LLW Repository Ltd

# LLWR Environmental Safety Case

## RECALL Interviews

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# RECALL Interviews


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# List of Acronyms/Abbreviations

| Acronym/Abbreviation | Meaning |
|---|---|
| BNFL | British Nuclear Fuels Ltd |
| BWD | Building Works Department |
| CEBG | Central Electricity Generating Board |
| CfA | Conditions for Acceptance |
| COMARE | Committee on Medical Aspects of Radiation in the Environment |
| CSD | Chemical Services Department |
| DU | Depleted Uranium |
| EA | Environment Agency |
| ESC | Environmental Safety Case |
| EURATOM | European Atomic Energy Community |
| HF | Hydrogen Fluoride |
| HMIP | Her Majesty's Inspectorate of Pollution |
| HP | Health Physics |
| HSR | Health and Safety Regulations |
| IAEA | International Atomic Energy Authority |
| ILW | Intermediate Level Waste |
| LETP | Liquid Effluent Treatment Plant |
| LLW | Low-Level Radioactive Waste |
| LLWR | Low Level Waste Repository (near Drigg in Cumbria) |
| LTP | Lifetime Plan |
| MAFF | Ministry of Agriculture, Forestry and Fisheries |
| MoD | Ministry of Defence |
| MoS | Ministry of Supply |
| NICOP | Nuclear Industry Code of Practice |
| NII | Nuclear Installations Inspectorate |
| NRPB | National Radiological Protection Board |
| OPC | Ordinary Portland Cement |
| PCM | Plutonium Contaminated Materials |
| PFA | Pulverised Fuel Ash |
| PCSC | Post-Closure Safety Case |
| QA | Quality Assurance |
| RAF | Royal Air Force |
| RPA | Radiological Protection Advisor |

| | |
|---|---|
| RSA | Radioactive Substances Act |
| RWMAC | Radioactive Waste Management Advisory Committee |
| SLC | Site Licence Company |
| THORP | Thermal Oxide Reprocessing Plant |
| TRO | Technical Records Office |
| UK | United Kingdom |
| UKAEA | United Kingdom Atomic Energy Authority |
| UKRWI | United Kingdom Radioactive Waste Inventory |
| VLLW | Very Low Level Waste |
| WAC | Waste Acceptance Criteria |
| WAMAC | Waste Monitoring and Compaction (facility) |

# Executive Summary

The Low Level Waste Repository (LLWR) is undertaking a programme of work to underpin the assessments made as part of an Environmental Safety Case (ESC) for submission to the Environment Agency in 2011. Part of this programme of work is the production of a robust and defensible inventory of past and future waste disposals.

The study reported here describes part of the review of past disposals that were made to the trenches on the LLWR site. Anecdotal evidence suggested that there may have been disposals to the trenches from Sellafield that were not recorded and that might significantly affect the estimates of the environmental impact of the Repository. The LLWR therefore undertook a series of RECALL interviews with current or retired staff from Sellafield and/or the LLWR that had operational and other relevant experience. This was done with the intention of eliciting information on past disposal practices and hence determining any significant impacts on the assumed inventory of wastes in the trenches.

This report:

- Contains a review of the recorded RECALL interviews with retired and current staff of Sellafield and/or LLWR who have knowledge of historical disposals to the trenches at LLWR;
- Presents a comprehensive listing of all issues raised in the interviews and the preliminary evaluation of those issues to rank them in terms of potential impact on the disposal inventory for past disposals to the LLWR trenches. The supporting text groups issues by theme and discusses aspects of significance and the uncertainties that are raised;
- Makes recommendations for follow-up work for each issue. The suggested work ranges from detailed investigation of high-priority issues to simple scoping calculations for issues ranked as low priority with little or no likely impact on the disposal inventory. The aim of the suggested work is to develop a documented response to each issue to show how it has been addressed by LLWR.

Twenty-eight RECALL interviews were analysed and 45 issues of potential significance for the LLWR disposal inventory have been listed. Some issues were raised by more than one interviewee. The interviews are informative, but rarely address issues in a quantitative way.

Judgements have been made to develop a preliminary ranking of the issues in terms of their potential impact on the disposal inventory in respect of factors such as uncertainty, record keeping and QA, impact on volume and location of disposals, activity disposed (with emphasis the key radionuclides identified in past environmental safety studies), wasteform and presence of other non-active materials that may affect safety.

For highly ranked issues, detailed analysis is proposed involving steps such as:

- Follow up interviews to develop a greater understanding of the issues and to explore the potential for quantification;
- Further analysis of disposal records, held on- and off-site, to determine if issues are already addressed within the existing inventory and whether quantitative data are available;
- Quantification of the issue to assess the impact on the disposal inventory in terms of volume, activity, uncertainty, etc.
- A limited number of further interviews with key waste consignors, e.g. Springfields, to gain further insight into issues relating to uranium wastes from this source.

Issues of less potential significance would be evaluated through simpler approaches, such as:

- Analysis of existing records to confirm the issue has been addressed within the existing inventory data;

- Simple scoping calculations to quantify the likely impact of the issue on the overall disposal inventory to determine significance.

For an intermediate group of issues, it is uncertain as to their quantitative significance and some simple scoping work is proposed to address that uncertainty. Some of these issues may then be downgraded or may require further detailed assessment.

The issues raised have been grouped into a number of broad themes to facilitate evaluation and proposals for further analysis of each issue are outlined.

# Contents

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# 1 Introduction

## 1.1 Background

The Low Level Waste Repository (LLWR) is undertaking a programme of work that will lead to the production of an Environmental Safety Case (ESC) for submission to the Environment Agency in 2011. One part of that programme of work is the production of a robust and defensible inventory of past and future waste disposals, which will underpin the assessments made as part of the ESC. Key aspects include:

- Review of past disposals and projected arisings based on recent studies for LLWR and newly emerging information, with the objective of improving the data where practicable;
- Development of scenarios for future waste management options encompassing different waste treatment and management options;
- Characterisation of uncertainty in radionuclide and materials data.

A significant amount of work has been undertaken over the last 10 years to calculate the inventory of Trenches 1 to 7 at LLWR arising from historic disposals that took place between 1959 and 1993. The trench inventory calculated for the 2002 Safety Cases [1] was derived from a combination of data extracted from the paper disposal records and the backfitting of inventory data from the most up-to-date published source at the time, the 1998 UK Radioactive Waste Inventory (1998 RWI). The backfitting methodology was based on the assumptions that the 1998 RWI waste-streams were similar to those disposed in the past, and that the detailed radionuclide fingerprints and materials contents of the 1998 RWI waste-streams were accurate and could be applied to the historical disposals. Owing to the volume of the paper records, it was only possible to extract data from a selection of these records. Therefore effort focused on 'specific' or 'key consignments' which were either those with higher specific activities or those derived from unusual sources that were not represented in the UK Radioactive Waste Inventory (UKRWI). These included major disposals of wastes containing radium, thorium, uranium and plutonium.

In subsequent work, the evaluation of the trench inventory has been improved in two ways [2]:

- by extending the capture of information from paper-based records focusing on 'key consignments'; and
- by making use of a greater variety of data sources for evaluation of 'routine consignments' to reduce reliance on data in the UKRWI; this was in recognition that although the UKRWI provides a comprehensive dataset of radionuclide activities and materials compositions, these are not necessarily representative of historic trench disposals.

The data have been used to evaluate [3]:

- trench by trench inventories for all safety-relevant radionuclides;
- trench by trench inventories of material types by volumes;
- detailed maps of radionuclide concentrations for specific radionuclides;
- detailed maps for the volume distributions of key materials including asbestos, lead, soil, rubble, cellulosics, wood, stainless steel and ferrous metals.

## 1.2 An overview of the current study

The study reported here describes part of the review of past disposals which were made to the trenches on the LLWR site. Anecdotal evidence suggested that there may have been disposals to the trenches from Sellafield that were not recorded and that might significantly affect the estimates of the environmental impact of the Repository. The LLWR therefore undertook a series of RECALL

interviews with current or retired staff from Sellafield and/or the LLWR who had operational and other relevant experience. This was done with the intention of eliciting information on past disposal practices and hence determining any significant impacts on the assumed inventory of wastes in the trenches. An initial analysis of the information gathered from the interviews is presented here.

The work reported here was undertaken, in part, in response to stakeholder concerns expressed about the extent of knowledge about past disposals. The approach adopted in this study is to focus on those radionuclides that are potentially significant contributors to the radiological risk via one or more of the potential exposure pathways. These key radionuclides (C-14, Cl-36, Tc-99, I-129, Th-232, Ra-226, U-234 and U-238, Pu-239, Pu-240, Pu-241 and Am-241) are expected to have a significant effect upon the ESC on the basis of analyses undertaken for the Requirement 2 submission to the Environment Agency in 2008 [4, 5, 6].

The contents of the report are as follows:

- Section 2 presents a summary of the history of the LLWR site, with emphasis on the timing of the operation of each trench and associated standards for accepting waste for trenches disposal over time. This summary helps sets the context for the interviews with the former members of staff;
- A summary of the RECALL interviews is given in Section 3, based on a review of the video recordings of the interviews (provided by LLWR) reported in Appendix 1;
- The comprehensive tabular listing of all issues raised in the interviews and a preliminary evaluation to rank them in terms of potential impact on the disposal inventory for past disposals to the LLWR trenches is provided in Section 4. The supporting text groups issues by theme and discusses them further;
- Recommendations for appropriate follow-up work for each issue are then presented in Section 5. The aim of the suggested work is to develop a documented response to each issue to show how it has been addressed and to amend the LLWR inventory if this proves appropriate;
- Some concluding remarks are made in Section 6; and
- Summaries of the information provided in individual interviews are included in Appendix 1.

Further analysis of the issues identified within this report is performed in a follow-up study [7].

# 2 History of the LLWR Site and Major Influences on LLW Consignments.

A 100-hectare site close to the village of Drigg and Sellafield was opened in 1959 for disposal of low-level waste. The LLWR site was run by UKAEA from 1959 until the Authorisation granted under the RSA 1960 was transferred to BNFL in 1971. Currently, the site is owned by the Nuclear Decommissioning Authority (NDA) and is managed under contract by LLW Repository Ltd. Since operations began in 1959, there have been a number of changes to the procedures and protocols for LLW disposal on the site.

From 1959 to 1995, the LLW was systematically 'tumble-tipped' into a series of seven clay-lined trenches in a process similar to that performed on municipal landfill sites. From 1988, the method of LLW storage started to change to that of engineered vault disposal. Small items and compressible LLW are compacted and grouted into drums, which are then placed and grouted in ISO-containers for disposal in a vault. Wherever possible, larger items, such as wood and metal, are decontaminated before being placed in ISO-containers and sent to the LLWR directly for grouting and disposal. The majority of waste was, and still is, consigned from Sellafield and generated in the various buildings within separation area, general site clearance operations and decommissioning activities. However, the site also accepts smaller volumes of waste from other nuclear sites and hospitals, universities and other organisations across the UK.

During the period of tumble-tipping in the trenches, and particularly over the last 30 years, the practices at both waste consignor sites and at the LLWR site have changed considerably. One of the most important elements of this change was the implementation of the 1988 update to the 1960 RSA authorisation introduced by Her Majesty's Inspectorate of Pollution (HMIP) and the Ministry of Agriculture, Fisheries and Food (MAFF). In 1986, the National Radiological Protection Board (NRPB) produced a post-closure safety case, which formed the basis for some of the changes in the 1988 RSA. After this, consignors were required to perform detailed characterisation of their waste-streams to determine the radionuclide fingerprint. Also, for the first time in the history of LLW disposals at the site, the radionuclides and their levels of activity had to be accounted for. Prior to this, the waste had to meet dose limits per $m^3$ but no particular radionuclide limits were specified. During this period, a set of guidelines, known at that time as Conditions for Acceptance (CfA) [1] would be developed which would ensure that the disposals would meet the limits authorised under the RSA 60 authorisation. The concentration of alpha activity in waste disposed at LLWR was limited by the disposal authorisation to 20 mCi $m^{-3}$ averaged over one days tipping. However, the activity concentration was not controlled directly by monitoring of this quantity but rather indirectly by an operational control limit on waste surface contamination levels to $10^{-4}$ μCi $cm^{-2}$. At this time, waste from Sellafield was consigned in skips. If a particular skip of waste did not meet the CfA it would not have been permitted for disposal. In the late 1980's, the Environment Agency introduced waste sampling and began taking waste containers at random to check that the consignment and that the radionuclide fingerprint is as described in the supporting documentation.

Other policy changes that had an affect on the amount of waste consigned to the LLWR include the introduction of waste segregation in the early 1980's and waste minimisation practices encouraged not least by escalating disposal charges. In 2004, Nuclear Industry Code of Practise (NICOP) was brought into practice, which allowed waste to be monitored and, if found to meet a strict set of

[1] The CfA were the equivalent of the current 'Waste Acceptance Criteria' (WAC). LLW Repository Ltd's Waste Acceptance Criteria detail what wastes can be consigned under the Waste Services Contract. Waste Acceptance Criteria are provided for each Waste Service that LLW Repository Ltd offers and there is also an Overview that provides generic conditions, definitions and details of the Waste Management principles that Customers should adopt in managing their lower activity radioactive wastes. As of the 1st January 2011, there are five elements to the Waste Acceptance Criteria: Overview, Metallic Waste, Combustible Waste, Supercompactable Waste and Low Level Waste relating to the available Waste Services. These five WACs can be downloaded from the LLWR website using the following link: http://www.llwrsite.com/customers/waste-acceptance-criteria.

criteria, classed as exempt and sent to a municipal tip. It has been noted by many past employees that the vast majority of waste in the trenches is in fact 'clean', but it was a long-standing policy that any materials that entered separation area were deemed to be LLW (or higher) and were sent to the LLWR as a matter of precaution. However, today waste is screened or decontaminated and any that can be classed as Very Low Level Waste (VLLW) or exempt is disposed of by other routes.

The 1988 revision to the 1960 RSA authorisation led to changes in LLW management across both the Sellafield and LLWR sites, including to the characterisation, documentation, collection and burial of LLW. It was also around this time that computerisation of records were introduced to Sellafield. Computers have since been used to track waste and compare consigned waste fingerprints against the corresponding consignment notes as well as help collate the information as needed. In addition it also meant that there was no need for central technical records office as all information was held locally and operators were responsible for the correct logging of information. The records continue to be maintained electronically by LLWR staff.

The Health Physics (HP) department performed a policing role across the Sellafield site for many years and had a lot of control over sentencing the waste generated by the buildings and around site. Prior to the 1988 RSA authorisation, there were HP monitors assigned to each building, each skip-wagon and the Sellafield site operation teams. They would measure the waste using hand-held monitors and give the all clear for disposal to the LLWR. Once the sacks of waste had been placed in a skip and the skip on a wagon, the waste would go though the Separation Area barrier and be monitored again as the wagon left the Area. It was considered important that the wagon and skip were compliant with the transport regulations, even when the majority of waste was routed via the railway from 1981. Once the skip wagon arrived at the LLWR, the skip would be monitored again, with the monitor contact and 1 m away from the skip (in case vibrations and movements during transport had caused the waste to settle). If a load was monitored and found to contain wastes in excess of the Drigg limits[2], the HP monitor would go to the tip face and monitor each bag individually and return any offending items. All LLWR personnel and machinery were also monitored on a daily basis and it is worth noting that not one of the operators interviewed was aware of an incident of worker or machinery contamination. This level of monitoring continued throughout the operational period of the trenches but was later performed by LLWR staff.

Disposals to the trenches ceased in 1995, by which time Vault 8 was already open and consignment of waste had already begun. Vault 9 is now built, fully commissioned and in operation. Recent advances in monitoring equipment and techniques have suggested that the quantity of radionuclides disposed to the trenches is less than that suggested by the inventory derived using modern fingerprints. In the early days of disposals, HP Monitors would monitor the LLW at source, i.e. outside the building of origin. Later, the radiation levels started to be measured in a lead shielded box to eliminate any background radiation. It was found that the radiation levels inside the shielded box are significantly less than those measured at source, suggesting that much of the activity implied by the measurements in the early days was a gross overestimation of the actual activity of the LLW waste being disposed of in the trenches.

[2] The phrase 'Drigg limits' was commonly used by the interviewees. This was taken to mean the equivalent of the current 'Waste Acceptance Criteria' (WAC), or 'Conditions for Acceptance' (CfA) as they were called, at the relevant time.

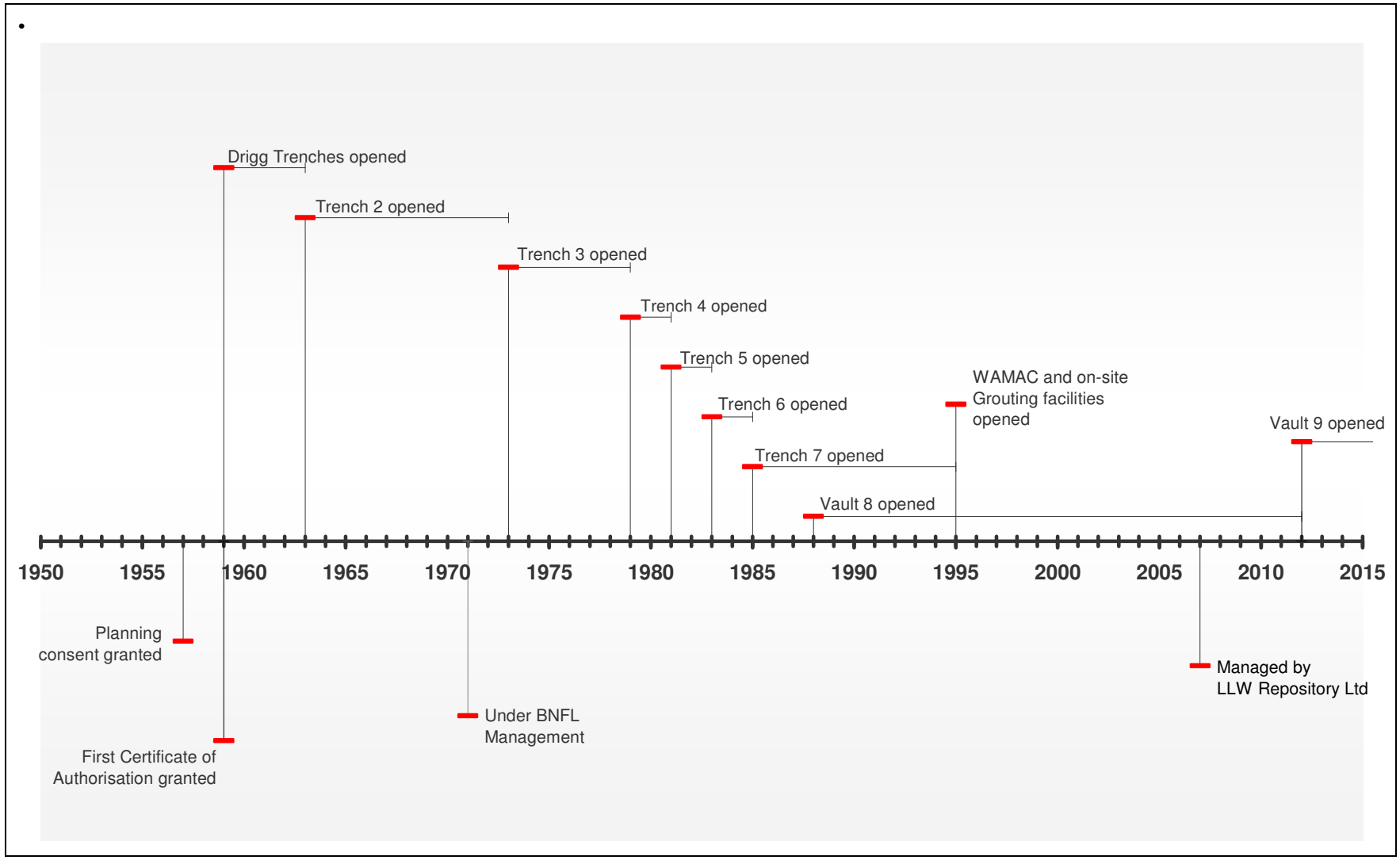


**Figure 1 Timeline showing the key dates in the operating lifetime of LLWR**

# 3 Summary of interviews

Interviews were undertaken with 28 current and former staff at Sellafield and the LLWR. The interviewees were identified in a number of different ways. Advertisements were placed in local newspapers asking for people with relevant experience to come forward. Several interviewees were contacted after having expressed concerns or having offered help at local stakeholder meetings. A number of current staff who it was known had relevant experience were also asked to provide information or be interviewed. Everyone who contacted the LLWR was interviewed unless it was established in telephone conversations that they had no relevant experience.

The interviews were independently arranged and carried out by EBM Strategic Consulting on behalf of the LLWR and recorded on DVD. The LLWR gave the interviewers general guidance on the type of information they wished to acquire, but did not specify questions or particular issues. The interviewers (who did not have a technical background in radioactive waste disposal) clearly sought to establish an open and frank description, from personal experience and memory, of the practices and procedures in consigning and disposing of LLW to the trenches at the LLWR site, referred to at the time as 'Drigg'. Some of the interviewees were interviewed more than once.

The staff interviewed had worked in various roles on the LLWR and Sellafield sites - from Health Physics (HP) monitoring, BNFL building operatives, BNFL site clearance team to operatives on the trenches. The interviewees recounted aspects of their working lives, from the 1950's through to the present day. The interviews are frequently candid and enabled a picture to be built up of various aspects of the BNFL consignor and LLWR site operations and past practices.

