

PLUTONIUM CONTAMINATED MATERIAL (PCM)

A Review of the Status at Sellafield, Dounreay, Harwell and Aldermaston

Introduction

Papers describing the PCM position at Sellafield (BNG) (Annex A), Dounreay and Harwell (UKAEA) (Annex B) and Aldermaston (AWE) (Annex C) are attached as annexes to this commentary prepared by RG2.

The papers include volumes and activities, current status of wastes and stores, strategies and plans for their future treatment and storage, and risks and constraints which may affect achievement of those plans. Additional information has been obtained by telephone where appropriate.

Volumes /Activities

Not surprisingly the total PCM volume, including estimated future arisings, is dominated by that at Sellafield (rounded values)

Site	Existing Volume (m ³)	Total (incl. future arisings)
Sellafield (+)	7975	22000
Dounreay	840	1250
Harwell	1230	1390
Aldermaston (+)	3400	6500
Total	13445	31140
(+) derived		

Not included in the BNG paper but according to the latest (2001) UK Radioactive Waste Inventory the existing Sellafield volume contains over 1 tonne of Plutonium. This represents a substantial proportion of the total Plutonium destined for disposal in a final repository. In addition certain streams (S, D and A) also contain fissile Uranium.

Current Status

PCM exists in a wide variety of forms, much of it polythene – wrapped, in simple 100, 200 and 400 litre drums, but also with significant volumes in crates, gloveboxes, filters etc. Certain waste streams, especially crates and gloveboxes, present difficulties for accurate inspection and assaying due to the self-shielding properties of some materials and thus need great care in the breakdown/repackaging process. Progress is inevitably slow. There are also significant numbers of Sea Disposal drums (H and A), which are at least 20 years old and for which a conditioning process has yet to be identified.

Only a very small proportion (about 5%) of the total existing stock has been conditioned to a form which NII would deem suitable for long term “safe and

passive” storage. NII’s requirements include meeting the current suitability for disposal criteria set down by Nirex and endorsed by the EA. At present this is being achieved only by Sellafield’s Waste Treatment Complex (WTC) which employs high force compaction of 200 litre drums with 3, 4 or 5 “pucks” being encapsulated in 500 litre SS drums. The capacity of this plant is currently limited to about 2000 product drums p.a. ie processing less than 2000 m³ p.a., although there are plans to double this over the next few months. Not all waste streams have been approved for treatment by this means. It should be noted however that meeting the Nirex criteria does not **guarantee** acceptance for actual disposal, although it is deemed to confer a “high degree of probability” on that acceptance. If WTC packages were ultimately to prove unacceptable for disposal, subsequent re-working could be difficult and undoubtedly expensive.

Nevertheless there have been significant efforts over recent years to improve safety by starting the transfer of material from old, unsatisfactory stores to new, purpose-built ones and by sorting, assaying and re-packing waste into new 200 l drums. This process is on-going but should be seen only as an intermediate step towards meeting the NII requirements.

Strategy and Plans

All the sites have what is essentially a two-stage strategy: first, to inspect, sort, assay and repackage all existing waste, as necessary, for storage in suitable, mostly new buildings. This is to be followed, wherever possible and in due course, by high force compaction and cementation in 500 l drums. As currently conceived this suggests that some wastes will remain in their existing state for **at least** 5 years before the first stage can be completed (particularly at S and A).

It is worth noting that although D, H and A have all recognised the possibility of transferring waste for processing in WTC, indeed it is the preferred option for both D and H, capacity limitations might preclude this on the desired timescale. Nevertheless discussions involving D, H and S, and with the NDA, are ongoing with a view to agreeing satisfactory arrangements.

(It is also possible, in the light of the recent decision to bar the transfer of LLW from D for disposal at Drigg, that a dedicated facility may be necessary for waste in Scotland.)

Packages produced during the second stage (currently via WTC) need to be suitable for a period of extended storage prior to deep disposal – this may last 100, 150 or even 500 years according to indications given by the Regulators and /or Nirex!

However because some streams contain materials, especially cellulose, which Nirex currently deems unsuitable for deep disposal, other options are being considered. The option of high temperature solidification (ceramicisation), which could potentially destroy all organic material, has been the subject of a BNG R&D programme; this is now in abeyance.

NII agrees with the volumes of material above. UKAEA is proposing to send PCM for H and D to Sellafield for storage, conditioning/repacking and post-preparation storage along with that on the site itself. NII states that such a plan would depend upon sufficient storage and treatment capacity being available at Sellafield. At the present time the capacity requirements are under consideration. No decision has been taken to manage the material at Sellafield and no proposal for agreement has been submitted to the NII.

NII also states that discussions on the proposals for PCM (segregation of waste and, at least initially, minimal conditioning) at the non-NDA site are at an early stage.

Government policy is to bring all ILW into a passively safe form. NII is working with the various site licensees to see this achieved. Disposal options are a future issue. Agreement on this from a number of agencies will be necessary including NII, EA, Nirex and (for some sites) NDA.

It is therefore considered essential that there is agreed, as soon as possible, a coherent plan, embracing all four sites, for the second stage of what should be the UK strategy.

Constraints and Risks

An important factor affecting progress through the first stage is the capability of inspection and assaying equipment, some of which is due for, or undergoing, renewal.

The key factor affecting confidence to progress into and through the second stage however, is the absence of a clear specification for a deep disposal package. Nirex is **not** a Regulator although its current role has that effect. This whole situation could be simplified if Nirex were to be contracted to the relevant Regulator ie the EA, rather than to the waste producer. The NII's position would then be straightforward: processing must meet the specification if re-working is to be avoided. Resolution of the cellulose question is also crucial; if such material **is** unacceptable in a disposal package then the R&D necessary to find an alternative to high force compaction and cement must be restarted. The NDA will have to resolve the inevitable commercial issues if the outcome is to be shared with all the parties.

Conclusion

It is encouraging that all the sites have recognised the importance of making progress towards converting their PCM wastes into a "safe and passive" state. There is, however, much to do, over many years, before this can be achieved, and this is especially true for those wastes where a process capable of meeting disposal requirements has yet to be identified.

**RG2, NuSAC
September 2005**

Strategy summary**The strategy for plutonium contaminated material at Sellafield*****The strategy for plutonium contaminated material (PCM)***

The strategy for PCM storage at Sellafield is to safely secure all such waste forms under a regime of safe surface storage pending the availability of a UK repository. The strategy delivers hazard reduction and achieves passivation of existing stocks and new arisings of PCM by 2020.

The high level direction for the retrieval and treatment of PCM is as follows:

- Minimise, so far as practicable, future PCM arisings
- So far as practicable, quality-assure, type-sort and package future PCM arisings at source in order to facilitate both safe surface storage of raw waste and subsequent processing to a form suitable for disposal or indefinite surface storage.
- Monitor, inspect and, when required, remediate the stored PCM inventory in order to preserve the integrity of containment
- Develop and implement, as soon as practicable, means of processing all existing PCM stocks and future arisings to a safe and passive form which does not compromise the ultimate aim of final disposal.

A safe and passive storage regime is one which demonstrably maintains the safety and integrity of containment of the stored material minimising the use of active safety systems and human intervention in order to maintain its safe state.

