LLW Repository Ltd

LLWR Environmental Safety Case

User Guide for PIER V2.2: A Tool for Calculating the Forward Inventory of LLWR

A report prepared by Serco for and on behalf of the Low Level Waste Repository Site Licence Company.

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User guide for PIER V2.2 :
A tool for calculating the forward inventory of LLWR

Prepared for	**LLW Repository Ltd**
Prepared by	**Serco**
Your Reference	**LLWRP1106**
Our Reference	**SERCO/E003756/013 Issue 2**

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Executive Summary

This document presents a user guide for V2.2 of PIER (Projected Inventory Evaluation Routine) a model for calculating the forward inventory of LLWR from data extracted from WIDRAM, and assumptions about waste routing and processing. The model has been produced in response to the needs of the 2011 Environmental Safety Case (2011 ESC), which requires a robust method for estimating the forward inventory of LLWR under a variety of alternative assumptions.

The projected forward inventory of LLWR will be a key input to the 2011 ESC. A number of issues are fundamental to projecting the forward inventory:
- Projected waste arisings
- Waste routing
- Waste processing

These are all subject to potentially significant uncertainty. The most effective method of developing inventories for different forward cases, and hence to providing the information necessary to assess the significance of the uncertainty, is to make use of a model, based upon the best available data for forward projections and simple but realistic algorithms. This report describes a model for projecting the forward inventory of LLWR. The function of this document is not to describe the implementation of the model in detail: rather it concentrates on approach, calculation route and the nature of the outputs.

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1 Introduction

The projected forward inventory of LLWR (the Low Level Waste Repository near Drigg) will be a key input to the 2011 Environmental Safety Case (2011 ESC). A number of issues are fundamental to projecting the forward inventory:

- Projected waste arisings – the base information here is the 2007 National Inventory [1], although there will be a need to acknowledge potential arisings from new nuclear build.

- Waste routing – there are, as yet, a number of uncertainties over which waste streams will be routed to LLWR: for example, it seems possible that a number of LLW streams routed to LLWR in the 2007 National Inventory may be reclassified as VLLW and routed to a fit for purpose disposal facility.

- Waste processing – the NDA National LLW Strategy [2] proposes a number of waste processing initiatives, such as the smelting of metals, to reduce the volume of material emplaced at LLWR, this may affect the ultimate capacity of the facility. The extent and effectiveness of these approaches are uncertain.

These uncertainties need to be taken account of in developing potential forward inventories for LLWR. The most effective method of of developing inventories for different forward cases, and hence to providing the information necessary to assess the significance of the uncertainty, is to make use of a model, based upon the best available data for forward projections and simple but realistic algorithms.

This document presents a user guide for V2.2 of PIER (Projected Inventory Evaluation Routine), a model for calculating the forward inventory of LLWR. It uses as its base data information from the 2007 National Inventory [1] as elaborated in Widram 2009. The model is devised to facilitate updating these base data as improved information becomes available. The model permits the raw data to be filtered to reflect alternative assumptions about waste routing. It also accommodates a number of alternative waste processing routes, allowing different assumptions to be made about availability and effectiveness. The model generates predictions of annual contributions to the LLWR inventory by material, volume and radionuclide. It also provides inventory data by vault.

This report is structured as follows:

Section 2 provides an overview of the calculation route adopted and indicates the QA regime adopted to ensure that the calculation route produces the intended outputs
Section 3 discusses the raw input data
Section 4 indicates how waste routing is implemented by filtering the raw datasets
Section 5 describes the inventory calculation
Section 6 gives an overview of the programme outputs.

2   Overview

The forward inventory calculation is undertaken in two independent steps as indicated in Figure 1. In the first step, datasets are prepared which contain inventory information on those waste streams assumed to be disposed of at LLWR. The second step calculates volumetric, materials and radionuclide inventories as a function of time based on assumptions about the nature, extent and effectiveness of waste processing activities. These time-based data are used to generate inventories by vault.

