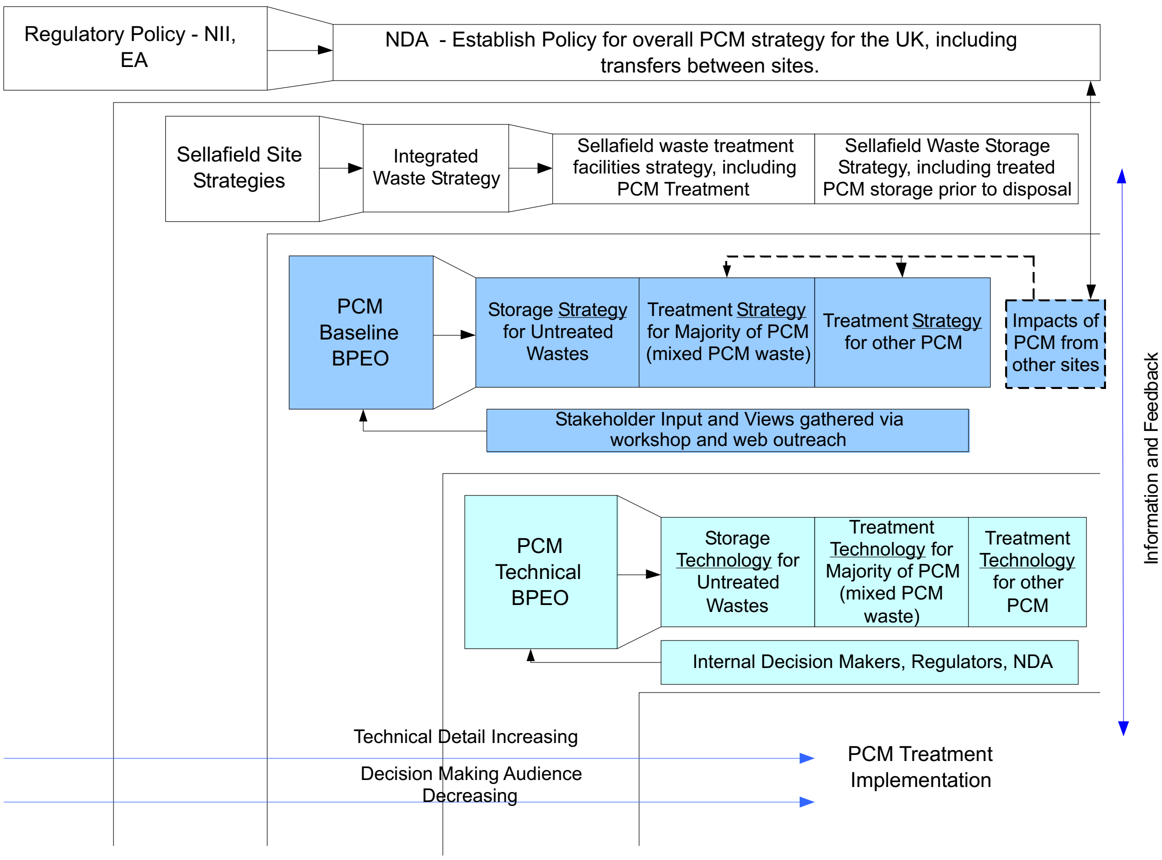
# 3. Scope, Aims and Objectives of the Current BPEO Study

Due to the limitations with the current treatment, British Nuclear Group Sellafield Ltd needs to advance the existing strategy for how PCM wastes will be managed in future. In developing the PCM strategy, British Nuclear Group Sellafield Ltd would also like to explore technical options that might allow PCM from other NDA sites to be processed at Sellafield.

The framework for analysis that will inform British Nuclear Group Sellafield Ltd's choice of a preferred strategy is a Best Practicable Environmental Option (BPEO) study. In the context of radioactive waste management, the BPEO considers the balance between environmental impact, health and safety, social and ethical factors, technical feasibility and cost. This broad balance between potentially conflicting objectives is particularly relevant on nuclear licensed sites, where there is an over-riding legal requirement that licensees must demonstrate that the risks associated with operations have been reduced 'As Low as Reasonably Practicable' (ALARP).

By definition, BPEO is consultative, thus stakeholder consultation is considered an integral component. For the Sellafield PCM BPEO study, stakeholder consultation is being achieved through an options assessment workshop on strategic issues. Consultation documents shall also be published on the internet to invite wider feedback.

The PCM BPEO contributes to the British Nuclear Group Sellafield Ltd's Integrated Waste Strategy, which is in turn a major component of the Integrated Strategy for Sellafield. All of these strategies are informed by stakeholder engagement as depicted in the figure below.



Due to the significant complexities associated with having to address a range of different waste groups, the BPEO approach for PCM is designed to consult stakeholders at different levels, thus the study involves two components:

1. A PCM 'Baseline' BPEO study, that will engage with external stakeholders with the aim of identifying key considerations that will govern the PCM treatment strategy. These considerations will be made in regard to issues that go beyond technical performance and operational feasibility and thereby will serve to frame the subsequent review of treatment options. The PCM Baseline BPEO study will not seek to identify a definitive treatment strategy for different categories of PCM.

2. A more detailed PCM 'technical' BPEO study, using a systematic decision support tool, involving a narrower group of technical specialists. This component will take into account the key considerations provided by the PCM Baseline BPEO study. This technical BPEO will analyse the available options in sufficient detail to provide justification for identifying a preferred PCM treatment option.