Key stakeholder commitments/Deliverables encompassed by the strategy

- Support to BNFL's commitment to Copeland Borough Council to retrieve PCM waste from the UK Low Level Waste Repository Site by the end of 2006
- Nuclear Site Licence Instrument 324 requires the old Waste and Effluent drum stores to have raw wastes removed facilitating their closure in line with their design life
- Nuclear Site Licence Instrument 326 is associated with the reduction of the PCM hazard by ensuring all stored PCM is in a safe and passive form
 - By August 2020 at least 90% of the total volume of all PCM waste originating from operations prior to 1st August 2000 and which has been accumulated as radioactive waste is to be in a 'safe passive form'.
- Progressive emptying of a specified series of old PCM Waste Stores to minimise seismic risk

Scope

The current scope of the PCM strategy covers:

- All future arisings of PCM at Sellafield and Drigg
- PCM currently in store in a raw or conditioned form including PCM waste transferred from Drigg (see the Strategy Summary paper for the Low Level Waste repository at Drigg for more details)

On the Sellafield site the following major plants are integral to the plan:

Buildings	Work breakdown structure (level 7)
• Waste stores and Waste and Effluent Drum stores	35095
• Engineered drum stores 1, 2 and 3 (under construction)	35095
• Waste Treatment Complex (WTC)	35090

Other major plants and services whose support is required for the success of the PCM strategy but which are not under the direct control of the PCM operations business group are:

Buildings	Work breakdown structure (level 7)
• Separation PFR plant	35205
• Services including the utilities (steam, electricity etc) and transport	35570, 35568
• PCM retrievals facilities which are capable of crate breakdown	35085

It should be noted that the PCM strategy does not cover decommissioning operations such as Separation PFR plant retrievals and North Group Compound retrievals. Where there are PCM arisings from these sources, however, the processing and long-term storage falls under the PCM strategy scope.

The Waste treatment Complex (WTC) at Sellafield is the only available processing facility which can condition PCM in compliance with a Letter of Comfort for disposal to a future deep waste repository. The feed envelope of WTC is limited and not all existing or future PCM is suitable to feed to WTC. Whilst the Letter of Comfort provides the best assurance available, it is not guaranteed that WTC product will be acceptable to a future repository without further processing. Therefore, the end point of this strategy is:

- All PCM will be stored in a form which is both safe and passive and has a high probability of acceptability to a future deep disposal repository

Strategy background

PCM has arisen from UK Atomic Energy Authority (UKAEA) and BNFL operations at Sellafield since the 1950s. It has been stored in various facilities adapted or purpose built at both Sellafield and the Low Level Waste repository at Drigg.

The original intention was to segregate PCM by plutonium (Pu) content sending low Pu waste for sea dump disposal and reserving the higher Pu content wastes for Pu recovery. Combustible and non-combustible wastes were also segregated at source with the intention that some wastes would be suitable for incineration.

In the early 1980s, the original Waste Treatment Complex was designed and built to segregate PCM waste by Pu content and into hard and soft waste. However, in 1983 the moratorium on sea dumping of radioactive wastes was introduced. It was also established that Pu recovery from waste was both uneconomic and environmentally detrimental due to the generation of secondary wastes. PCM incineration was also rejected due to concerns regarding aerial effluent emissions. At this time, uncertainties regarding the degradation of organics in the proposed ILW repository meant that there was no suitable disposal route for PCM and the WTC project was mothballed.

In the early 1990s a new WTC process was developed to supercompact 200-litre PCM drums, without sorting, and to grout the resulting pucks into 500-litre drums for disposal in the Deep Waste Repository. WTC was then modified. A Letter of Comfort was received from UK Nirex Ltd in 1996 for grouted 500-litre product drums arising from the revised WTC process for wastes originating from Thorp and Magnox Reprocessing, and earlier site operations. PCM crates and stillages will require pre-processing if they are to be conditioned in WTC. About 90% of the 200 litre drums will be compatible with the WTC process after modifications to the assay system have been made.

WTC commissioning of the drum supercompaction and grouting suite started in 1998. The plant has been operated in an extended commissioning phase within a fissile limit sanctioned by the NII. Currently, applications are being made to move to a full operational status at a higher fissile limit.

The first Engineered Drum Store (PCM store 1) was designed and built to store PCM for an extended period. It came into operation in 1993. The original intent for this facility was as storage for WTC product drums only although it was recognised that there would be a need to store raw PCM drums

pending WTC processing. With the filling of this store (and it is currently almost full), PCM store 2 was built and is in operation. More recently due to limitations associated with the Waste Treatment Complex, PCM store 2 is used additionally for extended storage of crates and filter stillages.

The current strategic position

The old Waste and Effluent drum stores have been emptied with the contents now in PCM store 1. Nearly all drums have been removed from the old Waste Store series. Space management and movements from the Waste Stores have required careful planning and supervision using modelling techniques so as to ensure operations elsewhere on site are not affected. Filter stillages and low fissile crates are to be placed in a suitable container and progressively moved to PCM store 2 over the next two years. Crates with a high fissile content nominally require further Safety Case work (CID omission case) before they can be accepted into the new stores.

The concept of safe surface storage of PCM is being developed. For items which cannot be readily conditioned in WTC, this would use containers with improved resistance to corrosion and an inspection and remediation regime that will assure the safety of long term storage. As a contingency until a deep waste repository is confirmed above ground storage of PCM may be required for up to 150 years. Safe surface storage is to be progressively implemented for present and future 'raw' PCM waste forms for which no processing route presently exists or which otherwise could not be processed within a timescale compatible with the projected longevity of current packaging. The safe storage regime will also encompass long-term storage of WTC product drums.

On completion of the retrievals of waste from the Waste Store (the North Group Compound at Sellafield), the opportunity exists to extend the use of the associated decommissioning facility (The Waste Recovery Decommissioning Facility) to breakdown existing stocks of PCM crates into a form suitable for conditioning in WTC.

The suitability of the WTC process has been reviewed given the uncertainty surrounding the deep waste repository and the applicability of the Nirex specifications and NII fissile limit to the nature of raw waste. A review of alternatives to compaction and grouting processing technologies has been undertaken. This concluded the only viable processes currently available or under development are either associated with compaction and grouting (as is currently practised) or thermal processes to destroy all organic components of the waste combined with high temperature solidification such as ceramicisation. Research and Technology work associated with ceramicisation has been initiated. The product from this process is such that its suitability for a future repository would be unquestionable. For now PCM will continue to be treated in WTC producing a 'safe and passive' waste form where there is clear compliance with the Nirex Letter of Comfort and regulatory fissile limits.

Wastes that are not demonstrably Nirex – compliant are to be repacked ensuring they are in a form suitable for safe surface storage. A process will be required for these if no agreement can be reached with Nirex.

In compliance with the regulatory specifications, the company will continue retrieval and relocation of historic PCM into new-design PCM stores. If package inspection indicates current containment integrity is compromised than repacking will occur.

The status of the modern PCM stores is as follows: PCM store 1(Engineered Drum Store 1) is currently almost full. Modelling work predicts that PCM store 2 will be full early 2006. PCM store 3 is under construction and will be available end of 2005. Modelling work has indicated that based on future Sellafield arisings, a small store 4 could be required in around 2020. The business is, however, looking to improve working efficiencies so that this store would not be required.

In summary, the following diagrams, extracted from modelling work, shows the status of PCM stores at the close of 2004 and the forecasted position for 2020.