This two-step approach is adopted to allow alternative assumptions about waste processing to be explored without unnecessarily incurring the overhead associated with filtering the raw data to accommodate assumptions about waste routing. To ensure that the output datasets are always consistent with the filtered data, and thus avoid potential confusions, the filtration routine begins by deleting all information in the output sheets.

Raw inventory data, derived from Widram, are held in three separate input datasets covering:
- Radionuclide concentrations for each stream;
- Non-radioactive material composition for each stream;
- The phasing of arisings for each stream, plus the assumed make-up of the stream in terms of waste type (waste type being used to determine the processing route, if any, for components of the waste stream).

An understanding of the data and the way in which it is processed depends critically on a clear understanding of the way in which the terms 'Waste stream', 'Waste type' and 'Material type' are used in this document.
- 'Waste stream' has the same definition as that used in the National Inventory [1].
- 'Material type' is taken to mean the chemical composition of the waste in broad terms as defined in the National Inventory – for example 'stainless steel' or 'asbestos'.
- 'Waste type' is essentially an aggregation of 'material types' and is used within the model to define processing routes. The relationship between 'Material type' and 'Waste type' is discussed at more length in Section 5.3.1.

The first step takes these raw inventory data and uses a set of user-specified criteria to filter out those waste streams which are not assumed to be destined for LLWR. It outputs three filtered datasets containing only those records which pass the filtration criteria.

In the second step, these filtered data are combined with information on waste processing by compaction, incineration and metal smelting to produce radiochemical and material inventories for LLWR as a function of time and of vault. These inventories take account of limitations to the capacity of processing routes, the generation of secondary wastes and, where appropriate, the association of radionuclides with different waste types.