Approximately 21 hours of interviews were recorded and these are available on three DVDs. To help focus attention on the issues of direct relevance to the development of the Disposal Inventory for the 2011 ESC, a template was constructed to structure and record the points made, examples of which are used in Appendix 1. The different sections of the template are listed and described below;

- Interviewees' name, date of interview and DVD number and time on the DVD. Each interview was assigned a unique number for ease of referencing within this report;
- Interviewee's background and role at LLWR or elsewhere, including dates. This was important to the timeframe to which comments relate and the interviewees' involvement and perspectives on operations;
- Points of note including the time on DVD so that comments could be readily re-examined;
- Record keeping and QA. This was important to all aspects of developing the disposal inventory. Points of focus were flagged, for example, how did interviewees know? Were interviewees describing normal and routine practice at the time or occasional deviations from the norm?
- Were waste disposals located where the records say they are? This was important for issues of inventory within individual bays within trenches and accuracy and uncertainties;
- Were the waste volumes recorded 'accurate'? This was important regarding total volume inventory and uncertainty;
- Was the activity disposed of what is on the records? Points to note relating to methods and quality of measuring and recording radionuclide content (assay), which was technically difficult for many of the long-lived key radionuclides. This was important for the total radionuclide inventory as well as the inventory of a number of radionuclides particularly important in terms of the environmental impact of the LLWR and for uncertainty and completeness;
- What is the nature of the wasteform? Source term models may take account of the chemical form of the radionuclide and its distribution in the disposed material. For example, surface contamination may be expected to be released more readily than activation products distributed relatively uniformly in bulk activated material such as graphite;

- Were the materials disposed of what is on the records? This was important with respect to aspects of accuracy and uncertainty. Some interviewees drew attention to disposal of non-active items, some of which contained oils, hydraulic fluids and other materials. This was recorded because such materials may influence radionuclide solubility and mobility and may be important for the 2011 ESC.
- Key messages; This was designed to synthesise points for further consideration and to draw links between comments made and 'backed up' by different interviewees;
- Follow up actions/issues/questions. This section was intended to record thoughts on any immediate follow up actions;
- Name(s) of staff completing the template.

All of the completed interview forms have been attached as Appendix 1. The interviewees names have not been included, to maintain their privacy. The forms include some thoughts and inferences drawn by the note makers regarding the points made by the interviewees. These are recorded in italic font to distinguish them from points made directly by the interviewees.

It is important to note that the interview notes in Appendix 1 reflect what was said, and believed to be true, by the interviewees rather than what is necessarily accurate. These interview records do not reflect any further analysis performed since the interviews but are merely a tool to capture the key points.

The interviews presented a number of challenges in the context of developing the numerical data that are needed for the 2011 disposal inventory. For example:

- Recall of the memorable and exceptional one-off incidents or 'unusual' practices or operations, rather than the routine, could give a distorted picture of past disposals;
- Individuals worked in specific areas and roles and did not necessarily know all the details or were not aware of all aspects of operations, monitoring and record keeping;
- The phrase 'Drigg limits' was commonly used by the interviewees. This was taken to mean the equivalent of the current 'Waste Acceptance Criteria' (WAC), or 'Conditions for Acceptance' (CfA) as they were called, in place at the relevant time. It was recognised that a clear timeline of the WAC/CfA would help put into context what would not meet the current WAC, but was at the time of disposal fully in accordance with 'Drigg limits';
- Dates were, not surprisingly, sometimes vague, e.g. during the 'late 1980's';

The anecdotal evidence was informative, but rarely addressed aspects in a quantitative way. Coverage of many of the issues identified in our template for recording issues was often limited. It was difficult to use the interviews to answer the specific quantitative questions set in the template directly. However, the interviews have enabled a wide range of issues of potential significance for the 2011 Disposal Inventory to be identified. These are listed and discussed in the following section.

# 4 Collation and Discussion of Potential Issues

Forty-five key messages and issues were identified during the review of the interviews. These are outlined in Section 4.1. In order to help assess the significance of the individual issues for the inventory work, each issue has been ranked according to its relevance and potential impact on the inventory.

Section 4.2 further groups these issues together based on commonalities, which include: disposal of high activity wastes; methods used to shield the wastes; non-active disposals; and other concerns.

## 4.1 Summary of issues arising from the interviews

Table 1 outlines all of the comments that may have a bearing on the inventory, both indirectly and directly. At this stage it is not clear whether these issues are the result of unrecorded and/or unauthorised disposals or disposals that occurred within the limits defined by the relevant CfA. A preliminary ranking of the issues based on their potential impact on the 2011 disposal inventory has been made. The word 'preliminary' is used to reflect the judgment made on the degree of further work required to address the issue. To prioritise each of the issues raised, they have been given a 'rank' number between one and three. Where appropriate, the Comments field in Table 1 contains notes regarding the ranking of the issues; further detail regarding the issue and/or questions that would need to be addressed to fully understand the implications of an issue on the inventory of past disposals.

- Rank 1 - Potentially important issue that justifies detailed further investigation. These could be related to the key radionuclides listed in Section 1.2, volumes and material composition, volatile organics, and topics that were raised by several interviewees.
- Rank 2 - Following initial analysis it is not clear how much further investigation would be required, such issues may move up or down the ranking following preliminary investigation.
- Rank 3 - Following initial analysis it is believed that these issues may require relatively little further investigation (e.g. because it has already been investigated in prior work and is fully documented and provided for in existing inventory data).

**Table 1 (Over 5 pages) Collation of the potential issues raised by interviewees that could have an impact on the development of the LLWR inventory of past disposals.**

| Issue | Issue Raised | Interview Number(s) | Rank | Comments regarding ranking and/or further details |
|---|---|---|---|---|
| 1 | Erroneous disposal of plutonium contaminated materials (PCM) drums into the trenches. | 1 | 2 | Plutonium is a key radionuclide, but it is unclear if the drums were a recorded disposal. |
| 2 | Disposal of 'Hex' cylinders, into Trenches 3 and 4, which used to contain uranium hexafluoride. | 1, 7, 27 | 1 | Cylinders potentially contain quantities of the key radionuclide uranium. |
| 3 | Disposal of waste into another building's skip without the knowledge of the building consignors. | 1, 2, 7, 11 13, 19 | 1 | The disposal of waste into a building's skip that is not accounted for in the waste fingerprint/consignment note accompanying the skip. |
| 4 | Disposal of waste arisings from clean-up in alpha plants. | 2, 5, 13, 19 | 2 | This waste would include paper towels used to mop spillages, contaminated clothing and gloves that may contain traces of the key radionuclides. |
| 5 | 'Lead sandwiches', 'painter's handbags' and other methods used to provide a level of shielding (double containers for waste laboratory solutions). | 2, 7, 10, 11, 12, 14, 19, 26 | 1 | This has been given a rank of 1 as the waste may contain high levels of β/γ contamination. May include waste from the Chemical Services Department (laboratory waste) or be a short-cut to dispose of ILW. |
| 6 | Disposal of plutonium and americium fused salts and/or plutonium/americium bearing liquids into Trench 2. | 2, 27 | 1 | Plutonium/americium have been classed as key radionuclides. It was noted that the disposal of this waste occurred over a two to three month period and was estimated at 30 2.5L Winchester flasks wrapped in lead. |
| 7 | Disposal of thorium containing ores and sands into the trenches. | 2, 27 | 1 | Thorium is one of the key radionuclides. It was noted that the Th sands were stored on site in the 60's, removed from site, but then later returned for disposal in the 70's. |
| 8 | Disposal of loose sacks from general site clean-up. | 2, 13 | 2 | The Sellafield site operative team collected general waste (sacks, other items) from around Separation Area and sent it to LLWR for disposal. |
| 9 | Disposal of redundant stainless steel tanks into Trench 2. | 2 | 2 | These were stored on the LLWR site, some full of water/contaminated liquor and were found to have α-contamination above Drigg limits. |
| 10 | A significant proportion of the material disposed of in the trenches was 'clean'. Any liquid | 2, 12, 27 | 3 | Any materials that entered separation area were classed as LLW as a matter of precaution, |

| Issue | Issue Raised | Interview Number(s) | Rank | Comments regarding ranking and/or further details |
|---|---|---|---|---|
| | or solid wastes arising in an 'active' area was deemed to be contaminated. | | | regardless of any dose measurements.<br>A second factor could be the low cost of disposal at LLWR until the late1980's. |
| 11 | Disposal of various items of machinery in the trenches; a bus, flatbed truck or trailer, car and a Drott (manufacturer's brand name of caterpillar tractor and low loader type trailer equipment). Disposal of liquids (includes petrol and diesel), oils and greases in the trenches and use of second-hand solvent/oil drums prior to 1972. | 2, 7, 8, 9, 16, 18, 22 | 1 | Points for consideration are whether flammable liquids were accepted under the CfA's and whether these wasteforms were accompanied by a consignment note. |
| 12 | Disposal of excavated materials, in particular soil (Mummery's mound), from the construction and decommissioning of buildings. | 1, 4, 13, 14, 25 | 2 | Large volumes of soil were tipped into the trenches. Each load was tested and designated as LLW prior to disposal at LLWR. |
| 13 | Use of 'averaging' to shield higher-activity wastes. | 4, 7, 8, 11 | 2 | Placing a 'higher' activity sack in the centre of skip and surrounding it by the lower activity wastes.<br>An important part of trying to understand the type of materials and frequency of this practice is to know what options were available for the disposal of ILW. |
| 14 | During excavation of the eastern wall of Vault 8, Trench 3 was disturbed. Two items of waste were exposed and found to be above Drigg limits. | 4, 5 | 1 | Points for consideration include whether there were any 'high' activity readings recorded and, if so, whether an investigation was conducted? |
| 15 | Disposal of plastic gloves to the LLWR trenches. | 10, 26 | 2 | Of the 'soft' waste consigned to LLWR, it was estimated that a significant proportion of this could have been unwashed plastic gloves. |
| 16 | Disposal of unirradiated natural uranium from the laboratories. | 10 | 1 | Uranium has been classed as one of the key radionuclides. If this was sent to LLWR then the wasteform and the volume/frequency are important considerations. |
| 17 | Disposal of alpha and beta contaminated source trays in the trenches. | 2, 10 | 1 | The CfA has changed and now these must be decontaminated prior to disposal. The impact of contaminated trays from early disposals may need to be assessed. |

| Issue | Issue Raised | Interview Number(s) | Rank | Comments regarding ranking and/or further details |
|---|---|---|---|---|
| 18 | Changing of floc in LETP was irregular and may have allowed waste solvents to go out to sea. | 5 | 3 | It is not clear whether this floc would have been sent to LLWR. |
| 19 | There were a number of trench fires over the operating life of the trenches. | 5, 9, 18 | 2 | Points for consideration are what could be the possible causes of the fires? Implies an inventory of volatile organics. |
| 20 | The practice of leaving the trenches uncovered overnight meant that waste was being blown about the local area. | 5 | 3 | In the early period of operation, the trenches were left uncovered, but later they were covered with at least 1m of soil everyday. |
| 21 | Removal of tools from LLWR trenches after they had been sent for disposal. | 5, 16 | 3 | There is only anecdotal evidence and no proof that this occurred. |
| 22 | Erroneous disposal of Trimphones (type of phone popular in the 1970's). | 5, 7, 8, 11, 25 | 3 | This incident has been investigated and the radiological consequences analysed. Tritium is not a key radionuclide and has a short-half life. |
| 23 | Storage of PCM waste on the LLWR site. Includes painter's handbags full of glass vials, drums of waste and gloveboxes. | 5, 7, 11, 12, 22 | 3 | PCM waste was stored in the magazines and latterly in a purpose built store, B720. Although PCM wastes contain a key radionuclide, it has not been given a rank of 1 as it has since been removed from the site. |
| 24 | Increasing authorisation limits for Sellafield discharges. | 5 | 3 | For a period, each application for the authorisation required an increase in the discharge limits as the waste generated on Sellafield was in danger of exceeding the previous limits. |
| 25 | Radiation measurements taken at the magazines during the course of retrievals may have been higher than quoted to the Drigg Parish Council. | 5 | 3 | This relates to an element of distrust between some of the Drigg residents/members of the Parish council and the site management (both LLWR and Sellafield). |
| 26 | Approximately 4,500 drums were removed from Trench 7 once WAMAC opened. Having been stored for a number of years, some drums had corroded and leaked. | 9 | 2 | From the remnants of the corroded drums sludges and material that was possibly uranium cake, were visible.<br>It is unclear how much material, or its chemical composition, remained in the bottom of Trench 7. |
| 27 | The skips were locked with padlocks, but some question remains as to when this was introduced, who had access to the keys, whether a single key could open all the padlocks and why padlocks went missing. | 1, 7, 13 | 2 | Understanding how and when the skips were locked may be useful to justify the arguments around Issues 3 and 5, and raise uncertainty in the volumes and radionuclide composition. |

| Issue | Issue Raised | Interview Number(s) | Rank | Comments regarding ranking and/or further details |
|---|---|---|---|---|
| 28 | Identification of useful documents and earlier relevant studies or investigations. | 11, 21, 22, 25, 26 | 2 | May contain information that will support any further investigative work. |
| 29 | Disposal of furnace liners (classed as ILW) in the Sellafield trenches (B291). | 11 | 3 | The disposal of this ILW waste in the Sellafield trenches was sanctioned by management at the time. There is supporting documentation to justify the decision. |
| 30 | Was any 'higher' activity waste generated from incidents such as the Pile 1 fire disposed of in the LLWR trenches? | 11, 13, 17 | 2 | The activity of the resulting wastes was probably too high for LLWR disposal. Such incidents could have an impact on the volume of waste and the inventory of priority radionuclides. |
| 31 | Greenpeace activists broke into LLWR site and took pictures of the trenches and in particular a glovebox in the open Trench 7. | 5, 11 | 3 | An investigation was completed in which the glovebox was found to be within Drigg limits. |
| 32 | A quantity of carbon-14 was disposed in the trenches in error. | 11 | 3 | Although carbon-14 is a key radionuclide, the issue has not been given a rank of 1 as a lengthy investigation was undertaken into this incident and the volumes etc. fully documented. |
| 33 | The question of whether any waste from the Chernobyl incident was imported to the UK and tipped into the trenches was raised. | 11, 13, 16, 24, 25 | 3 | After extensive environmental monitoring, high levels of activity were found across Cumbria/other counties and attributed to be from a passing rain cloud. |
| 34 | Each Sellafield building now generates a waste fingerprint on which the inventory is based. Over time this may change as the plant operations change. | 12, 27 | 1 | The current inventory uses current building operations and associated fingerprints to back-calculate the wastes for the operating period up to 1988. May raise some uncertainty if a fingerprint has changed over the lifetime of the plant. |
| 35 | Site clearance team (involved in site clear-up, see Issue 8) were not always fully appraised of the CfA. | 13, 14 | 2 | If the site clearance team were not fully aware of the conditions in the CfA, it may cause some uncertainty in the inventory. |
| 36 | Disposal of asbestos in the trenches. | 14, 18 | 2 | Asbestos was tipped in the trenches, but required additional paperwork and procedures. May have an impact on the previous chemotoxic inventory if it was unaccounted for. |
| 37 | Disposal of luminous dials such as watches and navigation equipment from the MoD. | 16, 21, 27 | 2 | The disposal of these old instruments, potentially containing the priority radionuclide radium, could have an impact on the |

| Issue | Issue Raised | Interview Number(s) | Rank | Comments regarding ranking and/or further details |
|---|---|---|---|---|
| | | | | inventory if not already accounted for. |
| 38 | Generation and disposal of high activity materials from buildings known to contain a lot of activity i.e. B30. | 19 | 2 | The inventory could be affected if disposals of high activity materials were unrecorded. |
| 39 | Storage of 'Seal' sands in Trench 7 prior to disposal in Vault 8.<br>Little is known about the chemical composition of these sand, at the time of initial analysis.. | 20 | 2 | Stored in Trench 7 for a number of years, consequently the storage drums began to corrode, spilling their contents into the trench. |
| 40 | Leachate from the trenches was regularly monitored and could provide evidence of the introduction of a particular waste-stream. | 7, 21 | 3 | Details of the chemical content of the leachate could support any further investigations. |
| 41 | Recollection of the disposal of a sludge tank that had been shown to have 'high' activity readings. | 21 | 2 | It is not clear what the origin of the tank is, but to give 'high' readings it may have contained key radionuclides. |
| 42 | During the routine monitoring at the skip handling facility at the edge of Separation Area, three bags of bird guano were found to be above Drigg limits and removed from the skip. | 22 | 2 | It is likely that wastes of this nature were not regularly disposed. Incident demonstrates that routine monitoring was effective at identifying items that did not meet CfA. |
| 43 | Disposal of Springfield drums, which may contain uranium residues. | 20, 25, 27 | 1 | Cylinders potentially contain quantities of uranium, one of the key radionuclides. |
| 44 | The sacks of LLW were monitored outside the building of origin and it is unclear whether a background correction was applied. | 21 | 2 | If the data was not background-corrected, this could have led to a significant over-estimation in the inventory. |
| 45 | Disposal of unwashed uranium and plutonium contaminated glass vials from the laboratories. | 5 | 1 | These disposals could contain key radionculides. If these were sent to LLWR the volume/frequency of disposal would affect their potential to impact upon the inventory. |

## 4.2 Grouping of Issues

### 4.2.1 Group 1: Unusual dispatches of materials of potential radiological significance

During the course of the interviews a number of 'one-off' dispatches to the trenches were described. It is possible that some of these waste forms contained high activity levels and included alpha wastes and the key radionuclides listed in Section 1.1. Some of these dispatches included materials that could have a significant impact on the inventory, such as plutonium-americium fused salts from the laboratories, source trays, MoD navigation equipment and luminescent watch dials containing radium, drums from Springfields, contaminated stainless steel tanks and thorium sands.

Some of these items, such as the source trays, are now only accepted for LLW disposal if they have been decontaminated. This change of practice indicates that their presence in the trenches could have an impact on the inventory if not already accounted for.

Further investigation may be able to determine whether these 'one-off' dispatches have been accounted for in the current inventory or if not, assessment of their impact on volumes, chemical composition and uncertainty should be carried out.

### 4.2.2 Group 2: Disposal of materials of non-radiological significance

It was noted by a number of the interviewees that organic and flammable liquids such as diesel and hydraulic fluids were often disposed of in the trenches from Sellafield, certainly up until early 1972, when no secondhand oil drums were permitted for reuse for disposal of LLW, but also possibly in later years. The organic materials had two different origins:

- Large items of redundant machinery, from both LLWR and Sellafield were driven or placed in the bottom of the trenches, very possibly without draining hydraulic circuits and other organics.
- Residual (non-active) contamination of previously used 200 litre type oil drums (which were used prior to 1972) for disposal of some LLW.

Under the current CfA it is not permissible to dispose of free liquids and oil; the latter because of their potential to enhance radionuclide mobility in groundwater. The question therefore arises as to whether the disposals were documented and, in the cases or items of machinery, whether their location within a trench was noted on the records.

### 4.2.3 Group 3: Disposal of materials of very low/negligible activity

It was stated by several interviewees that the vast majority of the wastes going into the trenches were 'clean' and showed no traces of activity. The cost of disposal in the trenches was cheaper that a municipal site in the early days, so it was found to be a cost-effective route for disposing of uncontaminated wastes.

Some of the non-active waste-streams were collected by the site clearance team from around the Sellafield site. In the 1970s, the Sellafield site housekeeping rules changed (following a visit by Conservative Minister Mr Heseltine) and any loose sacks or general waste around the site including outside the skips were picked up, placed in a truck and taken directly to the trenches at LLWR. It was not until after the 1988 update to the RSA authorisation that the cost of disposals started to go up significantly and consignors began segregation and minimisation of wastes.

A query has been raised as to how waste of non-radiological origin such as the site clearance disposals, or those disposals with activities at the lower limits of detection, were dealt with as the WAC evolved. The method by which such 'clean' wastes were formally recorded; whether, for example, they were accounted for by application of a general LLW fingerprint, could affect whether the inventory has been over-estimated.

### 4.2.4 Group 4: Disposal of material of potentially high radionuclide inventory

After review of the interviews given by people with experience of consigning waste from Sellafield to LLWR, it became apparent that there were a number of methods used to dispose of waste with activities possibly higher than Drigg limits.

- Painters' Handbags
  A tin, just like a paint tin, would contain the problematic waste and be filled with lead shot, concrete or just paper towels, before the lid was sealed with duct tape. This would have reduced external dose measurements by shielding the β/γ radiation so that the wastes could pass the Drigg limits. Empty tins were available from the site stores, and used for disposal of other wastes such as ILW or PCM in the magazines, so it has been suggested that their use for disposals to LLWR may have been authorised, at some level, by the management of the site. It is possible that such disposals are already be accounted for in the inventory but if the disposals were unauthorised then it is possible that such disposals went unrecorded.

- Lead Sandwiches
  This method was not mentioned as frequently as the painters' handbags by the interviewees. The problematic waste was placed inside a lead box, or sandwiched between pieces of lead, to shield the activity when the bag was monitored by HP.

- Undocumented Disposals
  This term is used to describe the disposal of waste into another building's skip without the knowledge of that building's consignors; the term 'fly-tipping' was used in reference to this practice throughout the interviews. Consequently, the waste may not be correctly recorded on any documentation. This could be significant if a building that produced significant quantities of key radionuclides put waste in a skip for a building with a fingerprint of lower 'significance' for the inventory of key radionuclides. A number of the interviewees felt that this could easily have occurred, particularly during the night shift, but that it was unlikely to be common practice.

  Perhaps in recognition of this behaviour, the skips were fitted with padlocks and the keys kept within the respective building supervisor's office. From the interviews, it is unclear when the skips were first locked. The earliest date mentioned was 1974, when new skips were introduced to the site, but staff that joined after this date also referred to periods when the skips were not locked. In 1984, heavy and light-duty skips were introduced to site, which also had lockable lids. It was noted in one interview with a site operative that padlocks regularly went missing and needed replacing. Another interviewee noted that the skip-wagon drivers were wasting a lot of time searching for keys, so new padlocks were introduced that could be opened by the same key. If this were the case, then it calls into question the effectiveness of locking the skips to prevent 'fly-tipping'.