Figure 1 – Status at 01/12/04

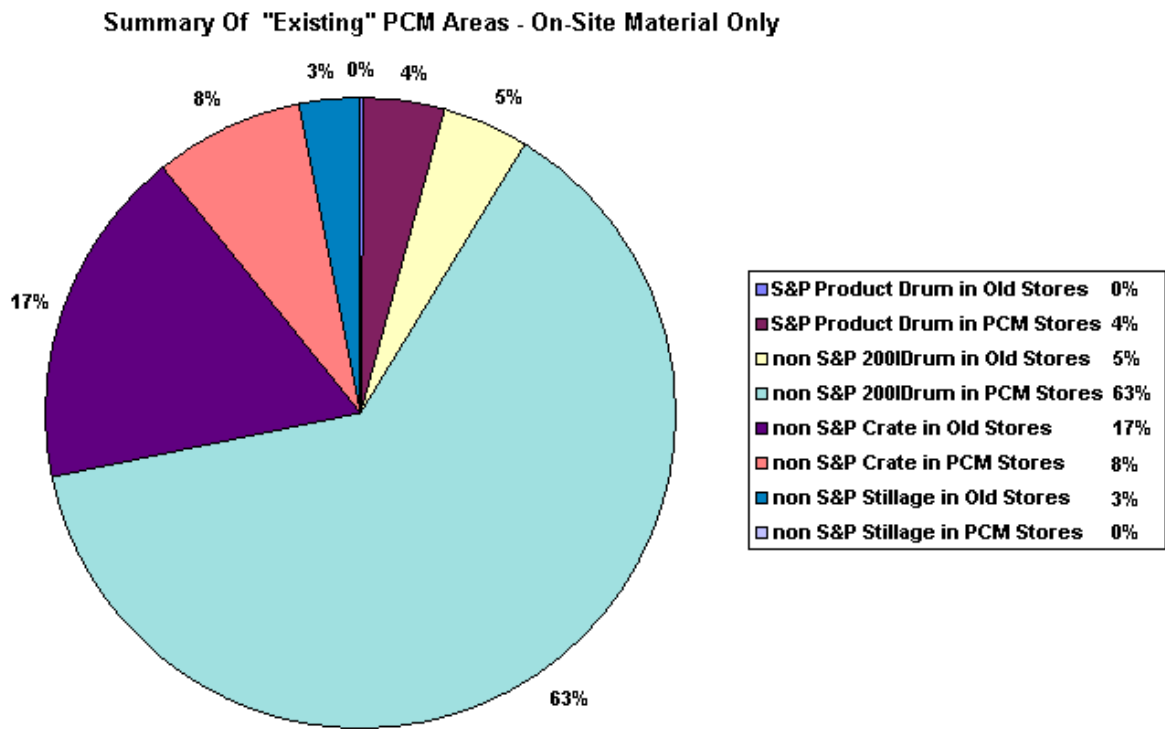


Figure 1 illustrates that only 4% of existing stocks at 01/082000 are deemed to be in confirmed safe and passive (S&P) form at 01/12/04

Figure 2 – Predicted status at 01/08/2020

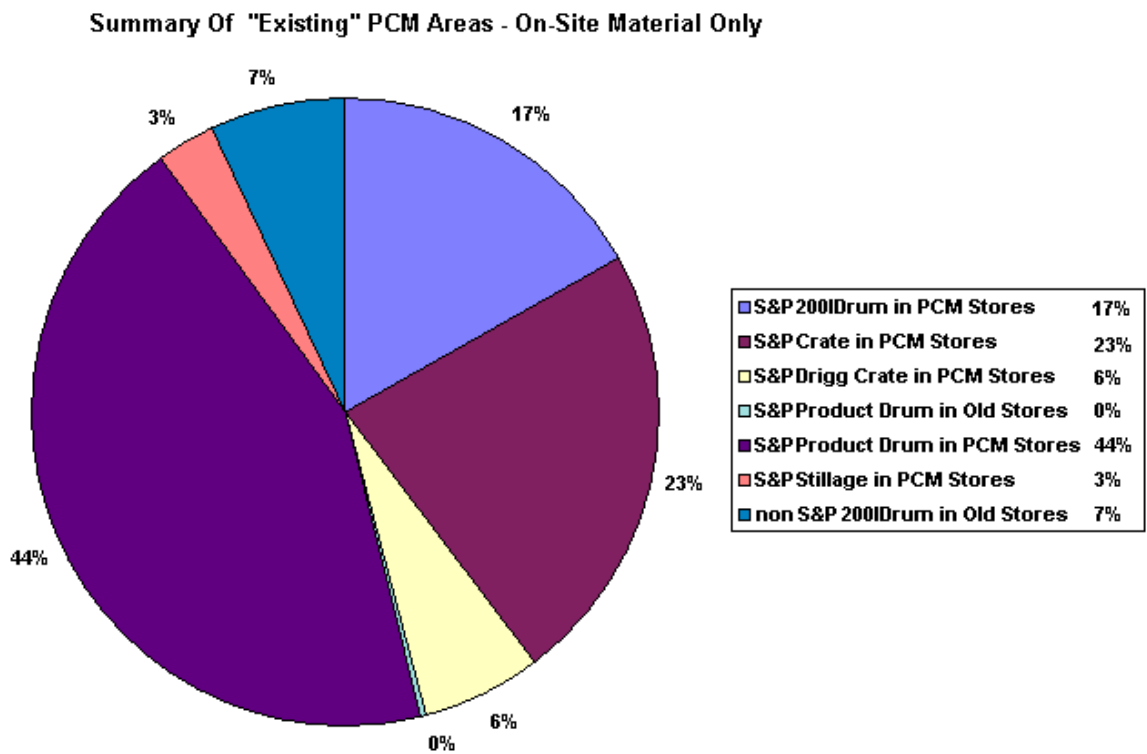


Figure 2 illustrates that 93% of existing stocks at 01/08/2000 are predicted to be converted to safe and passive (S&P) form at 01/08/2020

Key dates

- By August 2020 at least 90% of the total volume of all PCM waste originating from operations prior to 1st August 2000 and which has been accumulated as radioactive waste is to be in a 'safe passive form'.
- It is a business *aim* that by September 2005 the operation of WTC will be at full fissile loading per product drum.
 - Once full fissile loading has been achieved, the following objectives will be pursued in order to meet the 2020 target:
 - 1) The WTC assay equipment being capable of handling oxide fuel feed as opposed to just Magnox
 - 2) Agreement with Nirex regarding processing historic waste and decommissioning arisings which may have a different characterisation

Constraints

- WTC demonstrated capacity is less than 2000 drums per year. This needs improved to approximately 4000 drums per year which is considered achievable through process enhancements. Further throughput enhancement would be achievable by extending the shift pattern from the current 5 day double day working
- Planning permission for PCM store 4 (Engineered Drum Store). If waste from other sites is to be brought to Sellafield, this would be an issue
- In the long-term, the passive operation of the site. Power and services would be required for safe surface storage using the existing PCM store buildings.

Key Assumptions

- Drigg PCM retrievals will be complete by 2006.
- PCM stores will only receive PCM waste from Sellafield or Drigg consignors
- Forecast arisings of PCM from Sellafield decommissioning operations
- Contingency planning is required to mitigate the risk that a deep waste repository will not be available for a considerable period beyond 2040.
- WTC product will be suitable for the Deep Waste Repository

Key Risks

- Specification for waste to be disposed in a deep waste repository changes
- A national decision is made to store all UK PCM waste in a single facility
- Arisings from decommissioning are higher than forecasted consuming storage capacity
- WTC product which originally was designed for 50 years above ground storage may be unsuitable for disposal by the time a repository is available
- Deterioration of uncharacterised waste may make future processing more difficult
- More information on historic wastes may make processing more difficult
- Early processing may foreclose more appropriate future processing options
- The Nirex Letter of Comfort does not remain applicable

Opportunities

- If plant enhancements were successfully progressed and shift working patterns changed to increase the throughput of WTC, the opportunity could exist to handle extra material through this plant, for example, 'hand offs' from other nuclear sites. Current modelling, where Sellafield material is prioritised through WTC, shows additional material could be handled after 2020. Such additional work scope would be a decision for and at the request of the NDA customer. Whilst there are

obvious economies associated with using the WTC as a national facility, it would mean that PCM store 4 would require building. This whole issue would be a matter of national policy.