Calculations are undertaken using a number of Visual Basic routines operated from 'buttons' on data input sheets. Data are output to output worksheets. A list of input and output worksheets, and of their basic functions, is given in Table 1. All raw inventory data for the calculation routines was independently checked against the original information supplied by NNL to ensure that it had been correctly extracted. The functionalities of the VB routines for data filtration and for the processing calculation were checked through a series of hand and spreadsheet calculations undertaken independently of the originator of the VB code to ensure that the data output by the tool is consistent with the description given in this document.
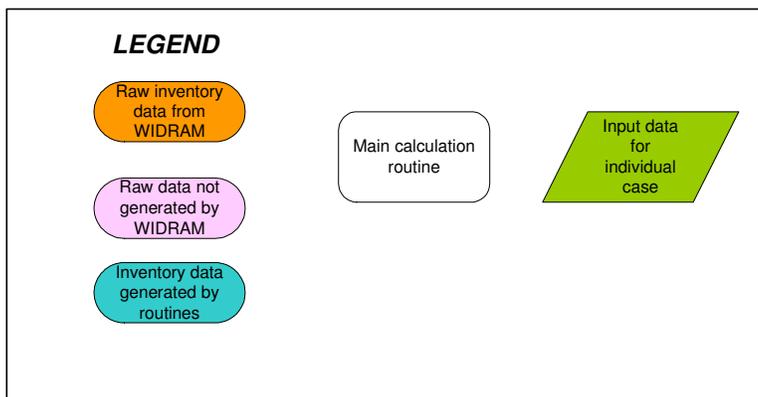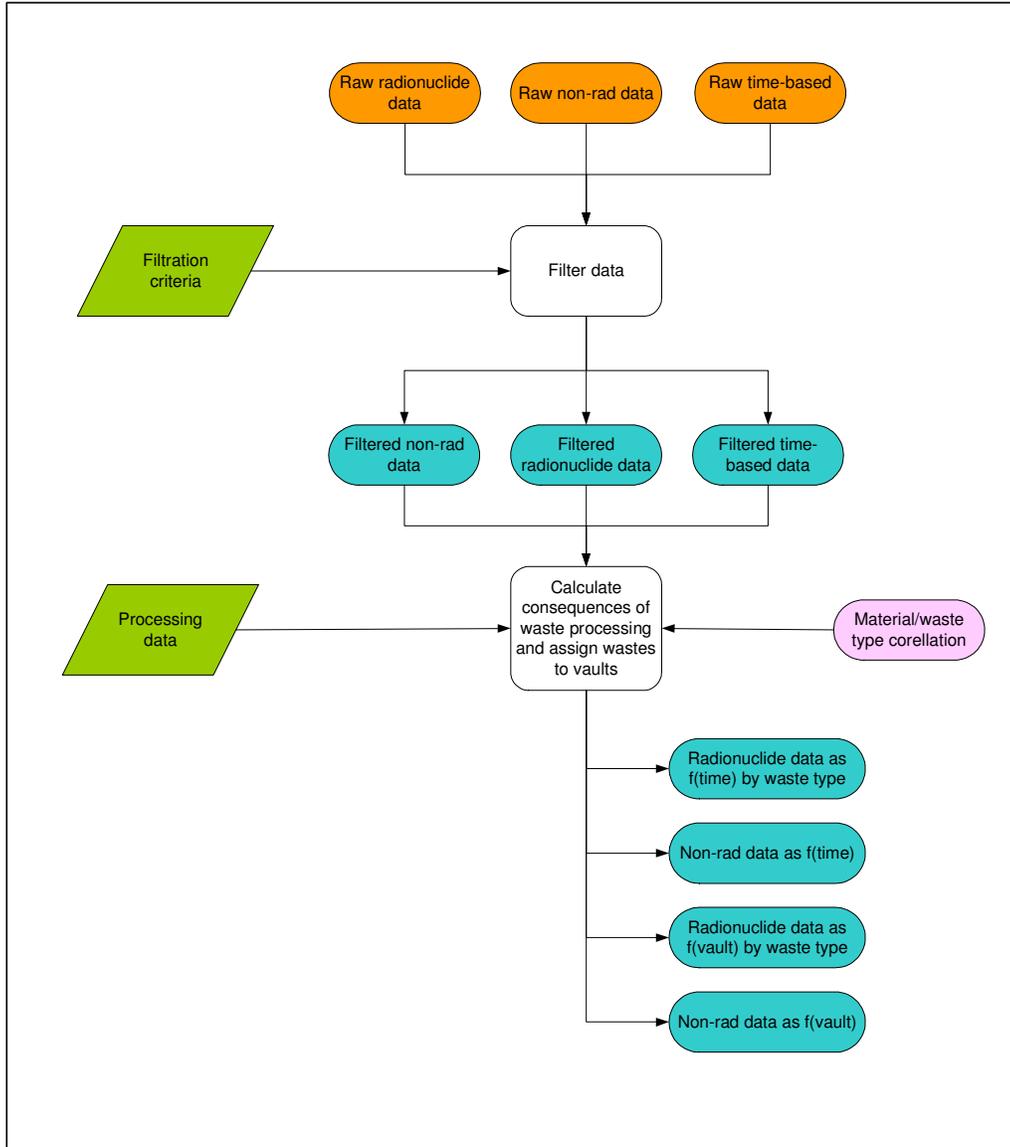
Figure 1: **Overview of calculation route**