BPEO studies at other NDA sites (Harwell and Dounreay) are expected to address on-site treatment options at those sites as well as the potential transfer of PCM to Sellafield. However, British Nuclear Group Sellafield Ltd's current understanding of regulator and NDA requirements is that the Sellafield PCM BPEO study will not consider potential transfer of PCM from Sellafield for treatment at other NDA sites. Seeking stakeholder views on this assumption is an element of the overall consultation process.

**Question 1** Do you have any comments on the overall objectives for the management of PCM wastes at Sellafield, and the aims of the Baseline BPEO study?

**Question 2** Do you have any comments on the continued treatment of Sellafield PCM at the Sellafield site?

**Question 3** Do you have any comments regarding the possible consideration of PCM transfers from other NDA sites to Sellafield?

**Question 4** Do you have any comments on the approach to stakeholder engagement adopted by British Nuclear Group Sellafield Ltd and how your views will be used to inform recommendations on PCM management for consideration as part of the Sellafield site and NDA strategies?

## 4. Minimum Requirements for PCM Options

Whilst the overall aim of the BPEO study is to consider as wide a range of candidate PCM treatment options as possible, the options must meet certain minimum requirements that need to be satisfied by whatever options are ultimately selected. The clear identification of minimum requirements is important to provide confidence in the options evaluation process, by 'screening out' from further consideration any options that are obviously unsuitable for more detailed assessment. Hence, whilst certain options may be technically feasible, they may not be implementable because they do not satisfy the minimum requirements.

The following set of minimum requirements is considered to apply to the PCM Baseline BPEO study:

- Legal standards for worker and public safety must be met.

- Proposed technology must be feasible, indicating that the technology should be either commercially available or researched and developed to such an extent that they can with confidence be expected to be available within an appropriate timescale.

Additionally, the treatment options must align with Government policy, current regulator requirements, principles and philosophies, including:

  - Government policy on the management of radioactive waste, as set out in Command Paper Cmd2919, which specifies that the burden of nuclear waste should not be left to future generations and that waste should be packaged for final disposal wherever possible.

  - Early removal of hazard associated with existing PCM in store, consistent with ALARP and regulator requirements, rather than in situ risk abatement. Interim storage may be considered, but only where justified using a risk/benefit approach that accounts for worker and public safety.

  - Adherence to the deep land repository packaging philosophy. This dictates a preference for a directly disposable package achieved in a single processing stage and when this is not immediately achievable, an interim product to achieve rapid hazard reduction accompanied by a credible re-work plan to produce a directly disposable product.

  - Adherence to the waste management hierarchy with a presumption that creation of additional wastes will be avoided where possible and where not possible, then any approach will encompass, in order of preference, reduction/minimisation, re-use, recycling and disposal.

# 5. Regulator, NDA and Nirex Expectations

### Nuclear Installations Inspectorate

In 1999, the NII published the findings of a review into Intermediate Level Waste (ILW) storage in the UK. As a result of the review, in 2000, the NII formalised its position on Sellafield via a series of Licence Instruments that specified the timescales for improving arrangements for ILW storage at Sellafield. The first stage Licence Instruments are primarily aimed at improving the status of ILW safety management within particular plant and facilities at Sellafield. This specified that PCM wastes, which at the time of the site review had been accumulated in a range of different buildings and facilities, should be stored in a place and manner approved by NII by 1 August 2004. This led to a programme of construction of 'modern standards' waste stores for PCM, within which the majority of PCM drums, crates and other wastes, as well as 500 litre product drums from the WTC, are currently stocked.

The second stage Licence Instruments, which are complementary to and overarching in their relationship to the first stage Licence Instruments, focus particular attention on those bulk ILW streams that represent the greatest hazard in terms of overall safety concerns. These waste streams include PCM, for which the NII provided an expectation that the majority of the wastes should be made passively safe and placed in fit-for-purpose storage by 2020.

Additionally, in 2002, the NII granted agreement to a British Nuclear Group Sellafield Ltd proposal that enabled the transfer of waste items from the older series of PCM stores into a more appropriate storage environment. Good progress has been made on the transfer of PCM waste, to the extent that the objectives of the proposal have recently been fully achieved. PCM is also currently being transferred from stores at the Low Level Waste Repository to Sellafield, and this task will be completed in the near future.

The NII wishes to see that decisions made by site licensees have regard to Government policy, as set out in Cmd2919, and take into account all relevant factors. The NII is therefore understood to be generally supportive of the BPEO concept and process, in so far as it enables a broad perspective to be taken of all factors that are associated with satisfying the ALARP principle in relation to the formulation of waste management strategy.

Demonstrating compliance with regulator requirements, which in the case of the NII relate to the Sellafield Site Licence and any associated Licence Instruments, is a key component of the PCM Strategy and, indeed, all other strategies at Sellafield.

### Environment Agency

The Environment Agency of England and Wales, following engagement with UK and overseas stakeholders, has granted an authorisation for the disposal of radioactive waste from the Sellafield site under the Radioactive Substances Act 1993. The authorisation defines discharge limits and conditions that provide an environmental framework within which the treatment of PCM must be conducted.