Topics of Note

None identified

Mitigation plans

The thermal process of ceramicisation is being investigated as the product produced by this means would unquestionably be acceptable to a future Deep Waste Repository. If the current letter of comfort remains valid and other PCM becomes acceptable to Nirex then ceramicisation would not be required.

Crates and filter stillages will be packed for safe surface storage but there is the risk that there is no form which the NII will accept as safe and passive without further conditioning of the raw waste.

Decommissioning facilities (e.g. the Waste Recovery Decommissioning Facility) could be used to breakdown existing stocks of PCM crates into a form suitable for conditioning in WTC.

Contingency plans

Under consideration

**Dounreay Solid Contact Handleable Intermediate Level Radioactive
Waste
(PCM) – Information for Review Group 2 NuSAC**

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- **INTRODUCTION**

1. UKAEA estimates that around 408m³ (raw volume) of CHILW (as PCM), will be produced during Dounreay site restoration in addition to the 837m³ that is already stored in the existing authorised facilities.
2. There are 35 CHILW streams listed in DRWI (Dounreay Radioactive Waste Inventory), 31 of these refer to solid waste, and 4 of these to liquid waste.
3. The thirty-one solid waste streams are divided into operational waste (that is, already generated and stored on site) or decommissioning (waste that will be produced by decommissioning operations). There are twelve operational streams listed in DRWI. This waste, which is described either as PCM (plutonium contaminated material) or UCM (uranium contaminated material) is all stored in D9867 with the exception of one stream, which consists of uranium contaminated graphite.
4. The PCM makes up the largest fraction of the CHILW currently stored on site. This waste stream includes waste from fume-cupboard and glove box operations. The waste comprises filters, glass, metal, concrete, process residues, tins, isomantles and general wastes such as tissues, swab, bags and gloves. The DRWD inventory (April 2004) shows there are 837m³, raw volume, in D9867 stored in 200L drums. Predicted future arisings are 408m³.
5. The majority of the PCM, which arose at Dounreay, was sorted into combustible and non-combustible streams (this was associated with previous PCM waste management procedures). The segregated wastes were packed into 180 litre alkathene (high density polythene) drums which in turn were overpacked into 200 litre galvanised mild steel drums. Some of the PCM was packed into fibre drums, which were subsequently overpacked into 100litre mild steel 'red-oxide' drums prior to being sent to D9867, where they were overpacked with 200 litre galvanised mild steel drums. The PCM that arose at Sellafield, was not segregated into combustible and non-combustible streams, and was packed in 200 litre painted mild steel drums.
6. The waste has been split into 7 streams for inventory purposes. These are shown with the DRWD stream identifier:

Stream	Description
5B24.01	Dounreay Operational CHILW
5B24.02	Ex-Sellafield CHILW
5B24.03	Ex-Cadarache CHILW
CSS/Op/CHILW/PC	D1200 Operational CHILW
D1208/Op/CHILW/PC	D1208 Operational CHILW
D2670/Op/CHILW/PC	D2670 Operational PCM CHILW
D2900/Op/CHILW/PC	D2900 Operational CHILW

7. The D9867 Store has been in operation since 1980. Its purpose is to receive solid CHILW from site operations, repack (if required) and store prior to final treatment

and disposal. The three storey building is around 60m long, 20m wide and 12m high. It is constructed with concrete bricks for the wall and pre-cast concrete units supported on steel beams for the roof. The store is divided into six bays, which contain vertical posts to support the stacked waste drums. Drum handling is carried out by a building crane.

- **COMPOSITION**

8. The composition of the seven streams is shown below. 5B24.02 and 5B24.03 were previously combined under one waste stream, which was characterised as a whole. This explains why 5B24.02 and 5B24.03 have identical composition data.

Stream	Description
5B24.01	Stainless steel (41.39%), mild steel (36.54%), concrete (2.32%), glass (1.89%), non-halogenated plastics (15.66%), halogenated plastics(0.63%), cellulose(0.56%), rubber (1.24%) and others (0.6%). The waste is neutral and neither oxidising nor reducing. The waste composition includes the drums and liners as well as the contents.
5B24.02	Stainless steel (27.98%), mild steel (56.33%), concrete (2.74%), glass (5.91%), PVC (2.03%), plastics(2.31%), residues(0.96%), rubber (1.41%) and others (0.25%). The waste is contaminated with small amounts of finely dispersed alpha activity, mainly plutonium in the form of PuO ₂ with traces of PuNO ₃ .The waste is neutral. The waste composition includes the drums and liners as well as the contents.
5B24.03	Stainless steel (27.98%), mild steel (56.33%), concrete (2.74%), glass (5.91%), PVC (2.03%), plastics(2.31%), residues(0.96%), rubber (1.41%) and others (0.25%). The waste is contaminated with small amounts of finely dispersed alpha activity, mainly plutonium in the form of PuO ₂ with traces of PuNO ₃ .The waste is neutral. The waste composition includes the drums and liners as well as the contents.
CSS/Op/CHILW/PC	Waste will typically consist of metal (37.5%), paper (20%), plastic/polythene (20%), rubber (10%) and glass (12.5%).
D1208/Op/CHILW/PC	Waste will typically consist of metal (90%), soft organics (10%) and plastics/rubber (<1%).
D2670/Op/CHILW/PC	Waste will typically consist of metal (15%), soft organics (10%), plastic/rubber/PVC (50%), gauntlets (25%)
D2900/Op/CHILW/PC	Assumed to be the same as 5B24.01

- **ACTIVITY**

9. The activity of the seven streams is shown below.

Stream	Alpha Activity (TBq/m³)	Beta/gamma Activity (TBq/m³)
5B24.01	4.82E-02	6.14E-01
5B24.02	6.47E-02	8.45E-01
5B24.03	5.4E-02	8.45E-01
CSS/Op/CHILW/PC	1.25E-01	2.45E+00
D1208/Op/CHILW/PC	4.82E-02	6.14E-01
D2670/Op/CHILW/PC	4.39E-02	1.91E-02
D2900/Op/CHILW/PC	4.82E-02	6.14E-01

- **BACKGROUND TO DEVELOPMENT OF STRATEGY**

- **Summary**

10. The long-term strategy has been to transfer the Plutonium Contaminated Material (PCM) component of the CHILW to Sellafield, along with other UKAEA solid CHILW, for treatment and conditioning in the WTC. BNFL had originally indicated that they would not be able to receive the waste for many decades, but due to recent changes in strategy at Sellafield, they have now determined that they could receive the waste much earlier. Any CHILW not suitable for transfer to Sellafield will remain in storage in D9867 until it can be treated by UKAEA. This fraction is expected to be the Uranium Contaminated Material (UCM). Discussions are ongoing with BNFL about the feasibility of the transfer route, and how a contract for the transfer can be agreed. The NDA is attending these meetings.

- **Previous strategy**

11. Early strategies involved storage, until the waste could be treated to retrieve the plutonium fraction. As stocks increased, strategies were assessed for sorting, segregation, repacking and compaction to increase the effective storage capacity. The option to process the PCM fraction of the CHILW was eliminated, as fast reactor development came to an end.

- **Options**

12. The option of treatment and conditioning at Dounreay has been considered, but now is only a fall-back if the option of the transfer to Sellafield is discounted. The only recent option has been to transfer the PCM to Sellafield for processing through BNFL's WTC facility, with subsequent storage of the conditioned product on the Sellafield site. The conditioned product would not be returned to Dounreay.