- Averaging
  This method involved the placement of higher-activity waste into the centre of the skip once the other lower activity bags had been cleared for disposal at LLWR by the building's HP monitor. When the skip was monitored by HP prior to transport and disposal at LLWR, the dose rate was measured as a function of the volume of waste in the skip, as defined in the CfA for the 1960 RSA. It was noted by one interviewee that this practice continued well into the early 1990's. Use of shielding was presumably carried out to reduce the external beta/gamma dose rate, which tends to arise from shorter-lived radionuclides such as Sr-90, Cs-134 and Cs-137, in order to present a dose rate within the levels determined by the CfA. This is potentially significant for the inventory as the beta/gamma dose rate can be used to back calculate the activity content of waste via application of the appropriate fingerprint. Thus, if the dose rate is artificially averaged, the back-calculations may misrepresent the levels of activities actually disposed.

It is not clear how often these methods of concealing higher- activity wastes were practised, but there was rigorous checking of the waste by HP before disposal, indicating that any regular disposals of this nature would have most probably been detected.

The following question was raised by a number of interviewees; *'Concealing the waste by the above methods would have been a deliberate act. Why would operatives do so when there were easier ways of disposing ILW waste?'.* Interviewees felt that most personnel were trained and understood the CfA and it would not have been in their interests to dispose of higher-activity wastes in this way. If a HP monitor found the offending item there would be a full investigation, as it could be indicative of a contamination trail and prove embarrassing for those concerned.

Two reasons for going to these lengths to dispose of problematic waste were, however, suggested by interviewees. The first was that in preparation for a visit by the NII or Health and Safety Executive, any 'problem' wastes would be hastily removed from a laboratory, and the easiest method was considered to be to consign them to LLWR. As an example of the different organisational culture in earlier years, one former site-operative noted that on some occasions a supervisor had instructed that the higher-activity wastes be deliberately concealed and placed in the centre of a skip after the sack had been checked, and rejected, by the HP monitor.

A second reason could be that there was some difficulty in consigning waste to the ILW stores. It was noted by one interviewee that, although there was a defined route for the higher-activity wastes, these were more difficult as the waste containers were in short supply and, in addition, there was more accompanying paper work. LLWR was often viewed as an unlimited resource to which waste disposal was easier.

### 4.2.5 Group 5: Identification of potentially inappropriate disposals

During the interviews there was recollection by a HP monitor of two publicised incidences where an alarm had been raised as to whether some items in the trenches were disposed of in breach of the CfA. The first example occurred in 1994/5, during the filming of a fly-on-the wall documentary, which saw the unearthing of a plastic container, similar to those used in the alpha-handling laboratories, from one of the trenches during the re-profiling of the cap. The second incident occurred when Greenpeace broke into the LLWR site and took pictures of waste while Trench 7 was still in operation. These pictures showed that a glovebox, similar to those used for high-activity work in the laboratories, had been tipped into the trench.

There are two well-documented and researched instances in which disposed waste was found to have breached Drigg limits. The most widely mentioned example amongst the interviewees was the disposal of Trimphones from Harwell, the dials of which were a source of tritium. The disposal breached the CfA due to an error whereby the activity of the dials had been incorrectly identified on the consignment note sent by the consignor. The second incident noted in the interviews was the incorrect disposal of C-14 into the trenches in 1999. This error occurred after an external consignor had not realised that their waste-stream had the potential to contain C-14. Both incidents and the ensuing investigations demonstrate that the management of the site took any failure to comply with the CfA seriously and assessed the radiological and environmental consequences fully.

There were also concerns raised since the Chernobyl accident that some of the Russian 'highly active waste' was sent to LLWR for disposal and that alarms across the site were set-off by this high-level waste. However, all those interviewees that referred to the incident stressed that the alarms were set off on the Sellafield site as a rain cloud carrying contamination from Chernobyl moved across Cumbria. Since the radionuclide fingerprint of the Chernobyl wastes was similar to that which could be produced by an accident at Sellafield, a full and thorough investigation was launched. However, the increased activity levels monitored across Sellafield site, Cumbria and other parts of the UK demonstrated that the contamination was indeed from Chernobyl.

During the excavation work to build the eastern wall of Vault 8, the adjacent trench (Trench 3) was disturbed. It was noted during the course of an interview that whilst most of the waste unearthed was LLW, there were two 'unknown' items which were found to have high activity readings above the Drigg limits.

### 4.2.6 Group 6: Quality of measurement

Although few interviewees discussed the monitoring equipment and procedures that underpin the radiation measurements explicitly, there have been underlying questions on the quality of the data. These questions have been reinforced by a number of statements regarding the overestimation and associated uncertainties of the current trench inventory.

In the early years, the sacks of waste would be monitored at source, i.e. outside the building of origin. However, today the radiation levels are measured in a lead-shielded box, to eliminate any background radiation. This difference in monitoring practices has shown that the radiation levels of the waste monitored inside the shielded box are significantly less than those measured at source. At this stage, it is not clear whether any background corrections were applied, but if not this could indicate that much of the activity implied by the dose measured in the early years was, in fact, a gross overestimation of the activity of the LLW waste disposed.

After the 1988 update to the Authorisation, there were significant changes to the procedures for LLW disposal on Sellafield site. The Authorisation required an inventory of the radionuclides, their origin and the weight of the disposal to be recorded To fulfil this requirement, each building or plant was sub-divided into areas that would generate waste with a unique radionuclide fingerprint. The monitor now weighs and takes the average radiation level of each disposal, and uses the documented fingerprint to estimate the radionuclide content. However, concerns have been raised that the operational use of certain Sellafield buildings could have changed over time, but the current inventory assumes the same fingerprint (last 20 years) over the lifetime of a plant. For example, the function of B204 was changed when the building was refurbished, but B30 pond has not changed much as little work has been done on it.

# 5 Methodology for Assessing Issues

As part of the work already undertaken, a preliminary classification of the issues has been generated, based upon their potential to have a significant impact on the inventory for the 2011 ESC. Classifications have been performed in respect of factors such as uncertainty, record keeping and QA, impact on volume and location of disposals, activity disposed (with emphasis the key radionuclides identified in past post-closure safety studies), waste form and presence of other non-active materials which may affect safety. In the next stage of work, it is proposed that, for each of the issues raised in Table 1:

- The preliminary view of the potential significance of individual issues should be confirmed through a scoping assessment;
- Where this scoping assessment confirms that the issue is significant ,a more detailed quantitative assessment should be undertaken and, if appropriate, updates proposed to the existing inventory;
- A transparent and auditable record of the entire process should be produced.

In devising a proposed detailed methodology for carrying forward this work, it is useful to note that the issues outlined in Table 1 fall under a number of broad headings (Section 4.2) and that, in detail, no single methodology is appropriate for all. Therefore, a range of approaches is proposed to evaluate the significance of the issues, and if appropriate, determine the necessary changes to the inventory:

1) ***Contact with interviewees and employees:*** for a few issues, clarification of the interviewee's previous comments would be beneficial in determining their significance. Discussions could also potentially be held with appropriate members of LLWR staff in order to elucidate issues and identify appropriate sources of information.
2) ***Archive and database searches:*** this would involve the identification and review of archived documents to elucidate several of the issues.
3) ***Review previous assessments:*** this would be relevant to understand the issues where previous studies have been performed. An independent evaluation (in light of any new information where available) would then be performed where this is thought feasible and potentially beneficial.
4) ***Scoping calculations:*** certain issues could be examined by performing a series of scoping calculations to determine the potential impact on the inventory.

Figures 2 and 3 outline proposed methodologies to Groups 1 to 4 and to Group 5, respectively, incorporating the approaches outlined above. Group 6, quality of measurement, is not considered here in detail as it will be evaluated for key waste-streams as part of other work undertaken to prepare the 2011 ESC.

## 5.1 Approach to assessing issues in Groups 1-4

As shown in Figure 2, the process begins with assessing whether the information available from the interviews forms an adequate basis for the scoping calculation. If this is not the case, the issue will be discussed further with appropriate individuals, either the original interviewee of an appropriate member of current LLWR staff. The focus here is less upon the elicitation of quantitative data than on clarification of those details that will allow us to make the reasonable, but cautious, quantitative assumptions that will form the basis of any scoping calculations. Following further discussion, any appropriate records relating to the disposal will be sought and reviewed.

### 5.1.1 Materials/Issues already identified in the inventory

The first step is to determine whether the materials in question are already identified in the inventory. Where this is the case, the original assessment will be reviewed in order to establish whether the quantitative data the inventory contains are credible. If this is the case, no further action is necessary, and the outcome of the assessment will be recorded.

In those cases where the review of the original assessment suggests that the inventory information may be flawed, perhaps in light of new information/evidence, then a more detailed assessment would be undertaken. This may involve some or all of the following activities:

- Further focussed interactions with individuals;
- Discussions with consigners;
- Further investigation of records held by LLWR and elsewhere:
- More detailed assessments of the input data to the scoping calculations to remove any inappropriate conservatisms;
- The use of more detailed calculation routes.

On the basis of the more detailed assessment, if appropriate, modified values for incorporation in the inventory will be proposed.

### 5.1.2 Materials not already identified in the inventory

If it is determined that a particular disposal has not been identified in the inventory then a scoping calculation would be performed which would be aimed at determining the likely significance of the disposal. Where the inventory of a key radionuclide falls below an agreed threshold, it is proposed that the scoping calculation be used to determine whether an update to the inventory is necessary. Where the inventory of a key radionuclide falls above the threshold, we will undertake a more detailed assessment along the lines described above to derive proposed updates.

### 5.1.3 Setting the threshold for more detailed assessments

Setting a threshold for quantitative assessments beyond the scoping level is inevitably a matter of balance. Too high a threshold and potentially significant effects may be missed. Too low a value and effort will be expended on matters of no significance to the 2011 ESC. There are a number of factors to consider when making the decision:

- Does the scoping calculation suggest a change to the inventory which is likely to affect assessments in the ESC in a material way, bearing in mind the uncertainties?
- Is the value generated by a detailed assessment likely to differ materially from that generated from the scoping assessment?
- Does the quality of the data actually or potentially available justify more elaborate calculations?

These judgements are inevitably case-specific, and must be made on an issue-by-issue basis. The following guidelines provide a starting point for decision-making:

- For waste-streams already in the inventory of the trenches, does the scoping assessment suggest a change in the assessed content of any key radionuclide, in either direction, in excess of 5% of the total inventory of that radionuclide in the trenches? This value is chosen to ensure that the changes, when predicted using conservative assumptions, are likely to:
    - Be significant in the light of the uncertainties in the characterisation of the waste-stream;
    - Generate a material difference to performance assessments.

- For waste-streams not already in the inventory, a key radionuclide content in excess of 1% of the total inventory of that radionuclide in the trenches. The threshold here is relatively small in terms of the assessments, but is chosen to reflect the definition of a key waste-stream from the forward inventory.
- Detailed assessments should not be undertaken unless the data and methods available for the calculation will yield a more robust result than the scoping value.

The use of 5% and 1% thresholds, for assessing the significance of the activities of waste-streams already included in or omitted from, respectively, the current inventory was selected as it is consistent with the approach used for the forward inventory [8].

It should be noted, however, that whilst this method of determining whether a disposal should be incorporated into the inventory is justifiable in terms of inventory uncertainties, any changes to the inventory on this scale are unlikely to affect the fundamental conclusions of the 2011 Environmental Safety Case.

### 5.1.4 Update and Implementation of changes to Inventory

If after investigation, it is recommended that additional data are required or existing data need to be revised, then this will be documented. Only after LLWR have reviewed and accepted the findings will the inventory be modified as outlined in the final stage of Figures 2 and 3, 'Implementation Decision'. The reasons for the updating or not updating the inventory will be fully recorded.

## 5.2 Approach to assessing issues in Group 5

The assessment of Group 5 issues differs a little in approach from that proposed for Groups 1 to 4, see Figure 3. We believe that many, if not most, of the 'accidental' disposals will already have been the subject of a full investigation and assessment by regulators and others. If this is the case, there is no point in repeating work already undertaken, and it is proposed simply to record the main findings of the existing investigations. Should no investigation have been undertaken, the significance of the disposal will be assessed using the same methodology proposed for Groups 1 to 4.

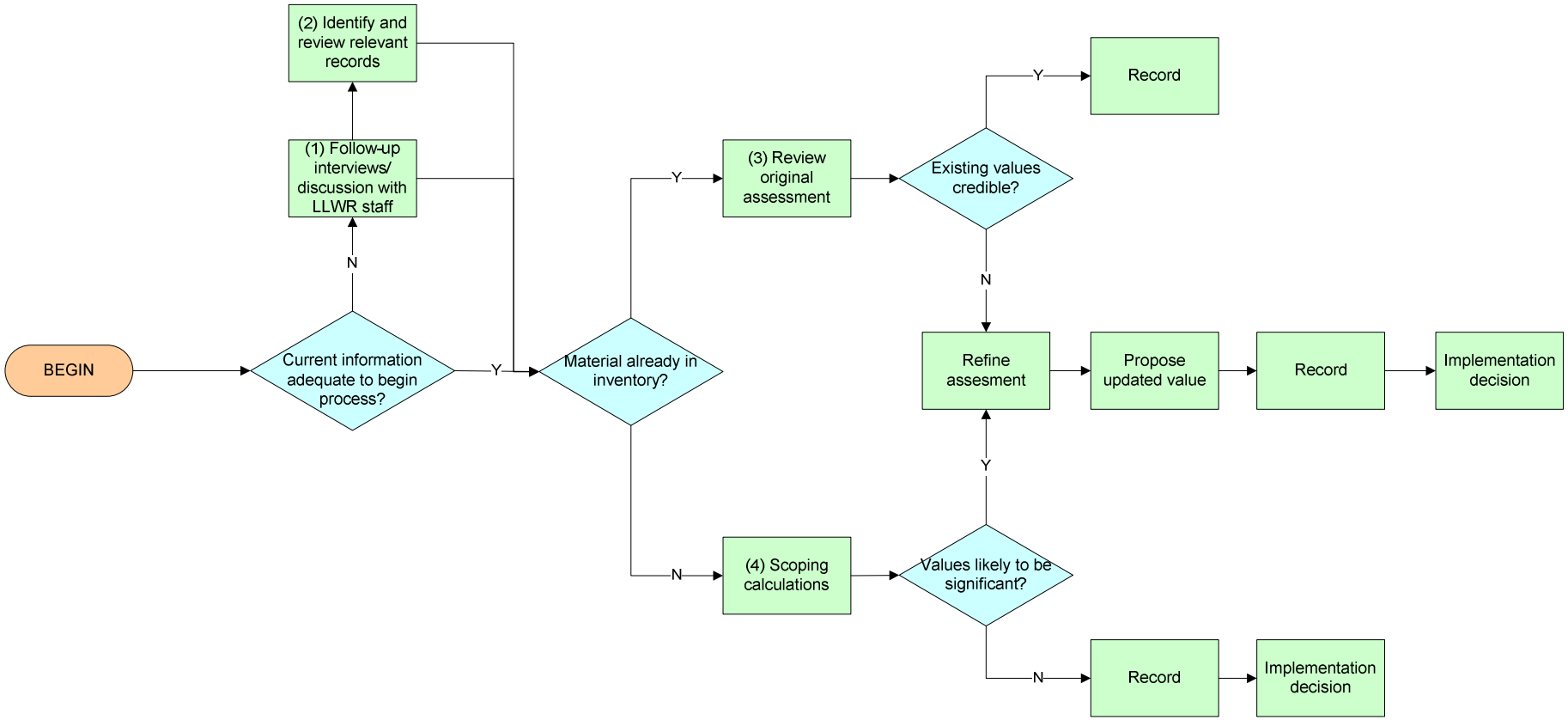


**Figure 2** **Flowchart outlining a proposed method to investigate the issues raised for Groups 1 to 4 (except those previously investigated and documented as part of past inventory work)**

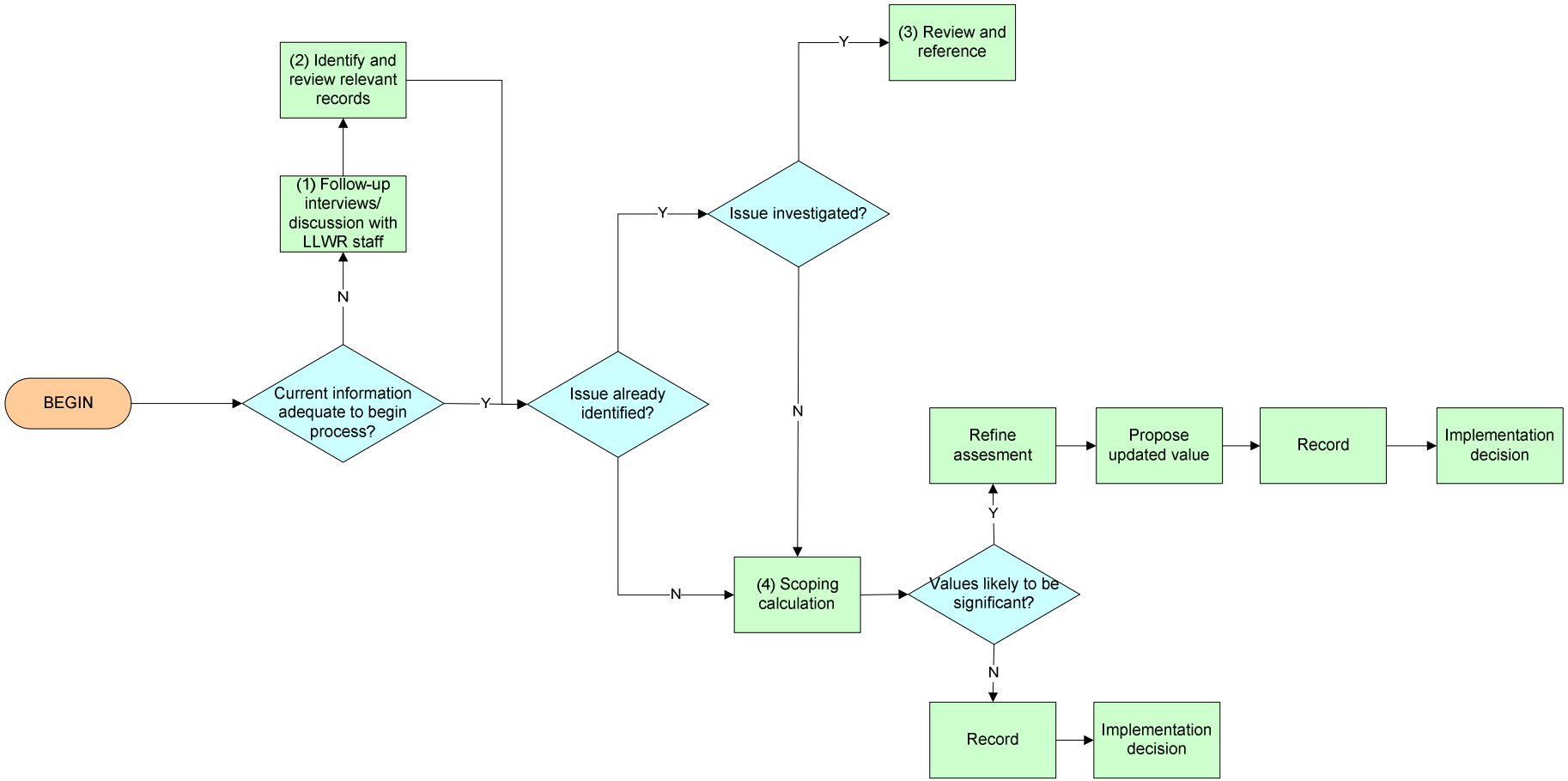


**Figure 3** **Flowchart outlining a proposed method to investigate the issues raised for Group 5 (except those previously investigated and documented as part of past inventory work)**

# 6 Conclusions

The study reported here describes part of the review of past disposals that were made to the trenches on the LLWR site. The LLWR undertook a series of interviews with current or retired staff from Sellafield and/or the LLWR that had operational and other relevant experience. This was done with the intention of eliciting information on past disposal practices and hence determining any significant impacts on the assumed inventory of wastes in the trenches.

Twenty-eight interviews were analysed and 45 issues of potential significance for the LLWR disposal inventory have been listed. Some issues were raised by more than one interviewee. The interviews are informative, but rarely address issues in a quantitative way.

Judgements have been made to develop a preliminary ranking of the issues in terms of their potential impact on the disposal inventory in respect of factors such as uncertainty, record keeping and QA, impact on volume and location of disposals, activity disposed (with emphasis the key radionuclides identified in past environmental safety studies), wasteform and presence of other non-active materials that may affect safety.

The issues raised have been grouped into a number of broad themes to facilitate evaluation and proposals for further analysis of each issue are outlined.

# Acknowledgements

The LLWR wishes to thank all the individuals who gave their time to provide information on past disposals at the Repository. The LLWR also wishes to thank EBM Consulting, in particular Katharine Harborne, for performing the interviews and providing helpful review of this document.

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# Appendices

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# Appendix I
# Summary of Interviews

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# Interviewee 1

| | | |
|---|---|---|
| **Interview number: 1** | **Interview with:** Interviewee 1 (I-1) | **Recorded on:** 4th March 2008 |
| **DVD number:** 1st Interviews, Disc 2 | **Interview duration:** 28 minutes | |

**Interviewee's role at LLWR or elsewhere, including dates**
From the mid-1980s, I-1 provided technical support by writing procedures, safety cases and risk assessments and was involved with operations on the LLWR site. During this period, staff were based at the Repository for two days a week and at Sellafield for the rest of the time.