Some of the key elements of the authorisation that guide the treatment of PCM include:

- A reduction in public dose uptake through reductions in aerial discharge limits and liquid discharge limits.
- No increases of discharge limits above previous levels.
- New conditions that include:
  - Control of discharges from individual plants as well as the site as a whole;
  - Strengthening the existing concept of Best Practicable Means, which relates to optimising how a specific process should be implemented, as opposed to wider strategic objectives that determine overall process choice;
  - A requirement to have management systems, organisational structures and resources in place to achieve compliance;
  - A significant programme of environmental improvements; and
  - A requirement to demonstrate that current disposal routes for all radioactive wastes represents the BPEO.

**Nuclear Decommissioning Authority**

Ownership of the Sellafield site was transferred to the NDA in early 2005, with British Nuclear Group Sellafield Ltd, as the Site Licence Company, operating the site on behalf of the NDA. The Site Licence Company name will change to Sellafield Ltd in the near future. The NDA expectation is that the Site Licence Company will ensure that the BPEO for waste management operations on the Sellafield site, including those necessary to manage PCM, is identified and justified. This will aid the NDA in determining where to target future investments on the Sellafield site.

**Nirex**

The role of Nirex is currently under review following the recent transfer of the company into the ownership of the NDA. It is anticipated that Nirex will continue to be responsible for development of the geological repository design concept and packaging specifications for the final disposal of ILW in the UK. Nirex currently administers a Letter of Compliance process. The Letter of Compliance is issued to producers of nuclear wastes who have demonstrated compliance with certain criteria regarding the stability and safety of their waste packages. The Letter of Compliance gives producers confidence that their waste packages will be acceptable for disposal when criteria for waste acceptance at the repository are formally defined. Regulators expect Site Licensees to seek assessment of any radioactive waste conditioning proposals via the Letter of Compliance process.

According to the regulators' joint guidance to the nuclear industry, one of the following successful outcomes is required in order to enable the issue of Letter of Compliance:

- All Nirex safety criteria can be met for the packaging proposal.
- Assessment of the packaging proposal shows that, for the specific waste stream being assessed, it is not necessary to meet all of the Nirex safety criteria.
- It is not possible to demonstrate compliance with all of the Nirex safety criteria now (thus a defined 'compliance gap' exists) but in Nirex's view the Licensee has demonstrated credible plans to remove the compliance gap in the future to produce a packaged wasteform that will be acceptable to Nirex.

Nirex already has available a repository concept and packaging specifications that cover PCM wastes. However, for some PCM wastes, their nature and knowledge gaps in the detailed inventory provide significant challenges for satisfying the Nirex packaging specifications. In order to avoid excluding options for the design of the repository, it is therefore necessary to design PCM waste packages that are robust against reasonably foreseeable eventualities. This requires that the knowledge gaps are closed sufficiently to provide an understanding of how the PCM waste package might perform in the long term. The pursuit of this understanding is ongoing, but may take a considerable time to obtain.

Moreover, even where the evaluation process has reached the point where a Letter of Compliance has been granted for a conditioned waste product, concerns may still remain in relation to waste producers' plans. For example, in relation to conditioned PCM from the WTC1A process, concerns have been identified with respect to:

- cracking of the encapsulant grout as a result of gas generation within the package or corrosion-induced stresses associated with the product contents;
- corrosion of the stainless steel container due to attack from corrosive substances produced within the product (e.g. from the degradation of PVC); and
- physical and chemical characterisation of individual waste packages.

Given this background, regulators recognise that it might not be practicable to demonstrate comprehensive compliance in a timely manner with all long-term safety requirements because treatment could be delayed to the extent that immediate safety concerns would become over-riding. Early and continued involvement of Nirex (and its successor within the NDA) is required to understand the precise difficulties associated with complying with Nirex safety criteria.

Interim treatment is a concept that a given waste treatment will be employed to reduce the risks associated with the waste with the understanding that a future final treatment will likely be required to allow for final disposal. Whilst interim treatment might achieve a timely reduction in risk, it must be balanced against the desire to avoid further reworking or repackaging (assuming that this would be practicable or even possible). It is assumed that any re-working would only need to be carried out immediately prior to final disposal and not at any interim stage. Nevertheless, there would be attendant safety and radioactive discharge implications associated with any reworking plan.

**Question 5** Do you feel you have a sufficient appreciation of the boundaries and regulator requirements applied in assessing options for the treatment of PCM at Sellafield?

## 6. Strategic Issues

Since the existing approach to the management of PCM was derived, a range of advances has taken place in terms of technological availability, decommissioning know-how and, in particular, the industry's approach to stakeholder consultation in strategic planning. These developments warrant a review of the management of PCM at Sellafield and help to frame the key issues of concern for the present process.

Over a period of many years, British Nuclear Group Sellafield Ltd (and BNFL before it) has carried out studies aimed at examining potential treatment options for PCM. This has resulted in the accumulation of a good knowledge base, but there are nevertheless several potentially controversial issues, the resolution of which could shape the future approach. The issues are interdependent and, therefore, potential solutions to any single issue should not be considered independently of potential solutions to others.

A key consideration is how the options appraisal should be carried out across a range of different PCM waste streams and package types, and the extent to which a single preferred best practicable option for the final conditioned wasteform can be identified for all (or the vast majority of) different PCM wastes. A further critical factor is the extent to which, where conflicting objectives exist, the strategy choice should be driven by longer-term containment considerations, and the desire to avoid reworking of the conditioned wastes, or short-term operational and hazard reduction issues.