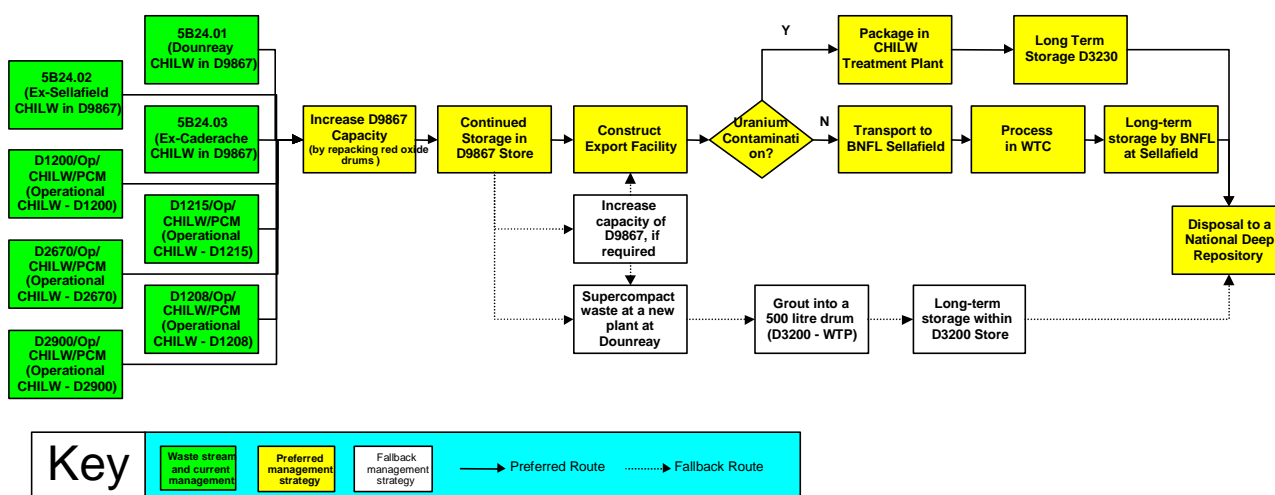
13. The options for transporting UKAEA PCM from Dounreay and Harwell to Sellafield have been reviewed. Road, rail and sea routes are possible. The option of constructing a new rail route directly onto the Dounreay site could not be justified economically. Road, then rail and lastly sea were deemed the most economic routes. Transport packages have also been reviewed.

14. In 2001, BNFL issued a new PCM Waste Management Strategy, within which they stated that they may not be able to receive and process UKAEA's waste on an appropriate timescale, in effect eliminating the current reference strategy for treatment of Dounreay's CHILW within the next two decades. A strategy development task force was established to review the options available for processing UKAEA CHILW into a passively safe state and to identify a preferred solution and fallback option, ensuring that a common approach is adopted across UKAEA where appropriate. However, in 2004 following changes in strategy at Sellafield, BNFL revised their predictions for when they might take PCM from

elsewhere. The LMU recognised the worthiness of the approach and best use of existing facilities.

- **Reference Strategy**

15. The assumed planning strategy is that the wastes will continue to be safely stored in D9867 until they can be transferred to Sellafield. Storage Bay 1 has been poled to provide capacity for raw CHILW arisings until the strategy can be implemented. Additional capacity could be made available, if required, by repacking selected drums. At Sellafield, the waste will be supercompacted in the WTC. The resulting pucks will be placed in 500 litre drums, grouted and stored pending a national final solution for conditioned ILW. Discussions are ongoing with BNFL about the timescales for accepting this waste. The transport containers will travel by road, sea, rail or a combination of these to a BNFL raw waste store at Sellafield, until WTC is available to accept them.
16. To underpin the planning assumption, UKAEA has decided to undertake public consultation on the long-term options for managing the waste. This consultation will be undertaken along with similar consultations for the treatment of Harwell CHILW (PCM).
17. The preferred strategy for Dounreay PCM may fail as a result of one or more of the risks identified being realised. The conclusion of options study work was that the fallback strategy should be to construct a new PCM supercompaction facility at Dounreay, with storage of the conditioned waste at Dounreay.



Flow diagram for Reference Strategy for 5B24

- **CONTINGENCIES**

18. There are three risks identified for the current strategy. These risks and the mitigatory actions put in place in the Site Risk Register are tabulated below.

Risk Description	Controls In Place & Handling Strategy
UKAEA cannot reach an agreement with BNG to allow the movement of PCM to Sellafield starting in 2010 (for Dounreay) for processing the compactable fraction through WTC and storage of non-compactable fraction for subsequent processing with similar BNG PCM.	UKAEA does not currently have an agreement with BNG. A number of meetings with BNG and NDA have been held to ensure an agreement is secured. The transfer of PCM from Harwell is an key milestone in the restoration of that site and a decision on the transfer has to be concluded by the end of March. Therefore, BNG and NDA know that UKAEA need to start moves in 2006 for Harwell and 2010 for Dounreay. Based on the last meeting in Dec 2005 UKAEA believes that BNG would also like to reach a decision quickly.
The outcome of the NDA national stakeholder consultation results in the decision to retain PCM at individual sites.	The NDA, BNG and UKAEA are planning to hold a meeting in mid-January to consider the stakeholder issues relating to the PCM moves. The EA has already carried out a consultation exercise on PCM transfers from Harwell to Sellafield. On the basis of that consultation transfers in the Harwell RSA were authorised.
UKAEA cannot meet the BNG Conditions for Acceptance of PCM.	A review of the UKAEA PCM against the CoA [APEC(04)P424] concluded that the vast majority of UKAEA's PCM will meet the CoA. There are a number of minor technical areas where there uncertainties remain, but this will be the same for some of BNG's older PCM stocks. UKAEA will work with BNG to demonstrate the acceptability of this waste.

19. Since the Site Risk Register was compiled there have been two changes;

- an ‘in-principle’ understanding has been agreed with BNFL representatives and detailed arrangements, including financial terms are currently under discussion.
- the national stakeholder consultations will be carried out at Dounreay and Harwell through the site Stakeholder Groups.

SUMMARY OF HARWELL PCM WASTE

INTRODUCTION

This sheet summarises the nature of the PCM waste at Harwell. It includes the inventory, physical content, compactable fraction, arisings timescales, storage locations/capacities and assay requirements for WTC. An Excel spreadsheet is also attached which details the costs used in determining the overall cost for each of the PCM management options. The various options are described on this sheet.

INVENTORY

2.1 Waste Stream Contents

Sea Disposal Drums [5C08]

- The waste within the SDD's comprises a diverse mixture of materials with a range of origins including general laboratory trash, sludges, cemented liquors and incinerator ash,
- The waste is known to be a mixture of RHILW, CHILW and LLW but only the CHILW fraction has been considered here
- Due to the uncertainties in the contents of individual drums and the nature of the packing of the waste (i.e. entombed rather than intimately encapsulated), it is likely that any future packaging of the waste will have to be preceded by a process of opening the drums, sorting and fully characterising the waste.
- Only the CHILW fraction has been included in the study.
- It has been assumed that the concrete surrounding 200l drum within the SDD will be disposed of as LLW when the drum is repacked and so has not been included in the waste volume.

CHILW [5C33]

- This waste stream comprises operational and decommissioning wastes from alpha-active cell and glove-box facilities
- The waste is a mixture of 'soft' materials (swabs, gloves, plastics etc.) and 'hard' materials (HEPA filters, tools, scrap equipment, size reduced glove-boxes)

Development Laboratory CHILW [5C304]

- This waste will arise from the decommissioning of B220.
- The waste will comprise mostly of sections of dismantled glove boxes, ventilation systems, pipework etc. together with small proportion of 'soft' wastes (gloves, swabs etc.).