**Points of note**
- Most personnel worked at both the Sellafield and LLWR sites. *Consequently, the same personnel were responsible for consigning the waste at Sellafield and for the disposal of these skips at LLWR.*
- All disposal procedures were a matter of routine, as all items required disposal authorisation to reflect the type of waste and its activity. Therefore, the waste was cleared for disposal in advance of being sent to LLWR.
- Very few incidents of particular wastes were mentioned as most of the disposed waste was rubble and soil from the construction and decommissioning work being carried out on the Sellafield site. The only items mentioned specifically were a number of PCM drums that were included by mistake (no disposal location given) and some Hex cylinders that were disposed of in Trench 3.

**Record keeping/QA**
It was stressed that many of the procedures followed were very routine, since the waste had been approved for disposal in advance. From the early 1980s through to the early 1990s, the protocols and procedures were improved so that by the late 1980s a full audit trail was kept. This audit trail began with the completion of 'skip log sheets'. These log sheets detailed which building had generated the waste, the date and an itemised list of the waste intended for disposal. The skips were locked when not in use and were transported to LLWR for disposal along with a consignment note. The position of disposal within a trench was noted on the consignment note by the LLWR operators.

After the paper system was supplemented by an electronic database system in the late 1980s, any waste that did not tally on the system was rejected. Paper consignment notes continued to be used.

**Are waste disposals located where the records say they are?**
It was a matter of routine to complete the consignment notes, stating in which grid the waste was disposed.

**Are accurate waste volumes recorded?**
It was noted that at peak approximately 100,000 $m^3$ of waste was tipped into the trenches in a year, which reduced to 10,000 $m^3$ per year once waste minimisation was introduced.

**Is the activity disposed of what is on the records?**
It was only in the late 1980s to early 1990s that waste sampling was introduced to confirm that the details of the consignment note were correct. It was noted that a number of skips were rejected.

**Form of radionuclides?**
No information given.

**Are the materials disposed of what is on the records?**
Before the skips were locked, it was not uncommon that once a skip assigned to a particular building was full, other waste from that building was sometimes dumped in a skip assigned to another building.

**Key messages**
The process of receiving the skips and tipping into the trenches was regarded as very routine.

**Notes made by:** Victoria Smith and Graham Hickford.

# Interviewee 2 (2 sessions)

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| **Interview number: 2&3** (recorded in 2 sessions) | **Interview with:** Interviewee 2 (I-2) See also interview 17, Appendix 1 | **Recorded on:** 4th November 2008 |
| **DVD number:** 1st Interviews, Disc 2 | **Interview durations:** 52 and 40 minutes | |

**Interviewee's role at LLWR or elsewhere, including dates**

I-2 began working on the Sellafield site in the early 1950s in Research and Development and worked in buildings B13, B55 and B229. Later, I-2 was involved in implementing the new site waste management scheme. I-2 went to LLWR in the early 1970s when Trench 1 was about one third full and left as Trench 4 was being dug.

**Points of note**

There were a number of methods used to conceal higher-activity wastes so that the levels of activity on the outside of the sacks and skips were within acceptable limits for disposal at LLWR. Some of these generalised methods are outlined below, followed by some specific examples.

- Spillages of active material in alpha plants would be cleared up with swabs which, if monitored outside the skip sacks would show α contamination levels in excess of the Drigg limits. However, the swabs would be placed inside PVC bags prior to placement in the skip sacks. This would also prevent any of the wet material on the swabs soaking through the paper skip sacks and raising the activity external levels.
- Other active wastes would be boxed in lead so that dose rate and or specific activity levels were reduced to Drigg limits. One such incident was described.
- Material that should not have gone into the LLWR was removed from the record keeping and QA procedures by placing it into skips allocated to other buildings
- One method for reducing surface contaminants was known as 'Painters handbag'. This consisted of filling old paint tins with waste and enough lead shot to keep the overall activity below Drigg limits. I-2 indicated that throughout the 1960s and 1970s, a number of 5 mg glass sample vials containing various wastes (α, β or γ) generated in the Chemical Services Department (CSD), were disposed of in this way in Trenches 1 & 2.
- The disposal of fused salts into Trench 2 was described. Around 30 2.5 L Winchester flasks, containing Pu/Am fused salts and Pu/Am bearing liquids (such as Pu nitrate) from Pu/Am recovery operations, were wrapped in lead and tipped into Trench 2 over a two to three month period. I-2 highlighted that, in their opinion, these were perhaps the most hazardous wasteform disposed in the trenches as they would contain a high alpha content.
- The disposal of thorium sands from a Widnes factory into Trench 2 was described. The thorium sands (or Th bearing material) was stored in drums and included rubble dug up from roads around the Widnes factory, where thorium sands had been spilt by lorries entering or leaving the factory.
- In the 1970s, the Sellafield site housekeeping rules changed (in relation to a visit by Conservative Minister Mr Heseltine) so that any loose sacks around the site, including any outside the skips, were picked up, placed in a truck and taken directly to the trenches at LLWR.
- There was a fenced compound on LLWR site, which housed about 12 to 15 redundant stainless steel tanks of 8,000-10,000L capacity. Swabs taken from the inside of the tanks revealed that they had an α contamination above the Drigg limits. Some tanks did not have lids and were full of α contaminated water or liquor, again above the Drigg limits. On returning from leave, I-2 noted that these tanks had been removed and most probably tipped into Trench 2.
- I-2 also noted that in the 1970s, levels of α contamination in the waste water were monitored.

**Record keeping/QA**

There was little mention of record keeping and QA procedures.
The site operatives were forbidden to check any waste or open any drums due to the potential radiological consequences to themselves, the surrounding environment and the public. This meant that they had to accept the waste on the basis of the accompanying consignors note and any readings of hand-held monitors.

**Are waste disposals located where the records say they are?**
I-2 indicated that some drums bounced forward from where they were tipped. i.e. they will not be in the bay to which they were logged.

**Are accurate waste volumes recorded?**
No information given.

**Is the activity disposed of what is on the records?**
The opinion of I-2 was that most trenches have a 60:40 or 65:35 ratio of clean to contaminated waste.

**Form of radionuclides?**
No information given.

**Are the materials disposed of what is on the records?**
It was noted that a number of drums were disposed of that had contained petrol, diesel, oil, hydraulic fluids and other flammable liquids. This was done as a matter of routine for some years until early 1972, when second-hand drums were no longer permitted in LLWR.
Other 'clean' items were tipped into the trenches, e.g. a bus and flat-bed from Sellafield. These did not have any paperwork.

**Key messages**
A number of ways of concealing higher-activity waste were practised by some consignors.

**Notes made by:** Victoria Smith and Graham Hickford.

# Interviewee 3

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| **Interview number: 4** | **Interview with:** Interviewee 3 (I-3) | **Recorded on:** 6th November 2008 |
| **DVD number:** 1st Interviews, Disc 2 | **Interview duration:** 20 minutes | |

**Interviewee's role at LLWR or elsewhere, including dates**
I-3 worked for the site construction team for BNFL at Sellafield from 1980 to 1999, checking that construction work was completed according to plan. All construction work was performed by contractors. Most of this work was in the active area of the Sellafield site. I-3 left BNFL in 2006 and has since carried out some consultancy work for the LLWR.

**Points of note**

- Before any excavation work began on Sellafield site, boreholes were drilled so that soil samples could be taken for testing. The results of the testing would then determine whether the soil waste was classed as VLLW or trace active and sent for disposal on the Sellafield site (at South tip or Calder tip) or assigned as LLW and sent to the LLWR.
- Typical excavated materials included alluvium materials (from the proximity of the River Calder), hard sandstone and any building waste from previous projects such as concrete, brickwork and steel.
- If assigned as LLW, the excavated materials would be loaded into wagons and covered before being transported by road to the LLWR. Sometimes the waste would be transported to the LLWR by train.
- On the few occasions that I-3 witnessed the tumble tipping, they saw only excavated materials and ordinary waste such as paper or paper towels, and nothing untoward.
- It was noted that the activity of the waste for disposal at the LLWR was measured as activity per unit volume. It was accepted that activity could be diluted by the addition of 'clean' or VLLW material, so that the average activity across the volume of waste was within authorised limits. This would have been mixed at the point of waste collection or generation.
- I-3 was involved with the construction of Vault 8. It was noted whilst the eastern wall (adjacent to Trench 3) was being constructed that the contents of the trench were disturbed. Nothing was done to address this *(as it caused no problems)* and the waste in Trench 3 is now against the concrete wall of vault 8.

**Record keeping/QA**
No specific information was given other than that there was a great deal of paperwork.

**Are waste disposals located where the records say they are?**
No information given.

**Are accurate waste volumes recorded?**
No information given.

**Is the activity disposed of what is on the records?**
No information given.

**Form of radionuclides?**
No information given.

**Are the materials disposed of what is on the records?**
No information given.

**Key messages**
Another method for reducing the average activity of the waste for disposal has been identified, which is the so-called ‘averaging’ of higher activity items by burying them in the middle of a skip of ’clean’ or very lightly contaminated waste.

**Notes made by:** Victoria Smith

# Interviewee 4 (2 sessions)

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|---|---|---|
| **Interview number: 5&6** (recorded in 2 sessions) | **Interview with:** Interviewee 4 (I-4) | **Recorded on:** 5th November 2008 |
| **DVD number:** 1st Interviews, Disc 2 | **Interview durations:** 39 and 58 minutes | |

**Interviewee's role at LLWR or elsewhere, including dates**

I-4 joined the scientific civil service in the late 1940s and was assigned to the atomic energy project. Initially, I-4 worked in the laboratories at Springfields, then in the Windscale laboratories in the early 1950s. Here their role was to sample U and Pu to determine purity levels at the different stages of extraction and enrichment. In the late 1950s, I-4 became a training officer in the correct handling of radioactive materials.

**Points of Note**

**Session 1:**

- I-4 was not told where the waste solvents, aqueous solutions, solids or general waste from the laboratories were sent as this was controlled by the site management team. They would have two bins in the laboratory for general waste, one for contaminated items (i.e. gloves) and the other for 'clean' waste.
- However, I-4 later found out that the floc (ferrous hydroxide) in the effluent treatment plant was not regularly changed, so that it would not be as efficient, which meant that waste solvents were allowed to be released into sea.
- I-4 noticed that the small glass vials used in the micro-analysis of the U and Pu samples were not always washed out prior to disposal in the laboratory bin.
- Again, I-4 does not know what happened to the stainless steel counting trays (an individual tray would be likely to be insignificant, but a collection would probably have fairly high activity readings) or the blotting paper used on workbenches and to mop up spills.
- Up until 1959 LLWR had not been opened so I-4 assumed that the waste was placed in drums and stored on site.

**Session 2:**

- In Drigg Parish Council meetings, concerns were raised as to the risk of fires breaking out in the trenches. A number had already occurred and it was understood that any flammable material should not have been put into the trenches. The council had growing concerns that other materials were being tipped that should not have been.
- The trenches were not being covered over at night so consequently loose materials such as paper and gloves were being blown about. The Council had concerns that the Repository was not being managed properly. In response, the Drigg operatives were instructed to cover the waste at night.
- I-4 noted that by the time Trench 7 was being filled, the site was being managed much better.
- It was widely noted that some items were taken from the trenches, such as tools, irrespective of their level of contamination (there was no police security at that time). There is no 'proof' of these practices.
- Parish council were again concerned after the 'Ministry of Defence' disposed of a number of Trimphones that contained tritium (*This may actually refer to the Harwell bulk disposal of Trimphones through the National Disposal Service, rather than the MoD).* Since levels of tritium continued to be detected in the stream and beach for some time and the half-life of tritium is relatively short, there was anxiety as to why it was still leaching from the trenches.
- In 1976, a report was published by the Government, the 'Flowers' report, which referred to drums of Pu waste being stored on the LLWR site. At that time they were to be moved to Harwell before being dumped in the Atlantic. After campaigning, this disposal route was stopped. Instead, the Pu drum waste was moved to a new store, B720, on the LLWR site.

Planning permission was granted on the basis that the store would be removed after 10 years as LLWR did not *(and still does not)* hold a licence for disposing of such active waste.

- During the construction of Vault 8, it was brought to the attention of the Council that the eastern wall had broken into the nearest trench. Consequently, some of the disposed material, and two items in particular, were dug up and were found to be highly active. Obviously, these items should not have been disposed of in the trenches.
- In 1974, a question of the discharges to the sea and the effect on the fishing industry in the Irish Sea (fish malformation etc.) was raised as the Authorisation limits for the site were being increased on a regular basis. A meeting of Copeland Borough Council, BNFL and various stakeholders was held in which the spokesperson from BNFL assured the attendees that the discharges were low and would be gone in 30 years. However, Pu liquid (which could have been Pu nitrate) had been detected and questions were asked as to the half-life of Pu (which is over 20,000 years). Not only did this matter raise concerns about the practices on the site that led to the release of this waste into the sea, but I-4 also felt that they were deliberately misleading the public by stating scientifically incorrect information to people who would not know any better. This caused a great deal of mistrust and scepticism of the Sellafield site practices and information given to the public.
- Another incidence that led to mistrust was the period when the magazine stores were being emptied. I-4 visited the site and was assured that radiation levels were low and within acceptable limits. However, a radiation counter was operating and a sign fixed to the near-by Portacabin stated that if the radiation level went above a given level then the charge-hand should be notified. This indicated to I-4 that this was not monitoring low-level radiation and that once again they had been misled.

**Record keeping/QA**
No information given.

**Are waste disposals located where the records say they are?**
No information given.

**Are accurate waste volumes recorded ?**
No information given.

**Is the activity disposed of what is on the records?**
Possibly not, based on the example of active waste dug up during the construction of Vault 8.

**Form of radionuclides?**
It was noted that soluble plutonium in the form of plutonium nitrate may have gone into the trenches.

**Are the materials disposed of what is on the records?**
Possibly not, based on the example of active waste dug up during the construction of Vault 8.

**Key messages**
I-4 has been consistently disappointed by the practices followed and misleading explanations given by the management teams on both the Sellafield and LLWR sites. I-4 gave a number of examples illustrating this which were consistent with other interviews *e.g. another interviewee stated that drums with flammable residues were being tipped when they should not have been, supporting the Council's concerns about practices on site.*
This interview could be used to support the case of uncertainties in the records.

**Notes made by:** Victoria Smith

# Interviewee 5

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| **Interview number: 7** | **Interview with:** Interviewee 5 (I-5) | **Recorded on:** 4th November 2008 |
| **DVD number:** 1st Interviews, Disc 2 | **Interview duration:** 49 minutes | |

**Interviewee's role at LLWR or elsewhere, including dates**

In the early 1960s, I-5 began training on the Sellafield site, but later left and worked in private industry. I-5 returned in the mid 1970s and was involved with work in B13. In the late 1970s, I-5 worked in the waste management team. The role was similar to one at LLWR so I-5 would often swap sites to cover holiday or sick leave etc.

**Points of note**

- There were four open-topped trucks loaded by hand or fork-lift trucks. Since the operatives would be in contact with the waste, it was monitored for radiation levels and would not have been over the Drigg limits as this would have posed a risk to the operatives (I-5 was certain about this). Each vehicle that was dispatched had all the necessary inventory paperwork, which was handed to the LLWR personnel on arrival.
- Once at LLWR, the skips on the back of the lorries were monitored again. However, only the external walls would have been monitored, which means that higher-activity wastes could very easily have been shielded inside the skip and would not have been detected. Equally, once tipped, all monitoring was performed from the tip face, and the distance between the monitor and the waste would itself reduce the radiation levels detected.
- I-5 mentioned that they were aware of a number of items that 'could' have been placed in the skips, but was unsure whether they were legally allowed to talk about them.
- In 1984 the railway line was used more to reduce the level of traffic going through Drigg village. The skip handling vehicles never left the Separation Area and were monitored on the 'clean' side of the fence before being sent to the railway head. Any waste going through the Separation Area fence would be classed as LLW, and so, to reduce the amount of LLW produced, Sellafield began to remove packaging on the clean side, so that it could be disposed of as clean waste rather than LLW.
- I-5 estimates that approximately 80 to 90% of the waste consigned to LLWR originated from the Sellafield site, the rest coming from external customers.
- Each building was assigned a 'Blue skip', with a unique padlock and key (approximately 20 plus in total) to ensure that the waste going into each skip was fully accounted for. However, on collection, the lorry drivers were spending a lot of time looking for the keys. To reduce this time, the system was changed so that one key was used for all padlocks. Consequently, people with access to a key could open a skip and dump waste from another building.
- It was noted that on one or two occasions, the radiation levels monitored at the external face of the skips exceeded Drigg limits. At this point, they were returned to the building of origin and it would be up to the building management to deal with. I-5 was not aware of how the 'active' waste within these skips was dealt with.
- I-5 was responsible for digging the end of Trench 4 and Trench 5. The trench would be dug down to the boulder clay, but if this ran out they would add Bentonite clay, which acted as an impermeable layer that allowed the leachate to be monitored and collected in a tank before being released at high tide. I-5 noted that in the earlier days a lot of leachate was produced, but that this reduced as the trenches continued. There was paperwork to record leachate from the trenches.
- There were daily sheets, which recorded the position on the trench grid that a skip was tipped. Tipping would continue from 8am to 3pm and then the trench would have been covered. The trenches were filled North to South and would be compacted as the vehicles came in from the North side to tip the incoming waste.

- I-5 noted that a tracked vehicle accidentally went over the edge of the tip face and was left in the trench as it would have cost too much to remove it and decontaminate it. This would have been approximately half way down Trench 5.
- In I-5's opinion, the cause of the trench fires was the presence of sodium lamps, which would cause a fire if they broke and came into contact with water,.
- I-5 is very doubtful that the LLWR would retain its LLW status if the facility were investigated, and this indicated that there is material in there that should not have been tipped, but was packaged or shielded such that it met LLWR requirements. However, now the containers may have degraded and no longer provide the shielding that they once did. For example, there was a requirement that all tritium waste disposed of should have been in containers that would not corrode over 10 years.
- Hex cylinders came from Capenhurst and were originally stored in the magazines. However, it became apparent that there were so many, approximately 200, that the magazine stores, where it was required to store waste from the Sellafield site, would have been filled up. Consequently, these hex drums, which most probably contained oxide residues, were tipped into the trenches. I-5 recollects that they went into Trench 4, but was not sure when, though before the late 1970s.
- I-5 was also involved in the clear up of the magazine stores in the late 1970s. This was a very difficult job as there was no lighting; water had ingressed and begun to corrode some of the waste drums, which meant that items balanced on top of these needed scaffolding for support. Items for removal included paint tins full of glass vials, and gloveboxes, both from the Chemical Services Department, and drums containing plutonium waste. Some of the drums (45-gallon) had corroded in the water and were placed inside a 90-gallon drum.

**Record keeping/QA**
Consignment notes always went with the trucks to LLWR.
Daily sheets were filled in to show where each skip was tipped.
There were record sheets for the leachate collected from the trenches.

**Are waste disposals located where the records say they are?**
Yes, as each skip that was tipped was marked on the daily 'grid' sheet at LLWR.

**Are accurate waste volumes recorded ?**
No information given.

**Is the activity disposed of what is on the records?**
Not always because in addition to the recorded wastes, I-5 was aware of other 'active' items going into LLWR.

**Form of radionuclides?**
The disposal of tritium drums and oxide residues from Hex cylinders was mentioned.

**Are the materials disposed of what is on the records?**
The records would be inaccurate as I-5 was aware of practices used to conceal higher-activity wastes.

**Key messages**
A number of 'active' wastes have been tipped into the trenches over the years after practices to conceal them on site were followed. Because of that, I-5 feels that the trenches should be left alone as any excavation would pose some serious risks to workers, public and the environment.

**Notes made by:** Victoria Smith

# Interviewee 6

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| **Interview number: 8** | **Interview with:** Interviewee 6 (I-6) | **Recorded on:** 7th November 2008 |
| **DVD number:** 1st Interviews, Disc 2 | **Interview duration:** 31 minutes | |

**Interviewee's role at LLWR or elsewhere, including dates**
In the late 1970s, I-6 joined BNFL in an administrative role. By the early 1980s the job included a public relations role. After a secondment to head office (Risley), I-6 moved to Sellafield in the late 1980s. I-6 left BNFL in the mid 1990s to work at Westlakes Science Park, and retired in the late 1990s.

**Points of note**

- It was from 1977 to the mid-1980's that I-6 had most contact with LLWR. Although I-6 was involved with transport on the site their remit did not cover the transport of LLW waste, but there were close liaisons between their department and the Site Services Transport Department.
- The first time I-6 witnessed the tumble tipping, as a non-scientist, they were shocked and concerned that radioactive material was being treated in this manner. They saw lots of towels, protective clothing, gloves, office equipment such as desks, and larger items such as a rail wagon and a tracked vehicle.
- I-6 recalls a good deal of anecdotal evidence of the systematic use of skips to get rid of waste that was a problem. One of the methods used was 'averaging', which meant that the higher-activity material was placed in the centre of the consignment and shielded by the lower activity material surrounding it, thus meeting the Drigg limits.
- Trimphones (popular in the 1970s) were sent for disposal in the trenches, but the dials included tritium. Tritium levels were detected at the beach, indicating that there was a route for the leachate from the trenches to the beach.
- I-6 has a lot of confidence in the construction and barrier design of Vaults 8 and 9 and has been involved in the planning process.

**Record keeping/QA**
No information given.

**Are waste disposals located where the records say they are?**
No information given.

**Are accurate waste volumes recorded?**
No information given.

**Is the activity disposed of what is on the records?**
Not always because in addition to the recorded wastes, I-6 was aware of other methods of disposing of more 'active' items, such as 'averaging'.