	Worksheet name	Function
Case control information	**Filter data**	Contains data controlling which waste streams are destined for LLWR, and facilities to launch the data filtration routines. It also contains facilities for updating some of the information in the raw data tables.
	Process data	Contains the information necessary to calculate the volumetric, radionuclide and materials inventories as a function of time and vault. Also provides facility to launch the inventory calculation.
Raw Widram data	**Time based data**	Widram data describing waste type and arising profiles on a stream-by-stream basis. The worksheet also contains flags controlling the inclusion or exclusion of streams from the LLWR forward inventory, and the assignment of radionuclides between different waste types.
	Rad data	Widram data describing radionuclide inventories on a stream-by-stream basis.
	Nonrad data	Widram data describing materials inventories on a stream-by-stream basis.
	Correlate	Data showing how the materials inventory and the assigned waste types which drive waste processing are correllated.
Output data	**Single stream**	Provides information on the location of a selected stream within the vaults.
	Filtered data time	Information in 'Time based data' filtered to exclude those wastes not assumed to be disposed of at LLWR.
	Filtered data rads	Information in 'Rad data' filtered to exclude those wastes not assumed to be disposed of at LLWR.
	Filtered data nonrads	Information in 'Nonrad data' filtered to exclude those wastes not assumed to be disposed of at LLWR.
	Vault dates	Closure dates for vaults.
	Graphite	Volume and radionuclide information for waste types as a function of time and vault. The sheets contain information only for those elements of the waste streams which have not been processed.
	Metals	
	Oils	
	Other	
	Plastic rubber	
	Soft organics	
	Soil rubble	
	Wood	
	Unknown material	
	Compacted puck	Volume and radionuclide information for secondary wastes arising from processing as a function of time and vault.
	Incinerator ash	
	Incinerator filter	
	Smelting slag	
	Smelting filter	
	Totals	Total volume and radionuclide inventories by year and by vault.
	Nonrad raw	Non-radioactive materials arisings by year. Takes no account of processing.
	Nonrad processed	Non-radioactive materials inventory by year and by vault. Accounts for the effects of waste processing.
	Data hidden	Used to store interim data. Not routinely visible to user.

Table 1:   Worksheets in V2.2

3 Base input data

3.1 Base data and its location

The base input data for the inventory calculation are held in four sheets:
- Time based data
- Rad data
- Nonrad data
- Correlation

Data in the first three sheets have been directly derived from data held in Widram 2009 [3, 4]. Where the work of Swanton [5] identified clear errors in the database, these were corrected. The fourth of these spreadsheets has been constructed as discussed later.

Time based data
The function of this sheet is to provide information on the arisings from individual waste streams as a function of time. In addition, it holds some useful descriptive material on each stream and information on the composition of the stream in terms of waste type. Details of each field in this dataset are given in Table 2. In addition to this information, the sheet also holds flags controlling the routing of wastes (Flag 1) and the assignment of radionuclides to components of the waste stream (Flag 2). The significance of Flag 1 values is given in Table 3.

Rad data
This sheet contains information on the radionuclide content of each stream. A description of individual fields and their significance is given in Table 4.

Nonrad data
This sheet contains information on the chemical composition of each stream. A description of individual fields and their significance is given in Table 5.

Correlation
This sheet holds information on the correlation between chemical composition and waste type for each stream. This information is discussed further in Section 5.3.1.

3.2 Accounting for new nuclear build

LLWR wish to make an estimate of the LLW arisings from potential new nuclear build and of their effect on the 2011 ESC. Inventory data are not available in Widram 2009, and have therefore to be estimated. Two issues need to be addressed when evaluating the potential arisings from new nuclear build:
- The type, volume, inventories and phasing of arisings from a single new-build reactor;
- The number of reactors to be constructed, and their phasing in time.

Both the reactor types currently expected to be constructed in the UK in the near to medium term (the AP1000 and the EPWR) are PWRs. No definitive data, expressed in UK classifications, are presently available on LLW arisings for these designs. We have therefore followed the approach adopted by Taylor [6], and assumed that the volumes and radionuclide inventories of waste arisings are the same as those given in the National Inventory for the Sizewell-B, making the assumption of a 60-year operating lifetime. It is recognised that this approach may well lead to an overestimate of arisings, as both AP1000 and the EPR are designed to give rise to lower quantities of operational and decommissioning LLW than Sizewell-B. However, the assumption made here is viewed as cautious and the most appropriate given present uncertainties, and could straightforwardly be updated if better information becomes available.

The number of new build stations is a rather less certain issue. The assumption made in the dataset built into V2.2 is for a total of eight new stations, with the first raising power in 2020 and the others at four-year intervals thereafter.