A number of issues of concern have therefore been identified as a basis for discussion within the PCM Baseline BPEO study. These are listed and discussed in turn below.

Issue 1

From the perspective of strategic optimisation, a key outcome of the current appraisal of PCM treatment strategies is expected to be the need to ensure that a conditioned wasteform is defined that can be applied to the largest possible proportion of the PCM wastes at Sellafield (and, potentially, to PCM wastes from other NDA sites). The largest proportion of waste is compactable waste, for example used protective clothing and trash. This waste must be treated to produce a conditioned wasteform that should be:

- **Robust -** in terms of storage requirements, safety and environmental impacts, and long-term suitability for geological disposal, as embodied by the Nirex Letter of Compliance process, which assesses suitability of the conditioned and packaged wasteform against its generic repository concept.
- **Technically** achievable - in terms of possible demand for the reworking of existing conditioned wastes, and providing a practicable approach for handling future wastes.
- **Reliable -** in terms of the extent to which it addresses throughput issues such as those currently posed at WTC by the liquid content of some existing drummed wastes.
- **Affordable.**

As such, the wasteform and underpinning treatment processes must address the potential issues posed by, for example, the PVC content of the wastes (as PVC can degrade to produce corrosive liquids along with other chemical effects), the need to assure passive immobilisation of the PCM waste product, and the design of the waste container for the treated product.

A key consideration is the balance to be struck between achieving a timely reduction in hazard (relating to the NII concerns about the need to move quickly to a more passive form), and the desire to avoid further reworking or repackaging. In the latter case, the emphasis may be on achieving waste packages that are robust against reasonably foreseeable eventualities in terms of how the waste package is expected to perform over longer time periods. Where emphasis is on the former, it may be appropriate to consider minimally processed packages if these were deemed capable of achieving significant benefits in terms of more rapid reduction of the need for active management to assure that hazards are ALARP.

The first issue of concern and associated questions may be summarised as follows:

*The BPEO for the treatment process must identify an acceptable packaged wasteform for the majority of PCM wastes associated with the Sellafield site. Should the treatment process be sensitive to the potential treatment needs of PCM wastes from other NDA sites? Should the wasteform be engineered for longevity and ultimate disposal, taking into account uncertainties in waste acceptance requirements for a future repository, or should the focus on basic stabilisation (potentially requiring rework in future)?*

**Issue 2**

The majority of untreated PCM wastes at Sellafield, including ongoing arisings from current operations, are currently stored in 200 litre drummed form. The 200 litre drums are the primary form of input to the existing WTC conditioning process. These wastes contain a wide mix of contents in terms of their waste type (chemical and physical) and their levels of plutonium contamination. These wastes are assumed to be included in those considered through the BPEO appraisal undertaken for Issue 1.

There are other existing PCM wastes with significantly different characteristics (e.g. 'crated' wastes, pipes, used equipment, HEPA filters and previously treated wastes) and future decommissioning PCM which do not yet have clearly defined characteristics. Because of the differences, primarily in physical composition, these wastes may require supplementary treatment and/or processing (or, in the case of existing conditioned wastes, reworking) to achieve the final wasteform proposed for the drummed wastes.

Indeed, it may or may not be true that the preferred final wasteform identified on the basis of evaluation of Issue 1 is also the BPEO for these other wastes. If it is, then the approach to pre-treatment and/or reworking other wasteforms will need to be developed and shown to be sufficiently well optimised against the criteria that are of greatest concern to stakeholders.

The second issue of concern and associated questions may be summarised as follows:

*The BPEO for treatment of other wastes other than the compactable waste addressed under Issue 1 must be identified. Should the treatment for the Issue 1 be considered for the other wastes inclusive of any additional treatment and conditioning requirements? Should future arisings be managed in a similar way to current wastes (e.g. could the use of PVC be reduced)? If the treatment option associated with Issue 1 is not the BPEO for other wastes, what wasteform(s) is (are) the BPEO?*

**Issue 3**

In addition to consideration of the conditioned wasteform and packaging, an important component in the management strategies for PCM on the Sellafield site is the current and future storage arrangements and the transport around the site. Current PCM stores (not including those at the Low Level Waste Repository near Drigg, from which PCM retrieval is currently nearing completion) appear to have performed quite well to date. Nevertheless, there have been some problems with drum corrosion requiring overpacking of some drums which show signs of external failure within larger drums. Current stores on the Sellafield site vary in their construction, some are unheated which can lead to condensation. Additionally, the Sellafield site is located close to the sea, with salt water aerosols present in the local atmosphere. Both of these can promote corrosion, especially in conjunction with condensation. This may have an impact on longer-term storage conditions and evolution of the packaged wastes.

Arrangements for interim storage of final packaged waste product, prior to its final transfer to a geological disposal facility, are considered as part of the wider Sellafield strategy and not therefore addressed here. However, the PCM management strategy under consideration must address how existing stocks and future arisings of PCM are stored prior to treatment.

To be consistent with ALARP, the preferred strategy should consider an initial processing step to reduce hazards, even if that did not achieve a wasteform capable of achieving Letter of Compliance certification. Storage would then be required for the interim product pending final reworking. The final conditioning might not be carried out until immediately prior to transfer for disposal to a future deep geological repository. NDA has advised site licensees that 2040 should be assumed for planning purposes as the date at which disposals to the repository may start, but the implications of both earlier and later availability are being examined in NDA's overall strategic planning. It is important that the wasteform, waste package and storage conditions should remain fully robust until whatever point disposal may take place.