**Form of radionuclides?**
I-6 mentioned the disposal of the tritium dials from Trimphones, but did not have access to such information.

**Are the materials disposed of what is on the records?**
No information given, but I-6 was aware of other methods of disposing of more 'active' items such as 'averaging' suggesting that the records are not accurate.

**Key messages**
There was a lot of local concern about the tumble tipping operations at LLWR and concerns about which materials were being disposed of.

I-6 felt that the last period of management by BNFL and the current regime appear to have the right attitude towards running the site, but I-6 felt this had not been the case in previous years.

**Notes made by:** Victoria Smith

# Interviewee 7

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| **Interview number: 9** | **Interview with:** Interviewee 7 (I-7) (and Interviewee 8 (I-8) -see Interview No.10) | **Recorded on:** 6th November 2008 |
| **DVD number:** 1st Interviews, Disc 2 | **Interview duration:** 38 minutes | |

**Interviewee's background at LLWR or elsewhere, including dates**
I-7 trained as an engineer and joined BNFL (Springfields) in 1980 as an inspector. I-7 moved to Sellafield in the mid-1980s, taking on an additional technical role within waste management, and remains there today. I-7 had close contact with the operators at LLWR as I-7 wrote operator instructions during the period after Vault 8 came into use (in 1988) but before trench operations ceased (Trench 7 closed in 1995).

**Points of note**
- When I-7 witnessed the tumble tipping, they noted that 'it was not unusual to see carbuoys of liquid, oils and grease tipped. I-7 noted that the procedures were not as strict as they are today and that 'everybody knew what was going on'. In hindsight, I-7 wonders whether they should have said something, but, being fairly new to the industry, did not.
- I-7 also recalled a number of occasions when smoke came from the tip face. This was not always attributable to a fire, but was instead a result of chemical reactions within the disposed waste.
- I-7 was responsible for the removal of 4,500 drums from Trench 7. They had been in the trench for three to four years and were always designated for processing at the WAMAC plant prior to vault disposal. (The WAMAC plant was not yet operational, so they were temporarily stored in the trench). Some of the drums had corroded in the trench and some of the waste was seeping out. I-7 could see sludges and what looked like in their opinion, uranium cake. These corroded drums were over-drummed.

**Record keeping/QA**
When a skip or truck was tipped into the trenches, a matrix of the trench layout was filled in to show the position of the waste. However, I-7 notes that this was inaccurate as there was no control over the waste's exact location once tipped. For example, drums could roll 10 or 15m away from the trench face.

Discussion of the audit trail for Vault 8:
Part of I-7's role today is to monitor the waste-stream characterisation, quality plans and conformance schedules produced by customers to show their compliance with LLWR CfA, as well as occasionally performing audits of the customers' procedures. Typically, an audit will be performed by a two-man team with a technical background. They review the customer's documentation, operating instructions, calibrations, how the waste is consigned, how it has been packaged and contained and how the activity has been assessed. There are three main methods of determining the activity of a waste package; high-resolution gamma spectrometry, low-resolution gamma spectrometry, and dose rate correlation. The latter involves taking 12 measurements around the drum and taking an average of the readings. The measured average activity of the package can then be broken down and contributed to particular radionuclides listed in the fingerprint (the breakdown is by % of each radionuclide).

Measurements by either of the two types of gamma spectrometer are more reliable than the dose rate correlation (which depends on the probe efficiency, its distance from the drum wall and the position of waste within the drum).

If a customer has been found to be in violation of the CfA then LLWR can embargo them. The MoD was embargoed for a couple of years as they had filed an inaccurate fingerprint. On analysis, the

MoD had not been checking for the presence of carbon-14 in their wastes and subsequently some was found to be present. Past wastes and documentation had to be reviewed.

Now that the waste is containerised, there is no visual inspection and the customers must be trusted to ensure that the details in the supplied documentation for that particular waste-stream are correct.

If an inconsistency in the paperwork and package monitoring is found, then a 'Waste Monitoring Receipt Level 1' is raised, assigned a number and investigated by discussion with the consignor. Level 2 monitoring can be performed using a low-resolution gamma spectrometer. On rare occasions, Level 2 monitoring has showed non-compliances and the presence of radioisotopes not listed. In these cases, an investigation was launched, which involved talking to the customer and was usually resolved by agreement on a corrective action. On two occasions the consignment was returned to the customer.

**Are waste disposals located where the records say they are?**
The matrix records are not accurate as some wastes would roll into other grid positions when tipped. However for Vault 8 they are accurate.

**Are accurate waste volumes recorded?**
For the trenches, no information was given. However for Vault 8 they are accurate.

**Is the activity disposed of what is on the records?**
Not for the trenches, but the activity in Vault 8 is correctly recorded.

**Form of radionuclides?**
For the trenches, no information was given. In the case of Vault 8, any radionuclides can be accepted as long as they are within the limits and are listed on the CfA. A D5 form can be filled in by a customer to apply for any variations to the CfA.

**Are the materials disposed of what is on the records?**
Not for the trenches, but for Vault 8 wastes there is a lot more confidence that consignors are complying with the CfA limits and LLWR policy, despite a lack of visual inspection.

**Key messages**
There is growing confidence that LLWR customers are remaining compliant with the CfA and that the supporting documentation is comprehensive, despite that fact that no visual inspection can be made.

Most of the information in this discussion focussed on the current waste management practices for Vault 8. Whilst this demonstrates that 'today's' LLW is dealt with stringently, it offers little information on practices adopted during the operation of the trenches.

**Notes made by:** Victoria Smith and Michelle Dickinson

# Interviewee 8

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| **Interview number: 10** | **Interview with:** Interviewee 8 (I-8) (and Interviewee 7 (I-7) -see Interview No.9) | **Recorded on:** 6th November 2008 |
| **DVD number:** 1st Interviews, Disc 2 | **Interview duration:** 38 minutes | |

**Interviewee's role at LLWR or elsewhere, including dates**
I-8 joined as scientific staff in the B229 laboratories in the early 1970s and worked there until the late 1980s. Today I-8 has a technical role in waste management; monitoring the consignment documentation and performing audits on customers disposing of LLW into Vault 8.

**Points of note**

- In their role in the laboratories, I-8 consigned waste to LLWR and in particular was involved in the weekly disposals of waste laboratory solutions from around the Sellafield site. The waste solutions would arrive in 5-10 ml plastic containers. The solution would be emptied into a container and sucked away using a swan neck. If the plastic containers had 'high' activity they would be put into a glass bottle, which provided some shielding of the beta radiation. All waste that was monitored and shown to be LLW was placed into a brown paper bag and placed into a blue bin. All the contents of the fume hoods would be disposed of in a similar fashion, into the blue bins. Glovebox waste, such as PCM, would be double bagged, the Pu content estimated and labelled with special codes before being placed in a red bin.
- Plastic gloves used in the laboratories would be turned inside out and sent to LLWR regardless of the level of contamination, as they could be contaminated with Cs-137 and Sr-90 which are major fission products, *although not key radionuclides for the ESC.*
- Magnox waste included natural U waste that had not been irradiated and could not go through the reprocessing plant (B205) or into the ponds. On one occasion, in order to dispose of a batch of this waste, the U was dissolved in nitric acid. When this failed due to the fracture of a glass container, the remaining solids were wrapped in polythene, placed in a container and sent to LLWR.
- Thousands of alpha/beta counting source trays would be placed in a cardboard box and placed in the blue bin for LLWR. I-8 indicated that their belief was that singularly, they would be LLW, but that the specific activity compared with weight for that many sources would be in excess of 4 GBq/tonne α or 12 GBq/tonne βγ limits and therefore not LLW. Today, these are only accepted as LLW if they have been conditioned and processed prior to disposal.
- There was no ILW store on site at this time (early 1970s), so some personnel made 'Drigg sandwiches' *(i.e. wrapped the waste in lead)* to shield higher-activity wastes, but I-8 noted that this was not common practice. Sometimes, in order to cut down the radiation from a glass bottle, it would be placed inside a cardboard box. This had little effect on the measured beta radiation, but did stop any alpha radiation *(so would the glass, therefore assume I-8 is referring to external contamination of the bottle)*. In those days, the primary concern was the levels of gamma radiation.

**Record keeping/QA**
Record keeping was excellent for Vault 8, but there was little mention of paperwork being completed during the period that I-8 worked in the laboratories.

**Are waste disposals located where the records say they are?**
No information given.

**Are accurate waste volumes recorded?**
No information given.

**Is the activity disposed of what is on the records?**
Not for the trenches disposals, as methods such as making 'Drigg sandwiches' to shield higher-activity wastes were mentioned.

**Form of radionuclides?**
No information given.

**Are the materials disposed of what is on the records?**
Not for the trenches, as I-8 mentioned a number of ways of packaging the waste to reduce its activity, so that it could be sent to LLWR.

**Key messages**
Some of the practices adopted in the early 1970s would not be permitted by present day standards.

**Notes made by:** Victoria Smith and Michelle Dickinson

# Interviewee 9

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| **Interview number: 11** | **Interview with:** Interviewee 9 (I-9) | **Recorded on:** 4th March 2009 |
| **DVD number:** 2nd, Interviews, Disc 1 | **Interview duration:** 1 hour | |

**Interviewee's role at LLWR or elsewhere, including dates**

I-9 trained as a physicist and joined the Health Physics Department at BNFL Springfields in the late 1970s. I-9 moved to Sellafield in the mid 1980s, again in a health physics role.. In the late 1980s, I-9 went to head office (Risley) and returned to Sellafield in the early 1990s to work in LLW Management. In the late 1990s, I-9 became involved with the management of plutonium contaminated materials. In 2000, LLWR became a separate site. I-9 left BNFL in 2005.

**Points of note**

- In 1986, NRPB delivered a post-closure safety case to BNFL which led to the introduction of a revision of the 1960 Authorisation in 1988, which included the wastes disposed at LLWR. This Authorisation differed to the consignor requirements adopted previously as it was the first time the concept of a radionuclide limit was put into practice. Prior to this Authorisation, the primary concern was the dose limit of the package and that it conformed to 12GBq/t for beta/gamma wastes and 4 GBq/t for alpha wastes.
- The 1988 Authorisation set a different standard for the site and this was reflected in the charge made to consignors. Up to 1986, the cost was £30/$m^3$. However, when the site moved to function on a fully commercial basis, the cost of disposal, future management and regulatory costs meant that the price increased to £660/$m^3$. Contracts were drawn up between LLWR and the consignors, which included detailed QA arrangements and levels of waste etc. These contracts were signed around 1993/4.
- Soon after I-9 joined BNFL in the early 1990s, they were asked to investigate whether the waste disposed in the trenches at LLWR could have had an influence on people's health, since there were higher than average levels of leukaemia in the region. To research this, I-9 researched the records of what was disposed of in the trenches; this included Sellafield records and public records. They did not find much detail of what wastes went into the trenches, but there was lots of detail on the management of waste such as its segregation, and operating instructions on plants for separation and disposal of wastes (dating from the1950s). I-9 produced a report (probably around 1994/5) for the Committee on Medical Aspects of Radiation COMARE to document the findings and all the supporting evidence was filed in the LLW offices in B90. I-9 found the information reassuring in that it detailed procedures that had been laid out for the monitoring and segregation of low-level waste and in that there were defined limits for acceptance (i.e. dose rate measurements, type of drum, accompanying records). I-9 also noted that there was no radiological protective clothing used as this was deemed unnecessary for the activity levels of the waste consigned to LLWR.
- One of the factors that could have caused 'undesirable' waste forms being disposed of in the trenches was a disconnect between the instructions and a decision made to dispose of a particular wasteform with the agreement of management. For example, following a fire in the Dry ILW Silo Store (B41) on the Sellafield site, a decision was made that furnace liners should no longer be sent to B41 but to the trenches on the Sellafield site. It is now accepted that these are the primary source of tritium in the B291 trenches. This shows that there was potential for the LLW criteria to be over-ridden by the management team, but if this was the case, there should be supporting documentation. From 1986 onwards, I-9 is not aware of any such decision.
- So-called 'Painters handbags': I-9 was aware that paint pots were used for the disposal of low-activity sources if it was likely that their radiation levels would breach the Drigg limits. However, taking the sealed container, activity and mass into account, they comply with the Drigg limits. I-9 noted that on some occasions, grout or concrete was used to package the waste inside the tins. This would have been a method by which the rules of LLWR could be met, but has little

applicability to most of the wastestreams, so would not have a significant impact on the inventory. The interviewer noted that some of the paint tins were filled with vials and lead shot. I-9 was not aware of this practice. However, if these were available from stores and used as routinely as has been suggested by others, then it must have been a sanctioned process (i.e. even if not formally noted in procedures it would have been known to laboratory management, laboratory operators, health physics operatives and radiological protection advisers (RPA)). However, I-9 queried why someone would go to those lengths to deliberately provide radiological shielding if the wastes were not within Drigg limits, when there were more accessible routes to dispose of ILW.

- Some unusual wastes from the research laboratories which were stored in glass vials e.g. ones containing Co-60 and Cs, could meet with Drigg limits, but depending on the isotope would require some form of radiological control.
- I-9 recalled that averaging was a feature in the early 1990s, which raised the question of how to determine an acceptable range of activity across a skip or for items within it.
- I-9 described some false alarms that initially looked like an obvious breach, but were in fact proved to be within limits. During some excavation work to re-profile the cap on one of the trenches, one of the vehicles unearthed a plastic bottle in the neighbouring trench. This bottle was like the type used in the laboratories for Pu work and could have been in breach of the Drigg limits. However, after examination it was found to be 'clean'. Another false alarm was raised when someone broke into the site and took pictures of Trench 7, showing a tipped glovebox. Again, this was examined and found to be clean.
- There were only two instances which I-9 could recollect that resulted in a breach of Drigg limits. One of these was the disposal of Trimphones (a source of tritium), the other some carbon-14. Both were tipped as a result of a mistake made by the consignors, who were non-Sellafield. I-19 stated that the incidents are well documented and the impact accepted.

- I-9 discussed of the Chernobyl incident in 1986 and whether any waste would subsequently have been disposed at LLWR. Since the waste would have been coming from abroad it would have required trans-frontier authorisation and a lot of other documentation, but there are no records to indicate any material coming onto site. Soon after the incident, a radioactive rain cloud moved across Cumbria and North Wales. Monitoring points were set up around the Sellafield site. It began to rain heavily across Cumbria, which set off the stack monitors and staff caught in the rain set-off personnel monitors when entering buildings. The effects of the rain on the sheep and Fells are well documented. Any clean up from the deposition in the UK would have gone into LLWR.
- I-9 discussed the LLWR magazine stores: PCM wastes had been stored in the magazines order to recover the plutonium, as and when a reprocessing plant was built, and were therefore deemed as valuable and would not have been tipped into the trenches.
- Fly-tipping of wastes was an issue and so there was a requirement for skip controllers and locking of the skips. There was some evidence of fly-tipping, such as the famous B30 'wellington boot', but generally any waste found by Health Physics was not a concern.

**Record keeping/QA**

I-9's first experience of LLWR was when working for British Steel and their department made a one-off consignment to LLWR in 1977/8. LLWR sent a truck to collect the waste and Health Physics checked all the paperwork and records, opened the drums to check that the waste was bagged up correctly, in agreement with the paperwork, and that activity levels were acceptable. I-9 felt that this was very thorough.

From 1988, QA procedures required more detail, such as listing the radio-isotopes and material composition. The QA documentation would have to be completed by the consignors, the waste material assessed on site and the waste investigated to ensure that it complied with the documentation. To aid this, there are the level 1, 2 and 3 monitoring procedures. Level 1 was the review of the documentation, Level 2 was the measurement of the drums at WAMAC and Level 3 was the breakdown and analysis to confirm that the given fingerprint was correct.
There were regular random checks of incoming waste that was performed on a percentage basis of waste coming into the site. Approximately half of the monitoring was directed at Sellafield consignors as these produced the majority of the waste.

Generally, the main problems were found when doing in-depth investigation of the wastes, but this would usually be only about once a year and was usually resolved following discussion with the consignors. As far as I-9 was aware, during the period 1992 to 2000, there was never a breach of the Authorisation in that waste got sent to LLWR that should not have been.

The most common reason for issues arising between the consignor and LLWR was the identification of a potential for sending non-compliant waste. Often this would take the form of procedures or protocols that were not rigorous enough to mitigate against a non-compliance.

The EA also occasionally selected skips on a random basis and took them to Winfrith for detailed investigation. These checks were introduced in the late 1980s to early 1990s; prior to this they did not perform any checking. There were only a couple of small non-compliances, for example involving batteries or uranium. Frequently the activity of the skip was found to have been over-estimated by the consignor. There are a number of reports documenting the results of these investigations, approximately six to ten in total.

**Are waste disposals located where the records say they are?**
No information given.

**Are accurate waste volumes recorded?**
From 1986 onward, I-9 seemed fairly confident that the records are accurate.

**Is the activity disposed of what is on the records?**
Yes, as far as the documentation allows. There has been validation when a couple of false alarms were raised.

**Form of radionuclides?**
No information given.

**Are the materials disposed of what is on the records?**
From 1986 onward, I-9 seemed fairly confident that the records are accurate.

**Key messages**
Since concealing higher-activity wastes as LLW was a very deliberate act, especially when there was a route for ILW, one possible waste-stream could have been ‘orphan waste’ or items that are not accepted by the usual disposal routes.

**Notes made by:** Victoria Smith

# Interviewee 10

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| **Interview number: 12** | **Interview with:** Interviewee 10 (I-10) | **Recorded on:** 2nd March 2009 |
| **DVD number:** 2nd Interviews, Disc 1 | **Interview duration:** 1.5 hours | |

**Interviewee's background/role at Drigg/ LLWR/ elsewhere, including dates**
I-10 went to work at Sellafield in the early 1970s after studying physics. For a period, I-10 performed criticality calculations, before becoming an operational Health Physicist (HP) based in the following buildings: B30, B29, B39, B229.

**Points of note**

- The laundry building, at the edge of the separation area, decontaminated and washed all protective clothing in order to recycle as much as possible. If after this procedure the items were deemed 'active' they were probably sent to LLWR. This building would therefore be a source of material to LLWR.
- Plutonium contaminated materials were stored in mild steel, black 50 gallon drums. If the plutonium content of the waste was monitored and found to be below a certain level, it would be sent for sea disposal. This practice was stopped in the early 1990s. Other plutonium drums were stored in buildings on site, such as B203, B204, B206 and B720, for processing. The magazines at the LLWR site were also used to store some of this material (e.g. items such as gloveboxes generated when buildings were stripped) as it was a convenient 'space' ('out of sight, out of mind'). I-10 noted that these were treated separately to the LLW disposal at LLWR. It was not until the late 1970s that they began looking into emptying the magazines and moving the waste to a purpose-built store. The WAMAC facility has been built to compress the material prior to storage into better quality drums.
- I-10 noted that the LLWR site did not have a lot of staff; a foreman plus two or three process workers and one or two HP monitors and that process workers probably tended to stay on the site for some time, whereas HP monitors moved around the buildings on the Sellafield site, so just one HP monitor could provide background information on a number of buildings.
- I-10 was not clear whether the waste was monitored once it arrived at LLWR, but the interviewer confirmed that the skips were monitored based on other testimonials. In light of this, I-10 went on to suggest that after being transported, the vibrations and movement may have caused the waste to settle further, so radiation monitoring could provide an extra level of confidence.
- The Nuclear Industry Code of Practice (NICOP) introduced waste clearance procedures and processes, which were brought into practice in 2004/5. This meant that waste with activity levels below a certain level could be disposed of as 'free-release', probably to municipal landfill sites. Waste was segregated into different coloured bags depending on activity levels and placed in a machine which characterised the waste in the bag.
- I-10 commented that any liquid waste arising in an active area is deemed as contaminated. The same concept is applied to solid wastes. Practices are now followed to separate the waste at source, to allow compliance with the NICOP above *and waste minimisation practices*.
- I-10 noted that that the building skips each had a designated position on the site and that during the 1970s and 1980s the doors were not locked and items could be placed in the skips by anybody.

**Record keeping/QA**
The Radioactive Substances Act 1960 meant that disposals required LLWR authorisations, covering the amount of activity that could be disposed. The Health Physics Department would then derive limits to be used for day-to-day operations on the site.

All HP monitor operatives had a set of operator instructions to adhere to that were in keeping with the policies and procedures of the HP department. These procedures were laid down in the 1950s and updated in 1980, but remained much the same. One of these policies would have dealt with handling LLWR waste.

Prior to 1987, each bag was monitored to ensure that radiation levels were within Drigg limits, approximately 750 mR/hr. Although not every sack reading would be recorded, it is likely that the logbooks for each building would have details of the highest activity reading for a batch. Each of the buildings consigning waste would have these records (some may be lost), but inspecting them and finding the average reading should give a better idea of what went to LLWR. I-10 estimated that the vast majority of activity readings were far below the upper limit.

The HP Department would produce an annual report (started in about 1950/1) to establish what was happening on site and in the trenches.

The environmental HP team were responsible for coordinating summaries and records of the monitoring of aerial and liquid discharges at LLWR. This would include the period from the late 1970s, when there was a lot of building work on the Sellafield site. This involved close liaison with contractors as it was inappropriate to bury activity, i.e. by putting a new building over the site of an old one. This meant that boreholes were drilled to allow soil sample analyses. A lot of soil material was sent to LLWR, but higher activity soils were sent to other areas of the Sellafield site and formed 'mounds'. The environmental HP Department would also determine quantities in terms of the Authorisation and discuss this with the regulators (the Environment Agency). They would also be involved in considering the procedures at different levels, from the top-level procedures (which were well documented) to the operators' instructions for the HP monitors.

I-10 did note that in the 1950s HP were not always kept well-informed, but that this was less likely in the 1960s as they had the RSA to comply with.