	Field	Function
	Site	Site at which waste originates
	Waste Category	Waste category
	Stream	Stream number
	Flag 1	Flag to control data filtration
	Flag 2	Flag to control assignment of radionuclides to waste type
	Description	General description of waste stream
	Physical Description	Description of physical state of waste stream
	Chemical Description	Description of chemical nature of waste stream
	GenericRoute	Route assumed in National Inventory
	PackageType	Package type
	Packaging Factor	Packaging factor
Waste type	**Graphite (Vol%)**	Fraction of waste stream assumed to be of given waste type / % by volume
	Metals (Vol%)	
	Oil (Vol%)	
	Other (Vol%)	
	Plastic / Rubber (Vol%)	
	Soft Organics (Vol%)	
	Soil / Rubble (Vol%)	
	Wood (Vol%)	
	Unknown Material (Vol%)	
	Year	Volume of stream in given year / m^3 ('Stock' taken as arising 2007)

Table 2:   Fields in 'Time based data'

Flag 1	Significance
0	Always exclude
1	Always include
2	Orphan waste stream
3	LLW routed to GDF
4	New build waste
5	Waste arising from remediation of contaminated land
6	Wastes which might be reclassified as VLLW

Table 3:   Significance of 'Flag 1' values

Field	Function
Site	Site at which waste originates
Stream	Stream number
Waste Stream Description	General description of waste stream
Total Activity Concentration	Total activity concentration in stream / TBq m^{-3}
Ac227	
Ag108m	
Ag110m	
Further radionuclides	Activity concentration in stream / TBq m^{-3}
.	
.	
.	

Table 4:   Fields in 'Rad data'

Field	Function
Site	Site at which waste originates
Waste category	Waste category
Stream	Stream number
Description	General description of waste stream
Aluminium metal	
Aqueous Liquid	
Asbestos	
Further materials	Fraction of stream comprised of material / % by vol
.	
.	
.	

Table 5:   Fields in 'Nonrad data'

4   Setting the waste destinations - Data filtration

4.1   Introduction

This section describes the facilities provided to construct datasets representing different waste routing scenarios. This is achieved by taking the information in the raw datasets and filtering them to remove those records representing streams not to be disposed of at LLWR. The process is controlled from the sheet 'Filter data' shown in Figure 2. This sheet also allows modification of the flag in 'Time based data' which, as described in Section 3, is used to control the filtration process.

4.2   Filtering the data

The area of the sheet marked 'A' in Figure 2 controls the waste streams allowed to pass the filter, and thus form part of the inventory of LLWR. The inclusion or exclusion of streams is controlled by Yes/No responses selected from dropdown boxes. The precise significance of the responses is shown in Table 6. It should be noted that the filter settings corresponding to 'Always exclude' and 'Always include' are not under the control of the filter and are always implemented.

Criterion	Routed to LLWR on response	
	Yes	No
Include orphan wastes	✓	✗
Include LLW for GDF	✓	✗
Include new build wastes	✓	✗
Include wastes from conland remediation	✓	✗
Reclassify wastes as VLLW[1]	✗	✓

Table 6:   Filter controls

Area 'B' on the sheet contains information about the size of the raw data tables, indicating the total number of raw records, the number of years for which time-dependent data are available and the first year for which data are available (taken to be the 'stock' value from Widram). It is the responsibility of the user to ensure that these are correctly set. Button 'C' initiates the preparation of filtered datasets. It should be noted that, to help ensure that all the output datasets reflect the content of the filtered datasets the button also deletes all previously calculated inventory data.

4.3   Controlling the filtration flags

A default set of values for the filtration flag, *Flag 1*, is provided with the programme. It is recognised, however, that for sensitivity analysis and for other investigations, it may be desirable to modify the values assigned to some or all of these streams, and the 'Filter data' sheet provides facilities to allow these changes to be made.

Area 'D' allows the flag associated with an individual stream to be assigned a specific value. The stream name and flag are selected from drop-down lists, and the change is implemented by using the 'Modify flags' button.