The third issue of concern and associated questions can be expressed as follows:

***The BPEO for management of PCM must consider the storage facilities and associated management arrangements for both raw and conditioned wastes PCM. How should uncertainties relating to the eventual availability of a future geological repository be addressed within the overall decision-making process?***

**Question 6** Do you have any comments on the issues of concern that are to be investigated in the BPEO study and on which feedback is sought? Have any significant overall strategic planning issues been overlooked?

## 7. Preliminary Review Attributes

For this BPEO study, a preliminary evaluation of treatment technologies has been carried out by British Nuclear Group Sellafield Ltd, based on the use of five main categories of criteria: Health and Safety, Environmental Impact, Technical Feasibility, Costs and 'Other Considerations'. Socio-economic impacts were not considered in great detail as they were considered to be better addressed in the context of broader site-wide strategic studies. Nevertheless, the category was included under 'other considerations' to enable any obvious issues to be identified and highlighted.

Under the five evaluation categories, the attributes being of primary importance in differentiating between PCM waste treatment options were identified. Attributes that were considered not particularly relevant in terms of their capability to act as differentiators (e.g. noise and traffic impact) were excluded at this stage. Clearly, this is not to say that the attributes themselves are considered unimportant; rather, that the impacts of the different treatment options being evaluated were judged to be very similar. It is recognised that these represent British Nuclear Group Sellafield Ltd's internal views at the time the work was undertaken and thus the criteria are subject to review through the stakeholder consultation process.

Below is a table listing the various attributes used in the preliminary evaluation study

| Evaluation Attribute Group | Attribute | Sub-Attribute |
|---|---|---|
| Health and Safety | Off-site dose | |
| | On-site dose | |
| | Fissile material accountability | |
| | Radiological accident | |
| | Conventional safety | |
| Environmental Impact | Waste volumes | Radioactive waste volumes |
| | | Other waste volumes |
| | Effluent impacts | Liquid |
| | | Aerial |
| Technical Feasibility | Viability | Maturity of technology |
| | | Process complexity |
| | Flexibility | Re-working of product |
| | | Sensitivity to other wastes |
| | Alignment with discharge authorisation | |
| | Achieve Licence Instrument 2020 deadline | |
| Cost | Cost | |
| Other Considerations | Socio-economic aspects | |
| | Meeting regulator standards | |
| | Nirex packaging requirements | |

**Question 7** Do you agree that this list of attributes is reasonable as a basis for comparing treatment options? Which attributes are of greatest importance? Have any attributes of particular concern that are relevant to the decision process been omitted?

## 8. Preliminary Options Review

A preliminary analysis of technical options for PCM treatment has been undertaken by British Nuclear Group Sellafield Ltd in order to support the information gathering requirements that will be an integral part of the more detailed evaluation. It is recognised that some stakeholders may have specific views on the selection of individual technical options, whilst others may be interested only in the broader strategic issues described previously. Clearly, however, some form of more detailed technical appraisal is required in order to support the definition of a proposed strategy. A very brief summary of the outcome of the preliminary study is therefore presented here in order to illustrate some aspects of the nature of the comparisons that can be made.

In undertaking the preliminary study, the outcome of two previous technology reviews (undertaken in 2004) was taken into account. The primary aims of these previous studies were to provide descriptions of technologies and processes for waste treatment and encapsulation that are used internationally. In the latest work, these analyses were supplemented by a search for information on subsequent developments, both in terms of technology improvements and possible new technologies.

A total of 73 generic technologies and variants were identified, which were categorised into nine broad technology groups. The technology groups adopted for the purposes of the study were:

- Aqueous based chemical oxidation
- Size reduction
- Surface decontamination
- Thermal treatment
- Organic destruction (for dilute aqueous solutions)
- Mercury stabilisation
- Immobilisation matrix technologies
- Stabilisation immobilisation technologies
- Others

The analysis was then refined by restricting consideration to those technologies that could either be considered mature or emerging yet feasible within known time constraints, as well as being capable of complying with relevant legislation. For example, no mercury stabilisation treatments were considered viable at the present time.

Rather than repeating the detailed analysis here, a table is provided representing the outcome of the preliminary study in terms of the performance of the major technology groups, focusing on relevant realistic examples as appropriate. Moreover, rather than repeating the 'scores' that were assigned against each of the assessment attributes, the focus is on identified potential advantages and disadvantages associated with each technology group.