Health Physics had robust quality procedures and practices to pick up "rogue" items which ended up in skips. In the 1950s if individual skips met the radiation levels it was okay to send them to the Repository. There were significant changes to the procedures for LLW disposal on Sellafield site in 1987, which took a lot of the control away from the HP Department. The Authorisation required an inventory of the radionuclides, their origin and weight of the bag. This was introduced to the site very quickly and the question was raised as to how to collate the required inventory information. Generally, each building or plant was sub-divided up into areas that would have a unique fingerprint. The average radiation level of a bag from a specific area would be measured and then the bag was weighed, to enable a fair estimate to be made of the radionuclide content from the typical waste fingerprint for that area. The bag went to a waste handling facility, was weighed and the data was logged on a computer so that the radionuclides could be tracked on a monthly basis. Trench 7 started being filled in December 1985, so these new procedures would be mainly applicable to the waste in this trench and the vaults.

I-10 noted that the waste footprints for each building would change over time. For example, the fingerprint associated with Pond 5 has changed dramatically over the last 10 years. Similarly the function of B204 was changed and then the building was refurbished, causing its fingerprint to change, but the fingerprint of B30 pond has not changed much as little work has been done on it. I-10 suggested looking at a building's history to help back track some of the waste fingerprints.

Some activity went up the ventilation stacks, so a review of the fingerprint of the aerial discharges might also provide some clues as to the functioning of the buildings. Liquid discharges differ in that they are sent to a central facility and measured there.

During the designs of new buildings or plants, the predicted levels and types of waste were usually extrapolated from older buildings performing similar functions. For example, the thermal oxide reprocessing plant (Thorp) used B27 as a basis. This may provide some idea or details of building's fingerprints.

It may also prove useful to look at supporting documentation of any enquires into incidents that occurred around the site.

At one stage in their career, I-10, searched site records and the public record office to find evidence to support BNFL in litigation cases, going as far back as the 1950s. The HP environmental records are held in one or two rooms on the LLWR site, and could include papers and reports on how the HP Department set the working limits and specified waste sentencing. There was a major archiving project that resulted in a lot of material being sent off-site to 'Iron Mountain', although I-10 noted that the boxes were not very well labelled or recorded.

**Are waste disposals located where the records say they are?**
No information given.

**Are accurate waste volumes recorded?**
No information given.

**Is the activity disposed of what is on the records?**
When a building had packed the LLWR sacks, a HP monitor would check each one for activity levels using a hand-held instrument and thus decide whether it conformed to Drigg limits. If accepted, the sack would be placed into a skip. If the sack measured high activity levels, it was emptied and the non-conforming item taken out before the sack was re-sealed and sent on to LLWR. Items found above the Drigg limits would be put in paint tins or placed into a flask and sent to the B38 ILW silos. (The B38 silos would receive all ILW and miscellaneous waste from across the Sellafield site, and occasionally from other sites, e.g. Chapelcross, though other sites also had their own ILW stores). I-10 stated that because of the method of recording the activity "in all cases waste was never more than 750 mR/h and that would be a gross overestimate".

Further tests would be performed on the skip before it left site and was sent to the LLWR. The skips were transported by road (and later by rail), which required that they met the transport regulations. Each skip was monitored for contamination on the outside at 0.5 m and in contact with the skip side. In later years, a new facility was built at the boundary between the separation area and the skip transfer facility. This formalised the control across the boundary between active and non-active areas. The skips were transferred from one transporter to another.

As far back as the 1950's and 1960's HP monitors performed a policing role on waste sent to LLWR: if a monitor detected something wrong with some of the waste, they would enter the information into an area logbook. The logbook was scanned and transferred into shift logs, which were read by senior HP people. There were a lot of checks, so I-10 felt that systematic breaking of the rules over a long period of time would not have occurred. As a starting point, the worker dose measured on their dosimeter badge would show increased levels which would be noticed by the HP team. I-10 felt that the HP procedures were robust enough that they would have detected most improper practices and asked the question 'why would the staff go to the trouble of concealing the wastes when there were other routes for disposal?'. For example, the 'Drigg lead sandwich' was highly unlikely to occur with any regularity.

**Form of radionuclides?**
The HP monitors were mostly concerned with measuring beta rather than alpha activity levels. The alpha activity could then be estimated from the waste fingerprint. Thus alpha activity was measured by an indirect rather than a direct method.

**Are the materials disposed of what is on the records?**
No information given.

**Key messages**

The HP Department were responsible for setting activity limits and monitoring the LLW prior to sentencing to LLWR. Annual reports were produced that may contain information such as the wastes being disposed of and when trenches became operational.

**Notes made by:** Victoria Smith

# Interviewee I I

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| **Interview number: 13** | **Interview with:** Interviewee 11 (I-11) | **Recorded on:** 5th March 2009 |
| **DVD number:** 2nd Interviews, Disc 1 | **Interview duration:** 30 minutes | |

**Interviewee's role at LLWR or elsewhere, including dates**
I-11 began work on Sellafield site in the late 1950s. I-11 joined the Building Works Department (BWD) and worked on a number of projects outside Separation Area. In the1960s, the BWD was re-named the Civil Engineering Department and I-11 began working inside Separation Area. I-11 was part of a newly instigated site clearance team to remove all LLW from around the site. I-11 retired in the late 1990s.

**Points of note**
- The site clearance team would remove general waste from around the site, but also help various buildings remove some of the more 'difficult' low-level waste, such as pipework, scrap metal and large objects that needed cutting up.
- All sorts of items were sent to LLWR, including scrap metal, other items left around Sellafield site, even an old crane (but not its wheels, chassis or engine). When asked why there was so much waste around site, I-11 suggested that buildings were charged for their disposals to LLWR and that they might have been trying to reduce costs.
- There were two types of skips: light duty ones, which were associated with particular buildings, and heavy-duty ones, which the site clearance team used for any larger items. I-11 noted that lifting the lid on the heavy-duty skips was a two-man job and so it is highly unlikely that any 'fly-tipping' would have occurred in them.
- When asked whether the stories of dumping 'high' waste in other skips were true, I-11 noted that outside working hours 'anything could have happened' and that it 'might have done'.
- I-11 was proud of the team's reputation for being very rigorous at clearing waste appropriately and according to the rules. Anything in the Separation Area that was not designated ILW was assumed to be LLW and would be sent to LLWR so as not to take any chances.
- One of I-11's roles was to check the skips on a daily basis, as it was fairly common that the padlocks would go missing. I-9 noted that all the padlocks were opened by the same key.
- I-11 recalls that no protective clothing was worn in the trenches or around LLWR site.
- When asked about whether any waste generated from incidents on Sellafield site was sent to LLWR as LLW, I-11 noted that such clear-up waste would be too 'high' for LLW limits and would not be sent.
- I-11 discussed the earth mound known locally as 'Mummery's Mountain'. I-11 thought much of this soil came from the building of a lagoon between B212 and B211 and that the site clearance team were responsible for sending the soil to the mound in the 1980s.
- I-11 attended a meeting in which a senior manager asked for everyone's opinion on how the site was run. I-11 gave an honest reply; that years ago management would listen to members of their team and consider their suggestions, sometimes acting on them, but that management at the time of the meeting would not make a decision or listen to the men on the ground and instead go to a more senior manager for advice.
- I-11 mentioned the seagulls on site, which the site clearance team were also responsible for culling. Typically, they would go onto the rooftops and pierce the eggs. However, this was stopped on health and safety grounds because there were no handrails around the rooftops.

**Record keeping/QA**
I-11 recalls that there was a lot of paperwork and it was filled in as they had to be compliant.

**Are waste disposals located where the records say they are?**
No information given.

**Are accurate waste volumes recorded?**
No information given.

**Is the activity disposed of what is on the records?**
I-11 noted that the team always disposed of waste according to the regulations. To begin with, the site clearance team were accompanied by a HP monitor at all times, to ensure that the waste they handled was within Drigg limits. Latterly, the team were trained in the use of the monitoring equipment so that they did not require a HP monitor and were able to work more efficiently (and safely) as a result.

All of the waste was monitored several times; in the building, before it went into the skip, in the skip itself prior to leaving site, in rail wagons at the sidings before departure to LLWR, and finally when the skips arrived at LLWR.

**Form of radionuclides?**
No information given.

**Are the materials disposed of what is on the records?**
No information given.

**Key messages**
The same key opened all of the padlocks on the skips.
There were high levels of monitoring of the waste assigned to LLWR.

**Notes made by:** Victoria Smith

# Interviewees 12 and 13

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| **Interview number: 14** | **Interview with:** Interviewee 12 (I-12) and Interviewee 13 (I-13) | **Recorded on:** 5th March 2009 |
| **DVD number:** 2nd Interviews, Disc 1 | **Interview duration:** 42 minutes | |

**Interviewee's role at LLWR and elsewhere, including dates**

I-12 started work for BNFL in the early 1980s as a site clearance operative. After this post, I-12 went on to a job involving waste delivery at Calder Hall and still holds that position today.

I-13 joined BNFL in the mid 1980s as a site clearance operative. I-13 now works in the Separation Area waste team and consigns the majority of solid waste to LLWR.

**Points of note**

- In the early 1980s, all LLW (hard and soft) was thrown into a wagon and tipped at LLWR. Each wagon had an accompanying HP monitor.
- In 1984, both heavy-duty and light-duty skips were introduced to the site and for the first time the LLW waste was being segregated. The light duty skips would contain items like gloves, tissue and paper and the heavy-duty skips would contain large bulky items (up to 2 m in length) such as metals and wood.
- In 1992/4 WAMAC opened and the process of LLW waste disposal became a lot more rigorous with a lot more paperwork. The soft waste was compacted in to boxes and sent to LLWR. The heavy-duty waste was taken to LLWR directly.
- The site clearance team were not always fully aware of the standards set out in the conditions of acceptance, so would send any item as long as it was below a certain limit according to the monitor.
- The interviewer asked whether they knew of people breaking the rules and sending higher activity items to LLWR. The interviewees felt that it would have been an easy way to dispose of 'problematic' items e.g. lead which would require a certain amount of paperwork to be completed in order to get authorisation from LLWR.
- Asbestos was tipped into a specific area at LLWR from specific skips on Sellafield site. Permission was required from the County Council prior to tipping asbestos at LLWR.
- Neither I-12 nor I-13 were aware of any fly-tipping into trucks and so do not think it was widespread practice. Also they could not recall any incidents of 'high' items being sent to LLWR. They noted that monitoring of the waste was rigorous. A monitor travelled with each wagon and checked everything going in, before it left the Separation Area and again at LLWR.
- However, it was noted that in their opinion the activity levels of the waste consigned to LLWR were within the levels of the Authorisation and would not breach the activity levels of the conditions of acceptance today, as the activity is averaged over the volume of waste.
- In the mid 1980s, much of the waste consigned to LLWR was bagged, whereas today there is a 50:50 mixture of metals and soft waste.
- The B38 tip sent tonnes of soil to LLWR. Another source of soil was from the garden of two old ladies who fed the birds from Sellafield. Their garden was found to be contaminated. Sellafield dug 4 ft down and removed all the soil to LLWR, then re-landscaped their garden.
- Following the incident at Chernobyl, all the skips were contaminated by the radioactive rain, but the waste inside the skips still went to the Repository as LLW. The skips were then decontaminated.
- It was noted that the workers and their families usually lived locally to the site so would not want to run the risk of disposing of higher-activity items.

**Record keeping/QA**

No information given.

**Are waste disposals located where the records say they are?**
In the case of fires, the waste would be moved to stop the fire.

**Are accurate waste volumes recorded?**
After WAMAC was introduced, I-13 estimated that there were on average 20 heavy-duty skips a day on a five-day cycle going to LLWR until Trench 7 was full in about 1996.

Current site clearance teams and procedures on Sellafield site are geared at minimising the waste assigned to LLWR, as the cost of disposal is high. After NICOP was introduced, some waste from Separation Area could be classified as 'exempt', which permits disposal in a municipal landfill site. In addition to this, there is now a tip on the Sellafield site that is used for the disposal of VLLW, again reducing the quantities of waste being consigned to LLWR.

**Is the activity disposed of what is on the records?**
In the early days, the HP monitors would categorise the waste and sentence it to LLWR, if it was within limits, or to the ILW store if not. As the site clearance team was not associated with any buildings but collected waste that had been left outside, this would include wet LLW bags, which were more difficult to monitor for alpha activity.

In the early days, they would monitor the LLW at source, i.e. outside the building of origin. However, today they measure the radiation levels in a lead-shielded box, to reduce the effect of any background radiation. The radiation levels for waste measured inside the shielded box are significantly less than those measured at source, suggesting that many of the measurements taken in the early days were in fact an overestimate of the radiation levels for the LLW waste being disposed of. I-12 went so far as to suggest 100 times overestimated in some cases. (In addition to using the shielded box, modern radiation measuring equipment is much more sensitive.)

The types of waste sent to LLWR have not changed that much between the early days and now. The main difference is in how the waste is managed; now there is a lot more processing and segregation of the waste. There have been new methods for cleaning up the LLW, i.e. wheel abrader and sponge jet, which decontaminate some of the waste so that it can be classed as exempt. Some rough figures were given to illustrate the impact on volumes of waste: in the mid 1980s approximately 2000 $m^3$ per week were consigned, whereas now it has been reduced to less than 200 $m^3$ from Separation Area as a whole.

In their opinion, the waste disposed of at LLWR is overestimated greatly because of the practise of recording dose rates outside buildings of origin with high background radiation. In their view, it is probable that 99.9% of the waste tipped in the early 1980s would comply with present day standards.

**Form of radionuclides?**
No information given.

**Are the materials disposed of what is on the records?**
No information given.

**Key messages**
- The site clearance team were not always aware of the Conditions for Acceptance.
- Background radiation had a significant impact on the radiation measurements at source in the 'early' days, leading to a gross overestimation of the activity levels.
- Today the cost implication of sending large quantities of waste to LLWR has resulted in significant waste minimisation and decontamination to 'exempt' levels.

**Notes made by:** Victoria Smith

# Interviewee 14 and Interviewee 15

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|---|---|---|
| **Interview number: 15** | **Interview with:** Interviewee 14 (I-14) and Interviewee 15 (I-15) | **Recorded on:** 11th March 2009 |
| **DVD number:** 2nd Interviews, Disc 1 | **Interview duration:** 6 minutes | |

**Interviewee's role at LLWR or elsewhere, including dates**

I-14 joined BNFL in the late 1970s as a shift worker in B30 decanning rods from B205. I-14 then moved to Pond 5, before going to LLWR around 1990 when Trench 7 was still open and Vault 8 had only just opened. Now Vault 8 is nearly full and Vault 9 is being built.

I-15 joined Sellafield around 1980 in the Civil Engineering Department. I-15 took on a number of different roles and then in 1984/5 moved to LLWR (when the end of Trench 6 was being filled and Trench 7 was being prepared). I-15 worked on the trenches until they closed and then moved to the grout plant for two to three years before becoming a process worker on PCM.

**Points of note**

- I-15 was involved with decommissioning the magazines and removing PCM waste from the LLWR site. Waste items would include gloves and protective suits. The latter would be sent back to Sellafield site to be washed. Other gear would be monitored by HP and a D11 form completed. The waste would be sent by road to WAMAC, where it would be compressed before being placed in iso-freights and returned by train to LLWR. At LLWR it would be grouted and put into a vault.
- Paperwork trail: the paperwork details where the waste material originates and it would be checked that it had been filled in properly at Sellafield by LLW coordinators. The waste would be sent to WAMAC, accompanied by the D4 form detailing the contents of the waste, where it had originated, its weight, HP monitored activity level and the date.
- Before, the LLW waste would be accepted if it was below a certain limit, whereas today the paperwork is a lot more detailed.

**Record keeping/QA**

See Points of Note above.

**Are waste disposals located where the records say they are?**

No information given.

**Are accurate waste volumes recorded?**

No information given.

**Is the activity disposed of what is on the records?**

No information given.

**Form of radionuclides?**

No information given.

**Are the materials disposed of what is on the records?**

No information given.

**Key messages**

None.

**Notes made by:** Victoria Smith

# Interviewee 16

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|---|---|---|
| **Interview number: 16** | **Interview with:** Interviewee 16 (I-16) | **Recorded on:** 9th March 2009 |
| **DVD number:** 2nd Interviews, Disc 1 | **Interview duration:** 52 minutes | |

**Interviewee's role at LLWR or elsewhere, including dates**
I-16 joined the AEA police force around 1980. I-16 underwent training including a firearms course. I-16 would only be posted at LLWR up to four times a year on a rotation basis.

**Points of note**
- A typical day at LLWR was described by I-16: The early shift, starting at 6am, would receive a verbal briefing from the night shift, inspect the incident log and patrol around the perimeter. (Note: Police incident logs and paperwork were only kept for five years.).The site workforce would begin at about 7.30am and would go to the Police Lodge to collect the keys for various buildings around site. The police would receive a briefing regarding the expected loads that day, any VIP visits or exercises (i.e. by the Fire brigade). Only planned loads would be permitted onto site. Work would finish on the site at 3.30pm. During weekends and Bank Holidays the site would be closed.
- The police had to be checked for contamination after they had been out on patrol, though I-16 never knew of anyone who had been contaminated.
- The police would check all the loads for safety, e.g. during the time that the IRA was a threat they would check the vehicles for explosive devices.
- Workers on the LLWR site were vetted. Police would perform searches of the staff, but nothing improper was ever found. I-16 thinks that the roster system employed by the police was in place to prevent friendships being struck up between the police and the workers.
- I-16 noticed the following items being tipped: scaffolding, old RAF navigation equipment, old watches that had luminous dials and could not be sold on the open market. The latter items were covered over immediately with soil so that nothing was open. 'Normal' waste was not covered over until there was enough present. I-16 noted that a lot of things went into the trenches that did not need to. T-16 commented that much of the material that went into the trenches was uncontaminated.
- One unusual item that went into the trenches was a Ford Granada car that had been used on Separation Area to drive VIPs around and had become contaminated.
- Regarding Chernobyl, I-16 commented that the rumours of waste from Russia were alluding to the deposition of activity as the rain cloud went over Cumbria. Some of the clean-up items i.e. towels but nothing more, would have been sent to LLWR.

**Record keeping/QA**
The site foreman was aware of every load to be tipped on a daily basis. If the load was not agreed in advance it could not be tipped.

**Are waste disposals located where the records say they are?**
No information given.

**Are accurate waste volumes recorded?**
No information given.

**Is the activity disposed of what is on the records?**
No information given.

**Form of radionuclides?**
No information given.

**Are the materials disposed of what is on the records?**
No information given.

**Key messages**
This interview corroborates some of the earlier interviews in terms of waste tipped.
Site workers were vetted, and checked before leaving the site.

**Notes made by:** Victoria Smith

# Interviewee 2 (3rd session)

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| **Interview number: 17** | **Interview with:** Interviewee 2 (I-2)<br>See also interviews 2 and 3, Appendix 1 | **Recorded on:** 3rd March 2009 |
| **DVD number:** 2nd Interviews, Disc 1 | **Interview duration:** 34 minutes | |

**Interviewee's role at LLWR or elsewhere, including dates**
See earlier notes from interviews 2 and 3
The interviewer asked a number of specific questions.

**Points of note**

- I-2 was asked to compare the monitoring by Health Physics (HP) at LLWR with that at Sellafield site. I-2 spoke about the period in which they were on the LLWR site, which was the mid 1970s when Trenches 2 and 3 were being filled.
- Waste collected by the site clearance team was checked by an accompanying HP monitor prior to loading onto the wagon and transfer to the skips.
- When the skips were loaded onto the trucks and they left site, they would be accompanied by all the health and safety paperwork and follow a specific route to LLWR. On arrival at LLWR, the vehicle would be stopped and a HP monitor would use a beta/gamma instrument to perform contact checks. These would usually comprise checks along the sides of the vehicle and skip, at the rear, around the cab and, when possible underneath. The results of this monitoring would be compared with the accompanying paperwork and the measurements taken before it had left the Sellafield site. The journey could have caused some movement of the wastes, so it might well be that the radiation levels would be very slightly different. If the two sets of readings were found to be different, then I-2 or another foreman would accompany the vehicle to the tip face and the load would be tipped at the edge so that the individual packages could be monitored again. If a high activity bag was found, it would be taken to one side, placed back into the empty skip and sent back to Sellafield. I-2 only recalled isolated incidences of this occurring during the filling of Trenches 2 and 3. Some of the differences between the monitor readings could be attributed to calibration of the monitoring instruments. However, these should all have read the same because they were calibrated with active sources in a lead-lined box on a daily or weekly basis.
- The Dempster Dumper skips were 5 $m^3$ in volume and, as there was less material going off site during the filling of Trench 1, took some time to fill. New skips, introduced in 1973/4, were 12 $m^3$ in volume, with lockable lids for security reasons and to stop the ingress of rainwater. The shift manager or supervisor would keep the key in their office.
- LLWR preferred to accept only skips full to capacity, which prevented movement of the waste (which could tip a truck) and would not waste fuel. On some occasions, buildings would give the site operators advance notice that a skip would be only partly full and it would be accepted. Otherwise they could refuse to empty the skip (although they usually did) and would send a warning to the relevant department.
- I-2 was asked why they thought people would go to the trouble of sending higher-activity wastes to LLWR when there were already procedures to deal with ILW.
- I-2 noted that every department had operating rules, but that from time to time they would collect some waste that could not go to LLWR. However, it would be embarrassing and raise awkward questions if during an NII or Health and Safety inspection this waste was still in the laboratory. Consequently, there would be considerable pressure placed on them to remove the waste as quickly as possible, as a failure to do so could lead to the laboratory being shut down for a period. However, I-2 felt that the majority of people from shift managers through to technicians and charge hands knew the Drigg limits and that it would be against their interest to send higher activity material to LLWR, so it would have been done only occasionally and most probably during the night-shift. I-2 recalls only a couple of cases of disciplinary action.
- I-2 noted that detection of any of these higher wastes would be dependant on the efficiency of the monitoring, for example in bad weather the monitor might rush and be half a metre away

from the side of the skip. However, I-2 commented that there were two HP monitors at LLWR, both of whom performed a thorough job, but was not sure whether stand-in monitors would.
- In the case of drums, it is possible that higher-activity wastes could be concealed inside the drum and not detected when monitored from the outside.
- If there were periods when consignors might have disregarded the rules, I-2 felt that this would not have been in the early 1950/60s because there was far less waste being assigned to the trenches then. I-2 felt that it was more likely that non-compliant material would have been sent to LLWR (into Trenches 2 to 7) once production on the Sellafield site was in full swing.
- I-2 was asked whether incidents on site would be likely to cause some waste being sent to LLWR that should not have been. I-2 felt that in fact the opposite was true. If there was an incident on site, most buildings were shut down and the amount of waste generated would have been low. Any waste that was generated would have been over the Drigg limits and placed in drums for ILW storage.
- I-2 noted that when the site was run by UKAEA, they did not have to declare incidents as they were Crown Property. For example, I-2 recalls that the residues of a fire were concreted within a building. BNFL, however, did have to declare incidents.
- Seagulls were a problem on site, but it tended to be mostly a human problem, i.e. attacking people and causing mess around the site, rather than a radiation problem. I-2 noted that the site clearance team would be involved in clearing the gullies and nests as well as pricking eggs. If there was any contamination in the eggs then it would remain on the roof as the eggs were left there to rot.