When a set of changes to flag values have been made it may be useful to store and assign a complete set of filtration flags. This is effected using areas 'E' and 'F' on the sheet. Up to 10 sets of

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[1] Refers to wastes currently classified as LLW but which could in future be reclassified as VLLW

user-defined flags can be stored within the model and recalled as required. Area 'F' allows the set of flags currently implemented in the input datasets to be stored in the set selected in the drop down box. Area 'E' allows a set of stored flags to be imported into the input dataset: these can either be one of the ten user-defined sets or the default dataset. Note that to prevent inadvertent loss of default data no automatic facilities are provided for modifying the stored default flag values: this can be achieved only by directly editing information in the hidden datasheet.

Button 'G' sets the filtration flags to exclude all streams. This facility was primarily provided to facilitate the construction of restricted datasets during model development and testing, and has been retained for these purposes.

FILTER		
Include orphan wastes	NO	
Include LLW for GDF	NO	A
Include new build wastes	YES	
Include wastes from conland remediation	NO	
Reclassify wastes as VLLW	NO	

Number of raw records ======>	963	
Number of years ===========>	121	B
First year ================>	2007	

Apply filter   C

MODIFY FILTER FLAGS

Stream	1A03	D
Flag	Always include	

Modify flags

USE STORED FLAGS

Flagset	Default	E

Use stored flags

UPDATE STORED FLAGS

Flagset	10	F

Update stored flags

G   **Exclude all streams**

Figure 2:   Sheet 'Filter data'

5 Calculating volumetric and radiological inventories

5.1 Introduction

This section of the report describes the calculation route used to determine the volumetric and radionuclide inventory of LLWR from the filtered raw data. Similar calculations are used to determine the inventories of non-radioactive materials. What follows is not intended as a detailed description of the code that underlies the calculations. Rather it indicates the basis of the calculation route and indicates, where appropriate, the algorithms underlying each calculation step.

5.2 Overview of calculation

Figure 3 shows, in outline, the calculation route adopted.

For each stream, the programme determines what fraction of the waste is associated with each waste type. This is achieved either by reading the data extracted from the Widram database and included in the sheet 'Time based data' or by using materials compositions in the sheet 'Nonrad data' and the material/waste type correlations in sheet 'Correlate'.

The model then determines for each year's arisings what volume of each waste type is associated with the stream, and on the basis of this information calculates the volume of each waste type to each treatment route. In making this determination the model recognises that:
- Not all waste types will be treatable: these waste types are passed through to the final inventory unprocessed;
- Not all treatable wastes will be segregated, and there will not necessarily be the capacity to treat all the segregated material.

The model then determines the volumes and radionuclide inventories associated with those wastes that are untreated, and the volumes and radionuclide inventories associated with secondary wastes arising from waste treatment. These values are then summed by emplaced waste type and by year to provide annual contributions to LLWR inventory. The model also calculates total annual volumetric and radionuclide inventories for the facility.

The total volumes are used to determine the dates at which individual vaults are predicted to be filled. This calculation takes account of the packing efficiency of wastes into HHISO containers and the packing efficiency of containers into vaults. These dates are used, in conjunction with the annual data already calculated, to determine inventories of individual vaults.

5.3 Defining the inventory calculation

The waste inventory calculation is undertaken using parameters held in the sheet 'Process data', which is shown in Figure 4. The values shown in the figure are not necessarily final values or best estimates, but are, where appropriate, broadly consistent with those used in calculations in support of the National LLW Strategy [7].

5.3.1 Materials and waste types

Area 'A' on the sheet controls the way in which the fraction of each waste stream associated with each waste type is calculated. The model allows two options, controlled by a selection in the dropdown box.
- 'Filtered list' uses the values in sheet 'Time based data' – these are drawn directly from Widram downloads.

- 'Correlation' uses the materials data held in 'Nonrad data' and a correlation between materials and waste types held in 'Correlation'.

The correlation matrix shows how materials should be distributed between waste types. The data are user defined, and there is no necessity for a materials type to be uniquely assigned to a waste type – it is permissible to split one material between waste types in a given ratio if desired. It is the user's responsibility to ensure that the fractions of a given material allocated across waste types sum to unity.