Other Decommissioning CHILW [5C310]

- This waste will arise from the decommissioning of a number of facilities on the Harwell site (e.g. Hangers 7 & 10, B393.6, B488).
- This waste is likely to comprise of mainly metallic material from decommissioned glove boxes, ventilation systems, pipework etc. together with some building fabric material (e.g. concrete) and a small proportion of 'soft waste'.

Winfrith CHILW [5G02]

- This waste arose from fast reactor fuel manufacturing operations in A52, A59 and B41 at Winfrith
- The waste is a mixture of operational wastes (e.g. contaminated gloves, PVC, polythene, paper, tissues) and decommissioning wastes (e.g. scrap equipment, sectioned steel, Perspex panels, pipework)

Winfrith Sea Disposal Drums [5G11]

- These drums are similar to the Harwell SDDs but only contain CHILW.
- They arose from the packaging of wastes from the plutonium oxide fuel manufacturing line at Winfrith.
- The waste comprises a mixture of contaminated laboratory trash (gloves, PVC, tissues etc.) and materials from glove-box refurbishment.

2.2 Waste Stream Volumes

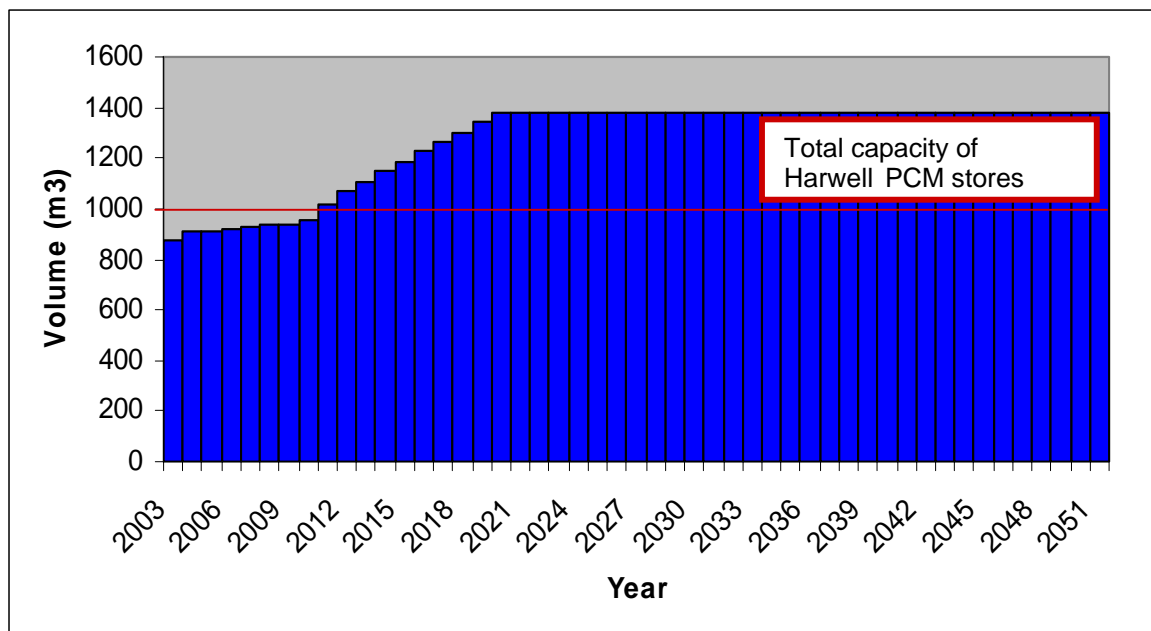
Waste Stream	Waste Stream Identifier	Sub waste streams covered	No. of drums		Volume (m ³)	
			Stock	Arising	Stock	Arising
Sea Disposal Packages	5C08	5C08/1a 5C08/1b	1823 SDDs	0	364.6	0
Harwell CHILW	5C33	5C33/1-4 5C22/7-8	2388 x 200l drums	150 x 200l drums	684.2	30
Development Laboratory ILW	5C304	5C304/1	N/A	N/A	0	55
Decommissioning: Other Facilities ILW	5C310	5C310/2 5C310/5 5C310/7 5C310/10 5C310/12 5C310/15	N/A	N/A	77.85	76.6
Winfrith CHILW	5G02	5G02/1	1600 x 100l drums	0	79	0
Winfrith Sea Disposal Drums	5G11	5G11/1	228 SDDs	0	22.8	0

COMPACTABLE FRACTION

- The fraction of compactable waste for Harwell was calculated by looking at the contents of individual drums within the HARWIN database.
- The Nirex criterion for successful drum compaction is that at least 50% of the waste volume is compactable.
- By applying this criterion against each drum it was possible to determine which drums would be supercompactable
- From this information, it was estimated that **67%** of Harwell PCM is supercompactable
- This value is quite low due to the fact that historically some of the drums were packed as so to minimise the holdings which resulted in a number of drums being unsuitable for compaction.
- This fraction maybe pessimistic as a further fraction could be deemed compactable for the following reasons:
 - A 2000 te supercompactor is capable of volume reducing even bulky metal items (assuming favourable in-drum geometry), lumps of cement, glass and solid plastic.
 - Much of the metal waste may be relatively thin (e.g. ductwork, filters, glove box components) and, in the case of Harwell waste, may have been shredded in the PSA to give compactable drum contents.
 - Careful repacking and sorting of drum contents could produce larger distribution of practically compactable drums.

ARISINGS TIMESCALES

The graph below shows the total waste volume arising from Harwell against time for the waste streams mentioned above. For the SDDs it has been assumed that they will be repacked over a period 2010-2019. They are shown on the graph not as stock but as arisings equally distributed over that time period. The graph also shows a rough estimate of the total capacity of current Harwell storage facilities.



CURRENT HARWELL STORAGE CAPABILITIES

B462.23 at Harwell

- Capacity of 2040 x 200l drums \equiv 408 m³
- Currently 100% full

B220.8 at Harwell

- Currently holds 1160 x 200l drums \equiv 232 m³
- Decommissioning of complex due to start 2007

B462.19 at Harwell

- SDD store
- Currently holds 1823 SDDs \equiv 364.6 m³ of CHILW waste

ASSAY REQUIREMENTS FOR WTC

- Harwell PCM waste has been assayed but UKAEA will need to be able to demonstrate the accuracy of the inventories of the packages provided to WTC and demonstrate the reliability of the measurement technique (e.g. calibration certificates, consideration of matrix effects).
- BNFL would also be interested in any algorithms or constants in the software of assay equipment used to calculate the inventory of these wastes.
- They will also be interested in the frequency and types of checks carried out on the assay equipment.
- WTC assay records 16 isotopes. UKAEA will have to identify any isotope that is outside this list.

PCM MANAGEMENT OPTIONS

The costs for the options are detailed in an Excel spreadsheet; the options are as follows:

Option 0 – This is the current reference strategy as stated in the Strategic Planning System (SPS) where BNFL will process UKAEA PCM starting in 2010.

Option 1 – This is a revised reference strategy of processing the compactable waste fraction at WTC starting in 2008 and storage of the non-compactable fraction on the Sellafield site.

Option 2 – This involves building new supercompaction facilities at both Harwell and Dounreay so that each site deals with its own waste.

Option 3 – This involves adding a new supercompaction facility to the already planned SEP at Dounreay and building a new supercompaction facility at Harwell.

Option 4a – This option assumes that a new supercompaction facility will be built at Dounreay to process both Dounreay and Harwell compactable wastes. This new facility also will deal with the non-compactable Dounreay and Harwell wastes.