| Option | Example | Outcome of Preliminary Assessment | |
|---|---|---|---|
| Aqueous based chemical oxidation | Catalyzed chemical oxidation (DETOX) | Advantages | 1. Significant waste volume reduction achievable |
| | | Disadvantages | 1. Requires preparation and sorting of wastes pre-treatment<br>2. Difficult to maintain fissile material accountability |
| | | Other considerations | 1. Capable of processing paper, cotton, latex, polyethylene and PVC plastic<br>2. Unsuitable for inorganic solids and sludges, debris or soils |
| | | Cost | Potentially high capital and operating costs (>£100M) |
| Size reduction | Supercompaction with cement grout encapsulation | Advantages | 1. Containment of drum content within puck aids fissile material accountability<br>2. Significant waste volume reduction achievable<br>3. No significant implications for discharge authorisations<br>4. Technology well established for radioactive applications |
| | | Disadvantages | 1. No removal of organics<br>2. Some PCM will require re-packaging or pre-treatment to make them suitable for this option<br>3. High maintenance requirement |
| | | Other considerations | 1. No requirement to sort wastes<br>2. Some drums may be unsuitable for the process |
| | | Cost | High capital and operating costs (>£100M) |
| Surface decontamination | Electro-deplating | Advantages | 1. Ready decontamination of complex shaped objects<br>2. Low volume of radioactive waste produced<br>3. Electrolyte may be recycled many times |
| | | Disadvantages | 1. Requires large volumes of electrolyte for large items<br>2. Electrolyte filtration plant required<br>3. Only suitable for metallic wastes |
| | | Other considerations | 1. Predominantly suitable for metal wastes in crates |
| | | Cost | £10M to £100M |
| Thermal treatment | Plasma treatment | Advantages | 1. Leads to complete destruction of organic materials<br>2. Very high volume reduction<br>3. Product is an inert ash |
| | | Disadvantages | 1. Extensive scrubbing system required to restrict aerial effluent discharge |
| | | Other considerations | 1. Suitable for organic and metals/inorganic materials |
| | | Cost | High capital and operating costs (>£100M) |

continued on page 21

| Option | Example | Outcome of Preliminary Assessment | |
|---|---|---|---|
| Organic destruction | Electron beam technology | Advantages | 1. Capable of comprehensive destruction of organics<br>2. Does not generate secondary wastes |
| | | Disadvantages | 1. Only effective for aqueous wastes |
| | | Other considerations | |
| | | Cost | High operating costs (>£100M) |
| Immobilisation matrix technologies | Phosphate ceramic | Advantages | 1. Excellent mechanical and physical properties, thermal stability, chemically inert<br>2. Cures rapidly good throughput<br>3. Good radiation resistance |
| | | Disadvantages | 1. Requires significant development work for use as a mature technology for these wastes |
| | | Other considerations | |
| | | Cost | Inexpensive raw materials and equipment (< £10M) |
| Stabilisation immobilisation technologies | Microwave melting | Advantages | 1. Large potential volume reduction factors<br>2. Process can be operated remotely |
| | | Disadvantages | 1. Not widely used/demonstrated, especially for PCM wastes |
| | | Other considerations | 1. Applies only to inorganic waste materials |
| | | Cost | High start-up and running costs (>£100M) |
| Others | Magnetic separation | Advantages | 1. Process is commercially available |
| | | Disadvantages | 1. Only effective in liquids/slurries<br>2. Organic contaminants may interfere with process<br>3. Treatment must be tailored to each waste stream and each component of the waste stream |
| | | Other considerations | Selective removal of components from the waste |
| | | Cost | £10M to £100M |

**Question 8** Do you think the technical options outlined here provide adequate information at a level sufficient to inform overall discussions on PCM management and treatment strategy? Have any options that may have significant strategic implications been omitted?

**Question 9** In reviewing the PCM Baseline BPEO Issues, is it helpful to consider options in terms of an overall strategy (pre-treatment, treatment, conditioning of final wasteform, etc.) and focus the technologies, within the more detailed BPEO studies? If so, what issues do you have regarding the various aspects of an overall strategy?

# 9. Success Criteria

It is the goal that the development of an optimised strategy for the management and treatment of PCM at Sellafield based on BPEO principles should meet the following criteria or demonstrate why other considerations may override a given criterion:

1. **Consultation Process**. A consultation process that delivers relevant understandable information to interested stakeholders, offers an opportunity for stakeholders to provide their views, considers stakeholder views and can demonstrate how stakeholder views have been considered.

2. **Feasibility**. Identification of a broad strategy for PCM management that is compatible with NDA and Sellafield site strategies. Subsequent identification of a technical strategy that can be implemented in a timely manner and is capable of addressing all existing and future PCM waste types, and, potentially, with the flexibility to accommodate the treatment of PCM from other NDA sites.

3. **Regulator Requirements**. Identification of a strategy that is able to deliver the NII Licence Instrument requiring at least 90% of existing PCM wastes (as of 1 August 2000) to be in a safe passive form by 2020.

4. **Occupational Safety**. Identification of a strategy that can be implemented to minimise potential radiological dose and conventional health and safety risks to workers associated with all operations, handling etc., so far as is reasonably practicable and ensures criticality issues fully are fully addressed.

5. **Public Safety.** Identification of a strategy (including any required waste transports) that minimises the potential radiological dose and conventional safety risks to the public.

6. **Environmental Protection**. Identification of a strategy that minimises potential releases from the wastes to the environment, taking into consideration the near- to medium-term (treatment and storage) and the long-term (likely disposal) timescales.

7. **Non-radiological Risks**. Identification of a strategy that addresses non-radiological risk factors or hazards associated with the treatment process and final wasteform.

8. **Security**. Identification of a strategy that minimises security concerns in relation to the handling and storage of PCM.

9. **Burden on Future Generations**. Identification of a strategy that minimises the need for re-working of the wastes in order to achieve a satisfactory wasteform for disposal.

10. **Consistency**. Identification of a strategy that is broadly in line with the British Nuclear Group Sellafield Ltd (and thus NDA) strategy for the Sellafield site, thus either avoiding placing unacceptable constraints on other operating units/management strategies at the Sellafield site or providing them with new opportunities.