**Record keeping/QA**
No information given.

**Are waste disposals located where the records say they are?**
No information given.

**Are accurate waste volumes recorded?**
No information given.

**Is the activity disposed of what is on the records?**
No information given.

**Form of radionuclides?**
No information given.

**Are the materials disposed of what is on the records?**
No information given.

**Key messages**
- NII or health and safety inspections might have placed pressure on staff to dispose of some 'problematic' wastes to LLWR. This would have only occurred occasionally.
- Very few bags of waste were rejected from the LLWR site.

**Notes made by:** Victoria Smith

# Interviewee I7

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|---|---|---|
| **Interview number: 18** | **Interview with:** Interviewee 17 (I-17) | **Recorded on:** 11th March 2009 |
| **DVD number:** 2nd Interviews, Disc 1 | **Interview duration:** 30 minutes | |

**Interviewee's role at LLWR or elsewhere, including dates**
I-17 joined Sellafield around 1970 in the Civil Engineering Department. I-17 had a number of roles there before moving to LLWR. I-17 worked as plant operator on the LLWR site for 20 years (from the early 1980s) and used to drive the tracked vehicle used on the tip face to bury the waste. I-17 retired around 2005.

**Points of note**

- I-17 recalled that a number of hex cylinders were stacked in the railway sidings and were put into Trench 6 (towards the end). They were placed right at the very bottom of the trench and covered with lime.
- I-17 described a typical day: Skip wagons would arrive from Sellafield, sent most of the waste, and external consignors. The site was always busy and the greatest number of loads that they had in one day was approximately 100. The waste would vary from steel, soil, different coloured drums (mostly black drums, but an electrical company sent waste in yellow drums). Medical waste would come in drums, but was tipped infrequently, only once or twice a year. Most items were bagged and drummed so I-17 could not see what the waste was. Sometimes when things were tipped there would be a lot of dust, which I-17 suggested may have been asbestos. Every night at least 1 m of soil was put on top of the waste. This was covered by a membrane, then stone and finally another layer to make it level. This would take approximately one and half hours, depending on how much waste had been tipped that day. They would always cover the waste with soil if nothing else. The activity levels of the tip face were monitored every evening. Sometimes, if the reading was high, a thicker layer of soil would be required.
- On many occasions I-17 would have to physically handle the drums of waste, rolling them off the back of trucks. *No protective gear was used, as the workers were confident that the waste was within limits.*
- I-17 recalls that some machinery was buried. An old tracked vehicle from the LLWR site was tipped over the side into Trench 7. A dragline crane was sent from Sellafield; this was driven into Trench 7 on to an area of hard-standing used to help store the iso-containers before Vault 8 was opened.
- I-17 had their own hand-held monitor, which they could use. No high levels of contamination were ever found on the tracked vehicle I-17 drove in the 20 years spent working on the site.
- I-17 recalls a couple of trench fires but was not sure how they started. There were rumours that sparks from tipping steel into the trench could have set paper waste on fire . Sometimes they would dig the tip face out to stop the fire spreading further back into the trench. The waste material was left in the trench to be covered over with the next day's loads.

**Record keeping/QA**
I-17 recalled that a log-book of all the incoming waste was kept by one particular individual, who would collect the paperwork from every load and then send it back to Sellafield at the end of every day.

I-17 feels that there are far more radiation checks made in the present day. They mentioned that in the early years there were no monitors at LLWR and the individual who collected the paperwork would also carry out the monitoring.

**Are waste disposals located where the records say they are?**
When fires occurred, the waste would be moved to stop the fire.

**Are accurate waste volumes recorded?**
No information given.

**Is the activity disposed of what is on the records?**
No information given.

**Form of radionuclides?**
No information given.

**Are the materials disposed of what is on the records?**
No detailed information given. Asbestos wastes were mentioned.

**Key messages**
The waste was always covered over with soil.

**Notes made by:** Victoria Smith

# Interviewee 14 (2nd session)

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| **Interview number: 19** | **Interview with:** Interviewee 14 (I-14) See also Interview 15, Appendix 1 | **Recorded on:** 11th March 2009 |
| **DVD number:** 2nd Interviews, Disc 1 | **Interview duration:** 36 minutes | |

**Interviewee's role at LLWR or elsewhere, including dates**

I-14 joined BNFL in the late 1970s as a shift worker in B30 decanning rods from B205. I-14 then moved to Pond 5, before going to LLWR around 1990 when Trench 7 was still open and Vault 8 had only just opened. Now Vault 8 is nearly full and Vault 9 is being built.

**Points of note**

- As a process worker on night shifts, I-14 would go through the barrier (assigned C1-C5 depending on how active the area was) and their gloves and PVC suit would be binned in a paper sack and put outside for the day workers. The bags would then be monitored by HP and placed in the skip. There were no labels or other identification of the wastes on the sack.
- If the HP monitor found a sack to be too high, then the shift workers were instructed by their foreman to get rid of the waste. They would re-bag it and make a nest to take it in the middle of the skip.
- I-14 noted that the skips were not locked so it was possible to dump waste in another building's skips, although they never saw or heard of this happening. *According to other interviews they should have been locked by this time.*
- I-14 recalls that there was a fire in B30 and they were the first to notice. All staff evacuated the building and the fire brigade was called. Wet waste generated from the fire was mopped up (including from the roads outside B30). Paper towels were soaked in a bucket full of decontaminate and used to clean areas around the building. The area was then dried with clean, dry paper towels. All this waste was placed inside plastic bags and then into the paper sacks before being sent to LLWR. All the gloves and protective suits were also sent to LLWR because they were above the levels for the laundry. Over this time, the plant was shut down and there were no operational wastes.
- By the time I-14 moved to Pond 5, the activity levels were written on the sacks and each sack was measured at source or when packaged. At B30 all the sacks generated were checked once a day by a HP monitor.
- I-14 noted that they themself had used paint tins to dispose of some waste. Jaws of master-slave manipulators, used in shielded cells, that were in contact with the fuel were 'burnt off' in acid (*we assume this means decontaminated with suitable contamination chemicals)*. It was this solution that was placed in paint tins and sent to LLWR. There was nothing else in the rest of the tin apart from paper towels i.e. no lead shot.
- I-14 went to work at LLWR in 1990 when Trench 7 was about half full. I-14 used to drive the tractor and trailer to transport the soil and rocks used in the backfill and worked along the sidings. Some of the soil came from the excavation work during the building of Vault 8 and a quarry would supply the hardcore. I-14 described the backfill as soil, followed by small then large hardcore, and lastly more soil. I-14 recalls batting the waste down and putting backfill on three times a week and comments that it was always possible to see the open end.
- I-14 remembers one wagon being tipped at the trench face. The workforce did not have any protective gear on and it was common in windy weather that they would get covered in dust. On this occasion a pink plastic bag containing asbestos tore open. There were HP personnel on the trench when tipping and an air monitor. I-14 has never been contaminated whilst working at LLWR, and there is no barrier to pass through when leaving the site.
- Empty skips were put back on the train and monitored before they left LLWR.
- The capping of the trenches was performed by outside contractors.
- The grouting plant is now up and running. Material is sent from Sellafield, weighed on the weighbridge and calculations performed to check that the load is within LLWR limits. Once

cleared, the container goes to the grout plant, is filled with grout, cured for about 24 hrs and then transported to the vault. The container is labelled on the outside with radiation stickers.
- I-14's advice was that it would be a major and difficult task to excavate the trenches.

**Record keeping/QA**
When a train came in from Sellafield, the skips would be put on a skip wagon, placed on a weighbridge and weighed. The operators would then perform some calculations to determine whether the waste complied with the 12 and 4 GBq/t limits of the LLWR site. If it was not within limits, the wagon would be put on hold, the supervisor informed and appropriate action taken. I-14 has never seen anything returned to Sellafield (other than some PCM waste recently).

Currently, a D4 form is sent with the waste from Sellafield, which details the percentage breakdown of the waste (i.e. % wood, % plastic etc). Although a lot of the process is computerised there is still an extensive paper trial.

**Are waste disposals located where the records say they are?**
No information given.

**Are accurate waste volumes recorded?**
I-14 recalls that between one and three skips would be sent to LLWR from B30 compound per week. Pond 5 would generate about one skip per week.

**Is the activity disposed of what is on the records?**
Some slightly higher activity wastes may have been disposed of, but this was generally considered acceptable provided that the overall skip met Drigg limits.

I-14 knows that some waste from B30 was sent to LLWR that should not have been, and this was done under the instruction of the building supervisors. The building operators would never have sent it to LLWR by themselves. As long as the activity was not higher than allowed by the transport regulations, which might require shielding in lead, then it was considered acceptable to send it to LLWR. I-14 indicated that this was what happened in B30, but suspects it may also have happened in other buildings.

**Form of radionuclides?**
No information given.

**Are the materials disposed of what is on the records?/ accuracy/ uncertainties**
No information given.

**Key messages**
If the monitor found the activity of a sack to be too high, then the shift workers were instructed by their foreman to get rid of the waste and they would re-bag it and make a nest to shield it in the middle of the skip. Some higher activity items were shielded by wrapping in lead. I-14 knows that some waste form B30 was sent to LLWR that should not have been and this was done under the instruction of supervisors.

**Notes made by:** Victoria Smith

# Interviewee 15 (2nd session)

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| **Interview number: 20** | **Interview with:** Interviewee 15 (I-15)<br>See also Interview 15, Appendix 1 | **Recorded on:** 11th March 2009 |
| **DVD number:** 2nd Interviews, Disc 2 | **Interview duration:** 24 minutes | |

**Interviewee's role at LLWR or elsewhere, including dates**

I-15 joined Sellafield around 1980 in the Civil Engineering Department. I-15 took on a number of different roles and then in 1984/5 moved to LLWR (when the end of Trench 6 was being filled and Trench 7 was being prepared). I-15 worked on the trenches until they closed and then moved to the grout plant for two to three years before becoming a process worker on PCM.

**Points of note**

- I-15's early work, from the mid 1980s, on Trench 6, usually involved moving soil around the site and in particular putting a 1 m layer of soil on the top of the trench. Most of the soil originated from the newly dug Trench 7 and the remains from Trench 6. The 1 m layer of soil would be covered by a layer of plastic membrane, then stone, before a layer of 'dust' was put on top to provide a good surface for the skip wagons. After about a week, everything would settle and more material would need to be spread to level the surface.
- I-15 was involved in digging out Trench 7 using a dragline (like a crane but with a bucket on the end instead of a hook). The soil was either put on Trench 6 or stored to be used for capping at a later date.
- Trench 7 is triangular in shape with a firewall down the centre, dividing it into two halves. The firewall was made from concrete panels (about 10 to 12 ft high) mounted on top of a concrete base (8 to 10 ft wide). In the middle of each half of Trench 7, a drain was installed in the form of a concrete pipe. When digging the base, sometimes areas would be found without any clay and it would be necessary to put down some bentonite clay. The clay was spread and 'rotovated' into the base. After it had gone hard, about 1 m of soil was put on top so that the clay layer would not 'break'.
- Some waste was stored on a piece of hard standing at the end of Trench 7 prior to going into Vault 8. This included 'Seal' sands which were stored for one or two years, and as a result many of the drums deteriorated. I-15 estimated that there were two or three iso-freights worth of drums *(from later interview each freight container can take up to about 30 tonnes of waste).*
- HP Monitoring: The HP monitor went on top of the trench to take a reading at the end of each shift. If the reading was a little 'high' then the HP monitor would get the tracked vehicle (Drott) to push the waste further down into the trench or cover with more soil. This would have to be done about once a month. I-15 was not aware of what 'high' meant.
- Each skip was monitored after it had been emptied and before it went back to Sellafield. 20 to 30 swabs were taken from the outside and around the lip of the tank.
- All of the staff were monitored with hand-held and foot monitors. In the 10 or 11 years I-15 worked on the LLWR site while the trenches were still open, I-15 was never contaminated.
- I-15 noted that a consignment from Springfield came every day, a very large skip full of squashed drums, drum lids and rusty metal. I-15 also noted that it was always dusty. Aldermaston would send one to two articulated trucks with 60 to 70 black drums that had to be rolled off manually. I-15 remembers some larger items would arrive on a flat-bed truck, such as an old crane lift.
- Contractors did the final capping of the trenches. I-15 noted that they dug a drain around the trenches, covered the trenches with plastic sheets that were welded together so that all surface water would flow into the drains, and then put about 1 m of sand (from the site) on top of that.
- I-15 noted that it would be very difficult to recover the material, in particular because there was a large amount of capping material and soil above the trenches.

**Record keeping/QA**

No information given.

**Are waste disposals located where the records say they are?**
I-15 did note that some waste would not be in the grid positions listed in the records as items such as drums could roll into other grid positions.

**Are accurate waste volumes recorded?**
I-15 estimated, from the period that they worked on the Drott, that approximately 60 to 100 tonnes of waste was tipped per day.

**Is the activity disposed of what is on the records?**
No information given.

**Form of radionuclides?**
No information given.

**Are the materials disposed of what is on the records?**
No information given.

**Key messages**
At no point in the 10 to 11 years that I-15 worked on the trenches on the LLWR site were any of the workers or trench machinery found to be contaminated.

I-15 provides further evidence that records of the positions of waste within the trenches could be incorrect.

**Notes made by:** Victoria Smith

# Interviewee 18

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|---|---|---|
| **Interview number: 21** | **Interview with:** Interviewee 18 (I-18) | **Recorded on:** 11th March 2009 |
| **DVD number:** 2nd Interviews, Disc 2 | **Interview duration:** 34 minutes | |

**Interviewee's role at LLWR or elsewhere, including dates**

I-18 joined the Environmental Protection Group after graduating in the mid 1980s and was involved in continuing the work to define an inventory of the radionuclides and their activities in the LLWR trenches. In the mid 1990s, I-18 performed uncertainty work on the inventory. In the late 1990s, I-18 worked as an auditor of the waste consignors.

**Points of note**

- The programme of work that I-18 joined, which had commenced in 1984, included taking bags from consignors' skips from various buildings and gamma scanning them to get the dose rates. This measured value was then used as a basis for the fingerprint for the respective building waste. In addition, a survey of the number of bags being disposed was carried out, to get an estimate of the volume of waste generated. In 1985, further scans were carried out on bags from some of the earlier buildings and some new buildings. External consignors were checked by going through the records of recorded activity and volumes for those sending minor volumes of waste, as the paperwork was too great for the larger external consignors. Minor consignors included Thorium Ltd (Th) and Harwell (carbon-14).
- The leachate was monitored and an experiment performed in the magazines. A very large plastic drum was filled with a selection of different wastes, mostly from Sellafield but also small proportions from Springfields (uranium) and Amersham (carbon-14). The annual rainfall was calculated and scaled down to reflect the volume of waste in the experiment, then poured through the drum. After a period of time, a steady-state was reached that allowed the level of activity to be determined from the leachate. The experimental work was later confirmed by measurements of the leachate from the drains. Any sorption onto soil was also factored into the calculations. A report was issued in 1987 outlining their findings and refined in 1991 with additional data. The main sources of activity remained the same.
- Leachate from stand-pipes was also monitored in addition to the leachate from the trench drains. The result of this monitoring would be in a report from the Environmental Department, and it showed a couple of results that were a little higher than from the drains, although I-18 was not certain about this.
- Much of the uncertainty work I-18 was doing from 1994 onwards was based on computer records and resulted in a report published in 1994. The records were interrogated and further sampling of bags was undertaken. For large external consignors such as CEBG power stations and Harwell, I-18 would speak to someone to get an idea of the fingerprint of their waste as there were too many forms to go through. Generally, smaller consignors would send wastes with the same fingerprint, just smaller volumes.
- When sampling campaigns were repeated on subsequent Sellafield waste, the results were similar, and since there is little information on the waste fingerprint during the 1950s and 1960s, it is assumed that they were the same then as in the present day.
- Most of the gamma readings on the sampled bags were the same as those documented by the building monitor.
- Buildings were given prior notice that their skips were going to be sampled when full, as the purpose of the work was not to catch anyone out but to understand the inventory. Some buildings would not be selected if the operations at the time were not 'usual', e.g. construction work was going on.
- When performing the calculations it was assumed that the skips were full, i.e. contained 10 $m^3$ of waste. However in some cases they might contain less, say 7 $m^3$. I-18 was unclear as to

whether this volume difference was factored into the calculations. I-18 noted that the heavy-duty skips were always full.
- There was no evidence in the inventory that any incident on the Sellafield site had any bearing on the activity levels within LLWR. The only exception to this that I-18 could recall was related to a sludge tank

**Record keeping/QA**
I-18 noted that the waste tipped into Trench 1 was not very well documented, but from about half way through Trench 2 the records became better.

**Are waste disposals located where the records say they are?**
I-18 saw a map which showed that Trench 1 was filled differently to all the others. Most of the trenches were filled North to South, but filling of Trench 1 started in the middle and was continued first to the South and then to the North from the middle. I-18 thinks the map may have been in a geological report of some kind.

**Are accurate waste volumes recorded?**
No information given.

**Is the activity disposed of what is on the records?**
When monitoring the sampled bags of waste they generally found that most of the waste was of relatively low activity, but some buildings such as B30 would have higher-activity wastes, but within Drigg limits.

I-18 has a vague recollection that there was a lot of plutonium-contaminated material in Trench 2.

Trench 6 contains a consignment of watch dials from Harwell that contained a lot of tritium. There was some confusion over the activity readings as it was per dial not per drum as originally thought. A decision was made to leave it because tritium has a short half-life and by the time authorisation and work had commenced it would have decayed.

**Form of radionuclides?**
No information given.

**Are the materials disposed of what is on the records?**
No information given.

**Key messages**
Work to understand the waste inventory at LLWR has been on going for many years and has been made more difficult as earlier documentation did not require submission of the waste fingerprints.

A significant amount of plutonium-contaminated material was consigned to Trench 2 prior to the mid 1970s,

**Notes made by:** Victoria Smith

# Interviewee 19 (2 sessions)

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| **Interview numbers: 22&23** | **Interview with:** Interviewee 19 (I-19) | **Recorded on:** 9 & 13th March 2009 |
| **DVD number:** 2nd Interviews, Disc 2 | **Interview duration:** 28 & 20 minutes | |

**Interviewee's role at LLWR or elsewhere, including dates**

I-19 joined Sellafield in around 1980 as a Health Physics (HP) monitor, working specifically in B229 in the late 1980s. In the early 1990s, I-19 moved to LLWR as site supervisor. When it became apparent that the PCM recovery from the magazines was requiring a great deal of time, an additional supervisor joined the site and I-19 took over responsibility for the PCM work.

**Points of note**

- In 1993 when I-19 came to LLWR, Trench 7 was almost full. It was closed two years later. The grout plant was being commissioned and they were in the early stages of retrieving the PCM waste. There were ten operators, one clerk and I-19 as site supervisor.
- When Trench 7 was closed, the site operatives became plant operators. In the early days, all operators were answerable to the Civil Engineering Department and then later to I-19.
- Grout Plant: any compactable waste was sent to Sellafield and returned to LLWR by train. The iso-freights (which could weigh up to 30 tonnes) were taken from the sidings to one of four grouting tables. Once on the grouting tables, they would be filled with pulverised fuel ash (PFA) or Ordinary Portland Cement (OPC), water and additives until they were full or weighed no more than 41.5 tonnes. A cement overlid *(or capping layer)* was then added, the cement allowed to cure overnight and the iso-freight taken to the vault the next day.
- Inventory of the magazines: the inventory of the waste in the magazines was accurate in so far that the number of packages or drums was known, but the activity levels remained unknown. I-19 attributed this to the technology of monitoring equipment in the earlier days. The first drum was sent in 1997 and the last in 2007. The buildings are now being decommissioned.
- The rail sidings opened in 1981 and then roads were only used to transport large items that could not fit into the skips.
- Changes in monitoring: monitors from the early days *(presume prior to the mid 1980s)* would think that some of the waste being consigned to LLWR in the present day should not be going. For example, when Sellafield refurbished the sea-line, the activity measured would have exceeded the old regulations, but because the new regulations allowed the activity to be averaged across the weight of the material, it could go to LLWR. This method allowed higher levels of activity, but this is also dependant on the isotopes; some are permitted in higher quantities than others.
- The approach to waste characterisation and its footprint have changed greatly. For example, whilst decommissioning the magazines, some bricks were found that were in there before the PCM waste was stored in them. These bricks have been tested in a laboratory to determine the levels of contamination across the material, (whether it is surface-contamination or has penetrated further in), and the particular isotopes, with the aim hopefully of concluding that they can be consigned as LLW. In earlier years, they would have been sent as ILW automatically.
- Waste is still monitored before it goes into the skips.
- The HP monitors role has changed in that in the early days they had more 'power' and 'control' over the waste and what was being sent to LLWR. They were also able to sentence waste on the spot. Today they are required to record the activity data and these are then checked by a supervisor for clearance to LLWR.
- In terms of dumping higher-activity wastes in the skips, I-19 was confident that if a HP monitor instructed the building operative that the waste could not go in the skip, it would not be put in. I-19 felt that the operatives would not mind either way. However, I-19 thought that the supervisors might object as it could raise awkward questions such as where the waste came

from. However, if HP found the higher-activity wastes, then an investigation into where it came from would have been launched because it could cause a trail of contamination across the Sellafield site.