Option 4b – This option assumes that a new supercompaction facility will be built at Dounreay to process both Dounreay and Harwell compactable wastes. This new facility will also deal with the non-compactable Dounreay fraction and a new facility at Harwell will be built to deal with the Harwell non-compactable wastes.

Option 5 – This option assumes that all waste is transferred to Sellafield for storage in a new waste store (EDS4). This is not a holistic option and does not include costs for converting the wastes into a disposable form at some point in the future.

Option 6 – This option assumes that the wastes will be stored indefinitely at Harwell and Dounreay with the provision of new stores as required. This is not a holistic option and does not include costs for converting the wastes into a disposable form at some point in the future.

Submission to NuSAC

Management of Plutonium Contaminated Material at Aldermaston

This paper summarises the management of Plutonium Contaminated Material (PCM) at Aldermaston. The paper will be used to collate information for a NuSAC paper in PCM management at Dounreay, Sellafield and Aldermaston.

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- **INTRODUCTION**

1.1 A paper is to be prepared for the July meeting of NuSAC which describes the approaches to Plutonium Contaminated Material (PCM) management at Dounreay, Sellafield and Aldermaston and which identifies any significant differences and their possible implications.

1.2 In order to assist in the production of the above paper, this paper describes the approach adopted at Aldermaston, and is structured as follows:

- a) Introduction (this Section)
- b) Overview of the waste streams encompassed by the definition of PCM. This includes a summary of volumes and radiological data;
- c) Management Arrangements – this discusses packaging, storage, transport and assessment of PCM;
- d) Regulatory Issues and Future Plans – this covers regulatory requirements and future plans for PCM. Risks of the current management strategy are also discussed;
- e) Conclusions

- **OVERVIEW OF WASTESTREAMS**

2.1 AWE presently holds stocks of PCM. For the purpose of this paper, PCM includes all waste contaminated by plutonium, for which there is no disposal route, and which therefore needs to be stored at Aldermaston. This waste comprises material that has been processed into a variety of waste packages. Apart from legacy holdings, ongoing operational and decommissioning activities continue to generate substantial additional volumes of this waste type.

2.2 The current strategy [Ref. 1] for dealing with PCM is to package the waste into AWE approved 205-litre drums and to store the waste in modern standard stores. The waste drums are stored in a manner that allows for inspection and retrieval. This is an interim situation prior to conditioning the waste for eventual disposal. However, the conditioning requirements for some future long term storage facility / repository are currently uncertain. The HSE-NII consider that the repository may be up to 100 years away from operation and they are likely to request that all Intermediate Level Waste (ILW) should be covered by a safety case for the 100-year period. In spite of the uncertainty applying to the suitability of conditioning treatments, the HSE-NII nevertheless require the waste to be made passively safe and compliant with the Nirex waste packaging requirements. This is being taken into consideration in an ongoing strategy review covering all solid ILW. The review will address the need to agree an acceptable waste product specification.

2.3 The current stock of PCM is approximately 17,000 waste packages of various types. Records are maintained for each waste package. If the current strategy of packaging into 205-litre drums continues, the following table summarises future arisings:

	Decommissioning		Operational	
	No. of 205-litre drums	Waste volume (m ³ – conditioned into 205-litre drums)	No. of 205-litre drums	Waste volume (m ³ – conditioned into 205-litre drums)
Future Waste Arisings from 2004 to 2040 [Ref.: 2]	12,500	2,500	3,000	600

Details of the material and fissile breakdown of the waste currently stored are given in Annex A.

• **MANAGEMENT ARRANGEMENTS**

3.1 Containerisation

3.1.1 All packages containing PCM waste are approved for transport and storage by AWE competent authorities.

3.1.2 Current arisings of PCM are packaged in AWE approved waste packages comprising a 205-litre steel drum with a 160-litre polyethylene liner acting as the principal containment. Prior to the use of this waste package various alternatives were used. The more significant include:

- ◆ 205-litre steel drum with fibreboard liner;
- ◆ 205-litre steel drum with shielding and 98-litre inner drum;
- ◆ 100-litre steel drum;
- ◆ 205-litre steel drum;
- ◆ 400-litre steel drum with 2 x 150-litre inner drums.

3.1.3 A number of drums containing PCM destined for sea dumping are stored. These date back to 1982, and were packaged just prior to the ban on sea dumping. Each package contains waste within a container which has been grouted within a 400-litre drum. There are various configurations of the inner container.

3.1.4 Other PCM waste is stored in packages which were designed as an interim storage arrangement awaiting further processing. These include:

- ◆ Crated gloveboxes – these comprise redundant gloveboxes containerised within fibreglass crates;

- ◆ Mogul Spheres – these comprise steel pressure vessels in which experiments have been carried out containing radioactive material;
- ◆ Pyrochemical wastes- these contain chloride salts from plutonium recovery operations, which have deemed as waste by the Ministry of Defence. These are currently stored in cans, most of which are overpacked in 205-litre drums;
- ◆ Filters – these are individually packaged in fibreglass packages.

3.2 Storage

3.2.1 A series of engineered stores are used to hold most of this waste. For current arisings, four 205-litre drums are loaded onto a stillage and the stillages stacked up to 5-high in double rows. This storage array allows for any drum to be easily retrieved.

3.3 On-site Transfer

3.3.1 205-litre drums containing fissile material content less than 30g are transported from the consigning plant to the stores in an enclosed trailer.

3.3.2 205-litre drums containing fissile material content in excess of 30g are transported on the Aldermaston site using a package known as the “transport safe”. This is a substantial package weighing 3,800 kg and it can accommodate (subject to fissile material content) up to 4 x 205-litre drums or 1 of 400-litre drum. The safe is not licensed for off-site use.

3.4 Non Intrusive assessment

3.4.1 Current arisings of operational and decommissioning wastes are routed for real-time radiography (RTR) inspection and assay prior to storage.

3.4.2 RTR inspection is used to establish that each waste drum is compliant with the requirements for acceptance by Waste Management. If drums are found to contain contraband items, these are returned to the consigning plant for removal of the contraband item(s).

3.4.3 Following the completion of the RTR operation, each drum is assayed to ascertain the fissile material content using either high resolution gamma monitoring or passive neutron coincidence counting or both. A significant proportion of drums that have been assayed are recorded as "below the limit of detection" a limit above the upper limit for Low Level Waste (LLW) (4 GBq/t for alpha emitters) and consequently also above the Drigg limit for plutonium contaminated waste of 0.1 GBq/t.

3.4.4 The assay system is approaching 20 years old and is to be replaced. The new system will employ high resolution gamma monitoring and is due to be installed in July 2005. The new equipment will allow the assay system to measure down to the ILW/LLW interface but not down to the Drigg limit for plutonium contaminated waste of 0.1 GBq/t.

3.4.5 Consigning facilities carry out a fissile material assay prior to dispatch. In cases where the assay system has been approved by AWE Non Destructive Assay Section, 90% of the waste drums are transferred directly to stores following RTR with only 10% of the drums being subjected to a confirmatory assay.

- **FUTURE PLANS**

4.1 Future Plans

4.1.1 AWE's PCM cannot continue to be stored indefinitely in mild steel drums as these do not meet the NII requirements for passive safety over a long-term storage period (considered as 100 years). AWE are undertaking a project whose aim is to treat the legacy stored waste and produce a wasteform that can be safely stored on site for up to 100 years and which will meet the disposal requirements for a national repository, should one become available.

4.1.2 An Options Study has been undertaken in order to assess viable options to treat AWE's stored waste. Several options are being taken forward for investigations in further detail into their viability in terms of technical risk, cost, timescales and practical implementation. Discussions are also being held with other sites that have waste treatment processes in place, in order to gather information on their practical operation and the lessons they have learnt.