11. **Cost**. Identification of a strategy that can be demonstrated to be cost effective in the short and long term

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| Question 10 | Do you think the success criteria are sufficiently comprehensive and if achieved will result in identifying the preferred PCM Management strategy for Sellafield? What (if any) additional factors would be relevant? |
| Question 11 | Do you have any other comments? |

## 10. Summary of Questions

**Question 1** Do you have any comments on the overall objectives for the management of PCM wastes at Sellafield, and the aims of the Baseline BPEO study?

**Question 2** Do you have any comments on the continued treatment of Sellafield PCM at the Sellafield site?

**Question 3** Do you have any comments regarding the possible consideration of PCM transfers from other NDA sites to Sellafield?

**Question 4** Do you have any comments on the approach to stakeholder engagement adopted by British Nuclear Group Sellafield Ltd and how your views will be used to inform recommendations on PCM management for consideration as part of the Sellafield site and NDA strategies?

**Question 5** Do you feel you have a sufficient appreciation of the boundaries and regulator requirements applied in assessing options for the treatment of PCM at Sellafield?

**Question 6** Do you have any comments on the issues of concern that are to be investigated in the BPEO study and on which feedback is sought? Have any significant overall strategic planning issues been overlooked?

**Question 7** Do you agree that this list of attributes is reasonable as a basis for comparing treatment options? Which attributes are of greatest importance? Have any attributes of particular concern that are relevant to the decision process been omitted?

**Question 8** Do you think the technical options outlined here provide adequate information at a level sufficient to inform overall discussions on PCM management and treatment strategy? Have any options that may have significant strategic implications been omitted?

**Question 9** In reviewing the PCM Baseline BPEO Issues, is it helpful to consider options in terms of an overall strategy (pre-treatment, treatment, conditioning of final wasteform, etc.) and focus the technologies, within the more detailed BPEO studies? If so, what issues do you have regarding the various aspects of an overall strategy?

**Question 10** Do you think the success criteria are sufficiently comprehensive and if achieved will result in identifying the preferred PCM Management strategy for Sellafield? What (if any) additional factors would be relevant?

**Question 11** Do you have any other comments?

## Appendix - Glossary of Terms and Acronyms

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| **ALARP** | As Low As Reasonably Practicable. In law on health and safety, measures necessary to avert risk must be taken until or unless the cost of those measures, whether in money, time or resource, is grossly disproportionate to the risk that would thereby be averted. When this point is reached, the measures taken are described as ALARP. |
| **Best Practicable Environmental Option (BPEO)** | The concept of Best Practicable Environmental Option gained widespread acceptance in the UK as a result of the work of the Royal Commission on Environmental Pollution, which in its Twelfth Report (1988) defined BPEO as:<br><br>*"...the outcome of a systematic and consultative decision making procedure which emphasises the protection and conservation of the environment across land, air and water. The BPEO procedure establishes, for a given set of objectives, the option that provides the most benefit or least damage to the environment as a whole, at acceptable cost, in the long term as well as the short term."*<br><br>In the context of radioactive waste management, the BPEO considers the balance between environmental impact, health and safety, social and ethical factors, technical feasibility and cost. This broad balance between potentially conflicting objectives is particularly relevant on nuclear licensed sites, where there is an over-riding legal requirement that licensees must demonstrate that the risks associated with operations have been reduced 'As Low as Reasonably Practicable' (ALARP). |
| **Criticality** | Criticality is achieved when a sufficient mass of fissionable material is brought together in one place that conditions are established for generating a self-sustaining nuclear chain reaction. The possibility of a nuclear criticality accident is minimised by analysing normal and abnormal operations involving fissionable materials to ensure that such conditions do not occur. |
| **Decommissioning** | Decommissioning involves the removal of plant and equipment and, wherever possible, a reduction in the area occupied by a facility. Facilities that have been decommissioned will be out of service with adequate regard for the health and safety of workers and the public and the protection of the environment. |
| **CHILW** | CHILW, or contact-handled intermediate level waste, is a category of solid radioactive waste that is contaminated with either<br>• relatively high levels of alpha-emitting radionuclides and comparatively low levels of beta and gamma-emitting radionuclides (in excess of acceptance criteria for low-level waste); or<br>• very low levels of alpha-emitting radionuclides but with levels of beta and gamma-emitting radionuclides in excess of acceptance criteria for low-level waste, but below those where remote handling is required. |
| **Environment Agency (EA)** | The Environment Agency of England and Wales, responsible for regulating both radioactive and conventional effluent discharges and other waste movements from the Sellafield site. |
| **Fissile Materials** | Fissile materials are composed of atoms that can be split by neutrons in a chain-reaction to release large amounts of energy. When the amount of fissile material is such that the chain reaction is self-sustaining, a criticality is achieved (see Glossary) |
| **Fissionable** | Nuclear fission is the process by which the nucleus of an atom splits into two or more smaller nuclei (known as fission products), with the release of substantial amounts of energy. A fissionable isotope of an element (such as Pu-239 and Pu-241) is capable of undergoing induced fission when struck by a free neutron. |