**Record keeping/QA**
I-19 believes that the record keeping of the waste in the magazines was poor. The records were paper records which invariably got lost, or archived somewhere, or the details could be unclear due to bad handwriting. Today I-19 feels the records are as good as they can be, e.g. they now include pictures for future reference.

I-19 mentioned the D11 form that still exists, which details every bag in the skip.

**Are waste disposals located where the records say they are?**
No information given.

**Are accurate waste volumes recorded?**
When Trench 7 was still in operation, 25 skips per day would be tipped.

**Is the activity disposed of what is on the records?**
I-19 spent some time working in the skip facility (B358), which monitored the skips before they were permitted to leave Separation Area and be placed on the trucks or railway wagons. The skips would not be allowed to leave site if they did not conform to the transport regulations. Monitoring was carried out on the external walls of the skip by hand-held monitors and 25 swabs were taken. Any 'high' items would have to be removed from the skip.
If the readings were a little high, the skip might have been washed down and allowed to go, but if the radiation was still too high the skip would be investigated by emptying it, or it would be sent back to the consignor. On one occasion, three bags full of bird guano, from clearing of the gutters, were found, which were well above Drigg limits. These were removed and disposed of elsewhere and an investigation was launched as to how they had been put in the skip

**Form of radionuclides?**
No information given.

**Are the materials disposed of what is on the records?**
I-19 noted that in the early days, the skips on Sellafield were not locked and agreed that anybody could fly-tip into a skip. I-19 felt that this would probably be a contaminated pair of shoes or rubber boots, which would not affect the inventory much as they would be insignificant compared with the weight of the skip. I-19 felt that although there may be such items unrecorded, they would have little or no effect on the inventory.

There was a lot of soil tipped from B38 tip (around 1980) and from 'Mummery's Mound'.

Large items were sent by flat-bed truck and taken to the top of the trench. The item would be lifted onto a chequered plate at the edge of the trench by a crane. The crane would then lift the plate up (by chains) and slide the item into the trench. Items included large vessels, usually wrapped, and if hollow they would be filled with soft waste. I-19 felt that any large items such as contaminated vehicles would have to be documented in the records because they would have to pass the transport regulations and possibly be wrapped.

**Key messages**
This interview contains another mention that after the authorisation in the mid 1980s, a number of changes were made.
The rail sidings were opened in 1981.

If the transport regulations were not met, the skip would not be sent to LLWR.

**Notes made by:** Victoria Smith

# Interviewee 20

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| **Interview number: 24** | **Interview with:** Interviewee 20 (I-20) | **Recorded on:** 12th March 2009 |
| **DVD number:** 2nd Interviews, Disc 2 | **Interview duration:** 50 minutes | |

**Interviewee's role at LLWR or elsewhere, including dates**
I-20 joined UKAEA in the mid 1960s in the analytical laboratories. Around 1980, I-20 moved to the Technical Records Office (TRO), which compiled information from plant operatives, including LLWR. I-20 went to work for IAEA in Vienna, worked as an independent consultant and then retired in the mid 2000s.

**Points of note**
I-20's advice was that it should be made easier for workers to maintain records in the future:
- Information about the same consignment should not be saved in separate unrelated places. Instead a system is required that links it together, or there should be one data file that can be added to as necessary. Any duplication also provides possible errors e.g. if the ID numbers (which can be 16 digits long) don't tally.
- I-20 wondered if it would be possible to put some diagnosis checks into the software.
- I-20 considered that computerisation is a very good tool, but it must have excellent user requirements to avoid wasting time through problems.

**Record keeping/QA**
Describing the documentation of consignments to LLWR, I-20 recalls that there were two categories of waste covered by the paperwork: (1) disposal of LLW from Sellafield and external consignors; (2) plutonium-contaminated materials stored in the magazines.

A copy of the consignment note would be sent to the TRO detailing the volume of material and the radioactive content. The TRO would compile these data and produce summary reports.
I-20 noted that the containers or skips were monitored by Health Physics (HP) with hand-held monitors in contact and at 1 m from the edge. If the skip was found to be within limits then it would be allowed to tip. If any higher-activity waste were found, these would be sent back to the consignor and the offending waste forms removed or re-packaged. This occurred very occasionally since the same tests were also performed before leaving site and so the skips would never be much in excess, perhaps only resulting from a discrepancy between monitors.

In addition to the consignment note, the TRO would also receive a copy of the notification from the producer of waste, so that they could check that they were in agreement.

These original documents would go into the archive at the end of every financial year. These were taken to a central archive in the about the late 1980s. Legally, Sellafield only had to keep records for 25 or 30 years, so some will have been destroyed. However, an archivist sorted through them and kept some that were felt to be important.

Computerisation in the mid to late 1980s had a large impact. At first, a mainframe computer, requiring data entry clerks, was installed at the records office. This helped compile the data from the records. Then personal computers (linked through a network) were installed across the site. This now meant that the plant operators were responsible for the record keeping, the Technical Records Office were not involved and records were no longer sent back to Sellafield from LLWR. As the TROs role changed, they became the Nuclear Materials Accountancy.

Any incidents on the Sellafield site usually meant that routine records would be supplemented by additional records. These would be kept and used to support any investigations or management committees or in some instances in litigation, e.g. material discharged to sea that should not have

been. Often such incidences would result in an increase in the sampling and monitoring around the affected parts of the site. Also, the Chernobyl accident lead to a large increase in the amount of environmental sampling conducted across the site and the County as a whole. However, the latter occurred when the Environmental Department was responsible for its own records.

Sometimes there were discrepancies in the paperwork. If any of the standard forms were not completed fully, were missing or duplicated, then someone from the records office would speak to or visit LLWR. Usually, if there were any mistakes, it would be from certain shifts. One of the first places that TRO would look to eliminate any discrepancies would be the shift log. Everything was written down in this log. The logs would have been archived by the plant operators.

The international regulators (IAEA & EURATOM) changed the requirements as they were looking for transparency (i.e. that the paperwork for uranium ore could be followed from mining through to reprocessing) and consistency. This meant that the TRO had to educate the plant operatives and management on the international safeguards. The staff were aware that the NII and Health and Safety could shut a plant down but, at first, did not believe that the international inspectorates had the same power. After an incident when they were reprimanded in the press, site workers realised the importance of complying with the safeguards.

**Are waste disposals located where the records say they are?**
No information given.

**Are accurate waste volumes recorded?**
No information given.

**Is the activity disposed of what is on the records?**
No information given.

**Form of radionuclides?**
No information given.

**Are the materials disposed of what is on the records?**
No information given.

**Key messages**
There are a number of annual reports that provide a summary of the LLW volumes etc. from the consignment notes.

**Notes made by:** Victoria Smith

# Interviewee 21

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| **Interview number: 25** | **Interview with:** Interviewee 21 (I-21) | **Recorded on:** 12th March 2009 |
| **DVD number:** 2nd Interviews, Disc 2 | **Interview duration:** 31 minutes | |

**Interviewee's role at LLWR or elsewhere, including dates**
I-21 joined the Health Physics (HP) Department in the mid 1970s to perform technical investigations in health and safety. I-21 took on a number of roles in the following years, including working in the Environmental Department from the early 1980s until the 1990s, after which I-21 left and joined Westlakes Scientific Consulting.

**Points of note**
- I-21 discussed the consignment to LLWR of the accumulation of soil known locally as 'Mummery's Mound'., This was near the sludge tanks adjacent to the sea, and located on top of the closed Sellafield trenches, which had been used to dispose of LLW prior to LLWR. The soil originated from construction work in the Separation Area on the Sellafield site. The mound built up as there was no decision on the most appropriate way to dispose of the soil. I-21 was part of the environmental team that performed monitoring and characterisation of the soil. The regulators gave permission for the VLLW soil to be taken to the South Tip and the rest to LLWR. The samples monitored were taken when the soil was transferred during excavation work. I-21 estimates that there were tens of thousand of cubic metres of soil in the mound, though much of it did go to South tip. This removal was done over about 12 months in 1979/1980.
- In 1984, levels of tritium in the Drigg stream were found to have increased significantly. This was attributed to the disposal of Trimphones with luminised dials from Harwell. The consignment was in excess of Drigg limits, but the activity levels were wrongly described on the consignment paperwork.
- In the early 1980s, discovery of tritium in a drain running alongside the railway track was attributed to the lateral migration of the radionuclide from Trenches 5 and 6. This signalled that the trenches had become waterlogged so the leachate was able to get into the more permeable layers higher up and was thus able to move laterally. Waterlogging could occur because the trenches were lined with a clay base which provides an impermeable layer to the leachate.. I-21 was not sure of the causative waste-stream, but the activity was possibly attributable to the Trimphones again. The drain has been monitored ever since.
- After the Chernobyl incident, environmental monitoring had increased the frequency of all monitoring on site and had picked up five times higher levels of activity around the local area. Investigations were performed to confirm that it definitely was not from an incident at Sellafield even though the contaminants would have been similar (The fingerprint from Cherobyl included chiefly I, Te and Cs). I-21 suspected that only contaminated clothing would have gone to LLWR.
- In the mid 1980s, work was done on the inventory, which included the back assessment from measurements in the leachate. The result was in good agreement with the disposal records..

**Record keeping/QA**
In the mid to late 1980s, I-21 was considering the licensing and dealing with the regulator (the Radiochemical Inspectorate). The LLWR Authorisation was not very specific and only loosely defined the activity limits and radionuclides. The Authorisation issued in the mid 1980s was written in response to a post-closure assessment that considered the risk posed in the future by the actual radionuclide inventory. For example, C-14 would not have been considered as important prior to mid 1980s, but after the Authorisation it was then regarded as more important. Subsequent Authorisations have varied slightly, but are based on the one in the mid 1980s.

**Are waste disposals located where the records say they are?**
No information given.

**Are accurate waste volumes recorded?**
I-21 noted that there was quite a substantial mass of uranium in the trenches, the majority of which came from Springfields. However, a lot of work has been done to work out where it is buried.

**Is the activity disposed of what is on the records?**
No information given.

**Form of radionuclides?**
No information given.

**Are the materials disposed of what is on the records?**
No information given.

**Key messages**
This interview gives another reference that a number of changes were made after the Authorisation in the mid 80s

**Notes made by:** Victoria Smith

# Interviewee 22

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| **Interview number: 26** | **Interview with:** Interviewee 22 (I-22) | **Recorded on:** 12th March 2009 |
| **DVD number:** 2nd Interviews, Disc 2 | **Interview duration:** 56 minutes | |

**Interviewee's role at LLWR or elsewhere, including dates**

I-22 joined BNFL in the early 1970s after completing a degree in physics and went into the Health Physics (HP) Department. I-22 stayed in this department for 30 years, but moved around the site doing different roles. I-22 was never a consignor, but advised the building consignors whether the waste generated was within Drigg limits. This decision was based on the disposal Authorisation and the practical application of complying with the Conditions for Acceptance (CfA), as understood locally by HP Department .

**Points of note**

- I-22 recommends reviewing the following reports as they outline how the waste was to be disposed (i.e. packaged) and the conditions for acceptance; Windscale and Calder Works Health and Safety Regulations, 1970, 1975, 1980, 1985 versions. These will also show how the criteria changed and were tightened up. I-22 was very confident that waste assigned to the Repository would have met the criteria specified in the regulations. These would be based on the 1960 RSA granted by the Ministry Inspectorate of Pollution and the Ministry of Agriculture, Fisheries and Food.
- I-22 worked in the HP Environmental Surveys team, which focussed on potential exposure pathways. In the case of LLWR, this was concerned with the dose a person would receive if they were standing on top of the trenches and this was linked to the limits on individual bags. A second pathway was that of leachate into the stream running through the site, from which beef cattle outside the site drank. The Environmental Surveys team would buy the cattle, perform tests on the meat and relate any radioactivity back to the monitoring in the stream.
- The role of the HP Department changed over the years. Their main role was to act as 'policemen', since it was felt that people could take short-cuts to dispose of higher-activity wastes. Although there was a defined route for the higher-activity wastes, these were more difficult, as the waste 'coffins' were in short supply, resulting in competition between the buildings, and there was more accompanying paper work. Drigg was seen as an unlimited resource where 'anything' could be sent.
- It was a number of years before locks appeared on the skips, so it is possible that some fly-tipping disposals could have been made, but I-22 felt that this would have been a very small fraction of the total waste.
- I-22 noted that there was limited opportunity for monitoring on an individual bag basis, and it was not until the late 1990s that detailed checking of the wastes against building fingerprints was introduced. I-22 noted that practice improved dramatically over the 30 years they worked there.
- Numerous items were consigned to LLWR. Some common items include gloves, of which many thousands must have been sent, tools and paper towels. There are some 35 mm slides that were used for training purposes that show examples of waste consigned to the LLWR.
- Although the HP Department was one of the largest, they would sit down at lunchtimes and exchange news and incidents from across the site. I-22 did not hear of any major incidents at LLWR. For a period, I-22 was on the investigation team which looked into various incidents across the Sellafield site. In the case of LLWR, I-22 recalls one incident where the site manager refused permission to tip a load and it was requested that other arrangements be made for its disposal. I-22 thinks that this was not related to the physical measurements, but something else logged in the paperwork. The investigation team was suspended as there was a witness account that I-22 had granted a specific concession for the item in question and the issue went to a full board of enquiry. I-22 was absolved, but feels this demonstrates how seriously the Conditions for Acceptance were taken by the management.

- The military nature of some of the work on the Sellafield site meant that HP probably did not know what was going in during the 1970s. It is likely that most of this military waste was not within Drigg limits, however I-22 doubts they were major consignors to LLWR. The major consignors would have been B205, reprocessing plant and the associated B268, and the Effluent Treatment Plant.

**Record keeping/QA**
The old records did not note the activity.

**Are waste disposals located where the records say they are**?
No information given.

**Are accurate waste volumes recorded?**
No information given.

**Is the activity disposed of what is on the records?**
No information given.

**Form of radionuclides?**
No information given.

**Are the materials disposed of what is on the records?**
No information given.

**Key messages**
Disposal of ILW was not straightforward. LLWR could have been seen as an easier option for some supervisors

**Notes made by:** Victoria Smith

# Interviewee 23 and Interviewee 24

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| **Interview number: 27** | **Interview with:** Interviewee 23 (I-23) & Interviewee 24 (I-24) | **Recorded on:** 13th March 2009 |
| **DVD number:** 2nd Interviews, Disc 2 | **Interview duration:** 36 minutes | |

**Interviewee's role at LLWR or elsewhere, including dates**
Both I-23 and I-24 have been searching through LLWR records and public records to provide an estimate of the inventory in the trenches. They now both work for NNL.

**Points of note**

- In the late 1990s, as a graduate, I-24 went to search through the disposal records at LLWR with a view to assessing them for the 1998 inventory.
- The disposal record up to 1987/8 only had details of dose readings and no activity information so about three quarters of the records were of no help in drawing together an inventory and identifying the radionuclides. They do detail when and were the consignments were tipped though.
- I-23 said that as a starting point, they took the then current national inventory (the 1994 inventory, which was being updated to the 1998 version), which covered all the current waste-streams and their radionuclide fingerprints. An assumption was made that the plants currently assigning known radionuclide fingerprints and waste would have been assigning similar wastes in the past. Taking the known volumes and dose readings from the disposal records, the current waste-stream radionuclide inventory could be used to back-calculate the radionuclides from earlier years. This holds for routine plant consignments, but if the plant changes process then this approach was not so accurate – *it has been noted by other interviewees that plants changed process and that consignments changed over the years.*
- It was noted that it was very cheap to dispose of waste into trenches (less than the cost of municipal tipping) so many non-contaminated and clean items went into the trenches. In the present day, the costs are much greater and so waste is segregated.
- They noted that as LLWR was considered part of the Sellafield site, and Sellafield consigned the majority of the waste, their paperwork was not as detailed as that of external consignors. They noted that Sellafield sent 80% of the waste, but less than 80% of the activity.
- External consignments had to be considered, of which there were a number of examples:
  Thorium containing ores were tipped in the 1960s.
  Thorium sands – these were stored on site in the 1960s, taken off site then returned for disposal in the 1970s.
  Radium sands – records were found in the UKAEA archives to indicate that these were tipped, but that those bags which had not split were later recovered for re-use..
  MoD - some radium dials were disposed. It was noted that some equipment was ignored in the interests of completing the radionuclide inventory to schedule.
- Waste was transferred from the magazines into Trench 2. They considered that the waste tipped into the trenches only contained small amounts of uranium and plutonium and so, after review, was within Drigg limits. The drums were buried in clean soil.
- Hex cylinders were sent from Capenhurst and tipped into Trench 3. These were stored on site for some time, but a report in 1976 outlined concerns about the production of HF gas from hydrolysis of uranium hexafluoride, so they were tipped into the trenches so that workers would not be harmed. Concerns remain over voidage. They were empty drums and as they decay they may collapse, causing subsidence.
- In terms of the post-closure assessment, uranium posed one of the highest risks, so there was a need to understand and characterise the uranium inventory further. Work was undertaken to record all the uranium from Springfields, and this detailed analysis resulted in the total uranium inventory decreasing.

- Since the mid 1980s, more detailed fingerprints of the waste going into Vault 8 have been made. Fingerprints have been taken over the 20-year period from 1988 to 2007, covering Trench 7 and Vault 8.
- It was noted that just because the waste was listed in the UK Radioactive Waste Inventory (UK RWI), it did not necessarily mean that it was consigned to LLWR.
- There was a tendency to over-estimate. They compared the Vault 8 records against the disposal records of the UKRWI and found an over-estimate in the data compared to the amount actually disposed. They found this to be the case on a number of occasions and a quick discussion with the workers often backed this up.
- As Vault 8 disposals are more expensive, the frequency and volumes of waste disposed was less.

**Record keeping/QA**
A database was set up, cataloging the disposal records (date, consignor, waste ID etc), which was able to correlate the disposal dates with locations within the trenches.

**Are waste disposals located where the records say they are?**
The thorium sands were documented as being tipped in Trench1, Bay 1. However, the sands did not arrive on site for tipping until after Trench 1 had been in operation for some time. After investigation, it was found that the sands had been tipped into Trench 2, Bay 1, even though Trench 1 was still operational at the time of the tipping. *(It was noted by I-18 that Trench 1 was not filled north to south (as other trenches were) and if this is correct then Bay 1 would not have been filled first. According to the dates on consignment notes, it should have been clear how the trenches were filled with respect to grid positions).*

There is some uncertainty in the recorded locations of the waste because the process of tumble-tipping would result in some wastes 'rolling' into other grid positions (although the waste would probably not be too far away from the recorded location).

**Are accurate waste volumes recorded?**
I-23 and I-24 are not sure about the accuracy but know there are extensive records of the volumes disposed of.

**Is the activity disposed of what is on the records?**
No information given.

**Form of radionuclides?**
No information given.

**Are the materials disposed of what is on the records?**
No information given.

**Key messages**
I-23 and I-24 also spoke to people during their investigations.

Just because the waste was in the UKRWI it did not necessarily mean that it was consigned to LLWR.

There was a tendency to over-estimate, which was demonstrated when looking at the uranium inventory in more detail.

There are known hot-spots, mostly attributed to external consignors.

**Notes made by:** Victoria Smith

# Interviewee 25

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| **Interview number: 28** | **Interview with:** Interviewee 25 (I-25) | **Recorded on:** 6th March 2009 |
| **DVD number:** 2nd Interviews, Disc 2 | **Interview duration:** 9 minutes | |

**Interviewee's role at LLWR or elsewhere, including dates**
It is thought that I-25 worked in the site clearance team. One of I-25's responsibilities was controlling the bird population in separation area (B29 pond). This task included pricking or removing the eggs as well as clearing up all the bird mess.

**Points of note**
- In 1957/8, seagulls were drinking water from the B29 pond and nesting on the roofs and guttering of near-by buildings.
- I-25 recalls collecting a couple of eggs. Even after scrubbing them, the contamination level remained too high for them to be taken through the barriers. I-25 was not sure of the activity levels but they were classed as LLW. In addition, the yolks were rotten.
- Sparrows nested on the skip handler during the night.
- The mess was placed in a paper bag and sent to LLWR.

**Record keeping/QA**
I-25 noted that there was a lot of paperwork associated with consigning waste to LLWR.

**Are waste disposals located where the records say they are?**
No information given.

**Are accurate waste volumes recorded?**
No information given.

**Is the activity disposed of what is on the records?**
No information given.

**Form of radionuclides?**
No information given.

**Are the materials disposed of what is on the records?**
No information given.

**Key messages**
Bird mess and eggs were sentenced to LLWR on a fairly regular basis.

**Notes made by:** Victoria Smith