4.1.3 A Product Specification is being developed, in order to define the wasteform that any future treatment process will produce. Discussions are taking place with Nirex as to the disposal requirements that will need to be met for a future repository. AWE are proceeding on the basis that a 500ltr Stainless Steel drum will be the most suitable container to be used. The Product Specification will be issued for approval by the NII by 31 December 2006.

4.1.4 Regular meetings are held and close liaison is maintained with the NII and the EA to ensure that they are aware of all developments on this project.

4.2 Risks of the Current Management strategy

4.2.1 Although there is no agreed strategy in place for the processing of PCM wastestreams for final disposal, a number of issues will need to be dealt with before such a strategy can be finalised.

4.2.2 There are some 4000 drums containing cellulosic materials in the form of fibreboard liners. There is concern in Nirex with regard to the complexing of cellulosic material with plutonium. This may create difficulties in gaining a letter of comfort for these materials and there is a possibility that the liners will need to be removed before the waste is processed into a passively safe state.

4.2.3 The fissile material limit of 50g per 500-litre drum that is currently being proposed by Nirex with regard to ILW product packages, could result in the abandonment of volume reduction as an option for processing the waste into a passively safe state. It may not be possible to devise a robust and acceptable strategy until the various regulatory bodies and Nirex agree on an appropriate fissile material content for ILW packages.

- **CONCLUSIONS**

5.1 AWE currently handle PCM arisings in 205-litre mild steel drums, but the storage of waste in these drums does not meet the NII requirements for passive safety over a long-term storage period (considered as 100 years). AWE's plan is to agree a Waste Product Specification with the regulators such that legacy stored waste can be treated to produce a wasteform that can be safely stored on site for up to 100 years and which will meet the disposal requirements for a national repository, should one become available.

REFERENCES

- [1] Elder W. F. – Strategy for the Management of RA Waste Streams, Trade waste and North Ponds Discharges, UK Restricted, Ref EDMS1/8006C610/B/A14.4/W0300, Issue1, September 2003.
- [2] Electrowatt-Ekono – 2004 UK Radioactive Waste Inventory: Detailed Information for MoD Wastes, UK Restricted, Ref. No 200362.13/08, May 2005.

Annex A

The data that the information below is based on was a snapshot of the AWE waste management database as of 1st October 2004

A1 To date, AWE has accumulated approximately 17000 packages of legacy solid Intermediate Level Waste (ILW) on the Aldermaston site. The majority of this waste is contained in 205-litre drums although there also remains a few hundred Sea Dump Drums, for which the originally intended disposal route is no longer available. Figure 1 below broadly identifies and quantifies the wastes that make up this ILW.

A2 The 570te of “Packaging” includes materials such as the mild steel drums, HDPE liners and fibreboard liners. The 180te of “Concrete/sand/shingle” is predominantly due to the concrete liners and other aggregate materials in the Sea Dump Drums, although small quantities also exist in other waste drums. The 275 te of “Total Organics” is made up of several components as shown below but does not include the organic material present in the packaging. The 379te of “Metals” is made up predominantly of aluminium, stainless steel, copper and ferrous metals.

A3 Figure 1 also identifies 45te of “Total Others Known”. This category consists of materials such as lead, beryllium, glass, graphite, aquablast media, asbestos and several other materials that do not fit into one of the main categories. Options for treating these materials are being investigated.

A4 Figure 1 also highlights that there remains 207te of unknown material, the majority of this being due to old historical data not being comprehensive. Reviews of the radiograph images are therefore to be carried out for the drums in this area in order to identify the contents and reduce this mass.

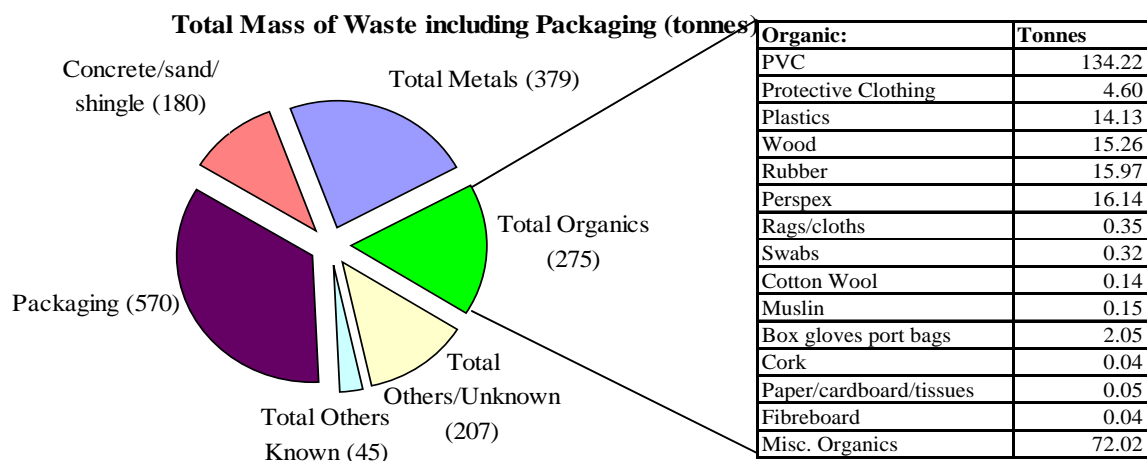


Figure 1. Quantities of Waste and Packaging

A5 Figure 2 below shows that over half of the 17000 packages in store (9584 packages) each contain less than 1g fissile material and that almost three-quarters of the packages (12390 packages) each contain less than 5g of fissile material. In total,

only 3% of the packages in store (556 packages) each contain greater than 50g fissile material.

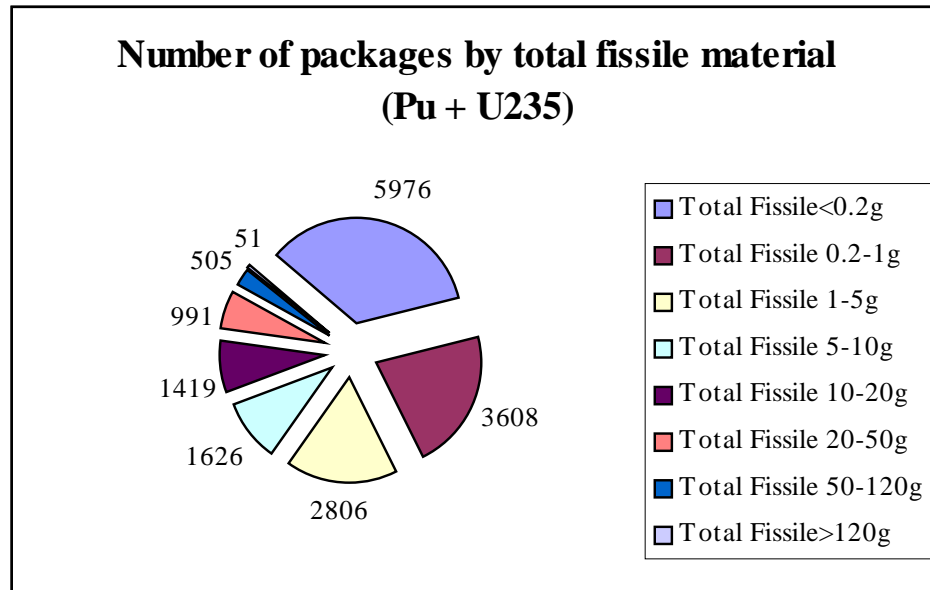


Figure 2. Number of Packages by Fissile Material Content