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| **Glovebox** | A glovebox is a total enclosure that is designed to allow the manipulation of objects in an atmosphere that is sealed from that of the operator's environment. Built into the sides of the glovebox are facilities for gloved hand entry, enabling tasks to be performed inside the box without breaking the seal. |
| **Government Policy** | Government policy on the management of radioactive waste is set out in Command Paper Cmd2919. Key principles are that the burden of nuclear waste should not be left to future generations and that waste should be packaged for final disposal wherever possible. Government policy on the disposal of ILW (including PCM) has recently been reviewed and is based on the use of an underground repository. |
| **Half-life** | The half-life of a radioactive material is the time it takes for the amount of radioactivity that it contains to decay to half of its initial value. Thus the amount of radioactivity present is reduced from an initial value by a factor of 8 over a time period three half-lives, 64 in six half-lives, and just over 1000 in ten half-lives. |
| **Hazard** | A factor that has the potential to cause harm to an individual or the environment. For example, the radioactivity in PCM is a hazard. For safety management purposes, hazard is sometimes expressed by means of a Hazard Indicator, which is a measure that depends on physico-chemical form, toxicity and the degree of 'control' required to ensure that the hazard is safely contained. |
| **Intermediate Level Waste (ILW)** | Intermediate-level waste is waste that has a radioactive content above the maximum for waste that is acceptable for disposal at the Low Level Waste Repository near Drigg. The upper limit on radioactivity content for ILW is the maximum concentration acceptable for disposal in a facility intended for non-heat generating wastes, and is set largely by consideration of heat generation rates. |
| **Integrated Waste Strategy (IWS)** | The concept of an Integrated Waste Strategy has been jointly developed by the NDA, nuclear site regulators and site operators. It describes how a site optimises its approach to waste management, taking into account waste streams and discharges from all processes and facilities on the site, including the legacies from past operations prospective future waste arisings. |
| **Letter of Comfort** | The name formerly given to the process by which Nirex endorses waste producers' plans for generation of a waste product, through assessing the suitability of proposals against requirements for safe transport and final disposal. The process is now known as the Letter of Compliance. |
| **Letter of Compliance** | The Letter of Compliance process is used to give the producers of nuclear waste confidence that their waste packages will be acceptable for disposal when a deep geological repository becomes available. The A Letter of Compliance is only issued when Nirex has been satisfied that the packages will meet required performance specifications, taking into account the requirement that they should remain passively safe following manufacture and will be capable of being transported safely to a phased geological repository facility and of being disposed there. The Letter of Compliance was previously known as the 'Letter of Comfort' (see Glossary). |
| **Liquor** | Radioactively contaminated liquid, in this context referring to any liquid associated with the PCM. |

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| **Low Level Waste Repository** | This site, located near Drigg in West Cumbria, has accepted low level wastes from the nuclear and other industries, universities and hospitals for nearly 50 years. The facility is currently operated on behalf of the NDA by British Nuclear Group. |
| **MOx Fuel** | Mixed Oxide Fuel. Nuclear reactor fuel consisting of a mixture of plutonium and uranium dioxide. |
| **NDA** | The Nuclear Decommissioning Authority; owner of and responsible for the decommissioning of UK public-sector civil nuclear sites. The NDA is funded by the Department of Trade and Industry (DTI). |
| **NII** | The Nuclear Installations Inspectorate, part of the Health and Safety Executive (HSE) and responsible for regulating activities on licensed nuclear sites to ensure that they are operated in a way that is safe for both workers and the public. |
| **Nirex** | UK Nirex Ltd, which is developing the underground repository design concept and packaging specifications for the final disposal of ILW in the UK. Nirex administers the Letter of Compliance process. Following a Government policy announcement in October 2006, Nirex responsibilities and staff have been transferred into the NDA. |
| **PCM** | Plutonium Contaminated Material a waste contaminated by direct contact predominantly with plutonium isotopes. The Plutonium Contaminated Material that is present on Sellafield site originates mainly from the refurbishment, maintenance or decommissioning of operational plants. |
| **Plutonium** | Plutonium (chemical symbol Pu) is a radioactive, silvery, metallic element, occurring in trace amounts in uranium ores and produced artificially by neutron bombardment of uranium. Its longest-lived isotope is Pu-244 which has a half-life of around 80 million years. The highly fissionable isotope Pu-239 (half-life approximately 24 100 years) is used as a reactor fuel and in nuclear weapons. |
| **Pyrophoric** | A pyrophoric substance is a substance that is capable of igniting spontaneously at room temperature. Certain metals may be pyrophoric, especially when powdered or thinly sliced. Pyrophoric materials are often water reactive as well and may ignite in contact with water or humid air. |
| **Regulators** | In this context, principally EA and NII. Nirex is not a regulator. |
| **Repository** | The term used for the proposed underground facility that will be used for the disposal of ILW in the UK. The design concept for the repository is owned and developed by Nirex. |
| **Risk** | The chance that something adverse will happen. For example, because of the age of some older PCM storage facilities, continued storage of PCM in such facilities carries a higher risk than storage in modern standards storage facilities. |
| **Supercompaction** | High-force compaction, or supercompaction, is a process by which wastes are reduced in volume under high pressure; typically 2000 tonnes per square metre. This gives rise to a significant reduction in volume and can help to generate a more coherent waste that acts to immobilise the radionuclides and thereby helps to prevent release. |
| **Wasteform** | The treatment and conditioning of wastes (e.g. supercompaction, followed by encapsulation in a cementitious grout) results in the generation of a wasteform. In the case of ILW, the final wasteform and its disposal container constitute the waste package, which is evaluated by Nirex under the Letter of Compliance system. |

British Nuclear Group

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