It should be noted that these two calculation routes do not give equivalent answers. This arises because there is no coherent correlation between the materials data in Widram 2009 [4] and the waste type data from the same source. The matrix provided has been devised to give as close an overall match as possible, but agreement is far from exact in all cases. As a result, if 'Filtered list' is selected from the drop down box the radiological inventory will be calculated without reference to the materials data, whereas this is not, indeed cannot, be the case for the non-radiological inventory. This results in some small inconsistencies between the two approaches. Selection of the 'Correlation' option is therefore recommended to ensure self-consistent inventory data.

5.3.2 Segregation efficiency

Area 'B' on the sheet contains the fraction of treatable waste types assumed to be segregated from the overall waste stream. This is a parameter freely defined by the user, who must ensure that it is positive, greater than zero and less than or equal to one. The same value is applied to all waste streams and to all waste types.

5.3.3 Associating radionuclides with waste types

Each radionuclide within a waste stream is distributed between waste types proportionally to volume. A flag is provided in the input data to allow different arrangements to be implemented for individual waste streams if desired.

5.3.4 Assigning segregated wastes to processing routes

The model recognises four approaches to waste treatment:
- Disposal unprocessed
- Compaction
- Smelting of metals
- Incineration.

Area 'C' of the sheet indicates how different waste types are assigned to the different treatment options. Each cell of the matrix indicates what fraction of the waste type is to be associated with each processing route. The rightmost column simply sums the fractions for each waste type as a check that they sum to unity. It is the user's responsibility to ensure that this is the case. These values are applied to all waste streams.

5.3.5 The fraction of segregated wastes actually processed.

The model recognises that not all the treatable material segregated will necessarily be processed. This might arise from limitations in the available processing capacity due either to the build-up of capacity in the UK or to some limitation on what is, in the event, practicable. The variation of processing capacity with time is described by the simple model shown in Figure 5. The user-defined parameters controlling this model for each of the waste processing routes are given in area 'E' of the sheet. The user must ensure that:
- YearA < YearB
- $0 \leq Maxfrac \leq 1$

5.3.6 The generation of secondary wastes

Waste processing routes are assumed to give rise to secondary wastes as follows:

- Compaction
  - Pucks

- Incineration
  - Ash
  - Stack filters

- Smelting
  - Slag
  - Stack filters

The ratio of the volumes of each secondary waste to the volume of raw waste for each route is given as a user-defined parameter in area 'D' of the sheet.

The radionuclide inventory present in the secondary wastes is determined using the information in area 'G' of the sheet, which gives the fraction of the activity associated with the compacted puck, incinerator ash and smelting slag. Where there are two secondary wastes associated with the route, the balance of the activity is associated with the stack filter. In the case of compaction, all the activity is assumed to be associated with the compacted puck. In the case of incineration and smelting, the activity not associated with ash or slag is assumed to be trapped by the filters. All secondary wastes are assumed to be returned to LLWR.

5.3.7 Assignment of inventories to vaults

The opening and closing dates of individual vaults are calculated from the cumulative total waste volume after processing treatable wastes. The calculation of the waste volume which can be emplaced in an individual vault takes account of the packing efficiency of waste into containers and of containers into the vault. Data for the calculation of individual vault capacities is given in areas 'F' and 'H'. Up to 30 forward vaults can be accommodated within the model: area 'F' had been truncated in Figure 4.

5.4 The fate of a single stream

It may be of some interest to understand the location and inventory associated with a single key stream. The calculation can be effected using sheet 'Single stream'. The stream of interest is entered using the drop-down box marked 'Set stream ID' and the calculation initiated using the button 'run single stream'. The remainder of the sheet then presents the radiological inventory data by waste type and vault.

In generating the information, the routine requires the vault opening and closing dates obtained from a full inventory calculation. These dates are stored by the model and accessed as required, and so it is therefore essential that the full inventory calculation is run before the single stream calculation is attempted.
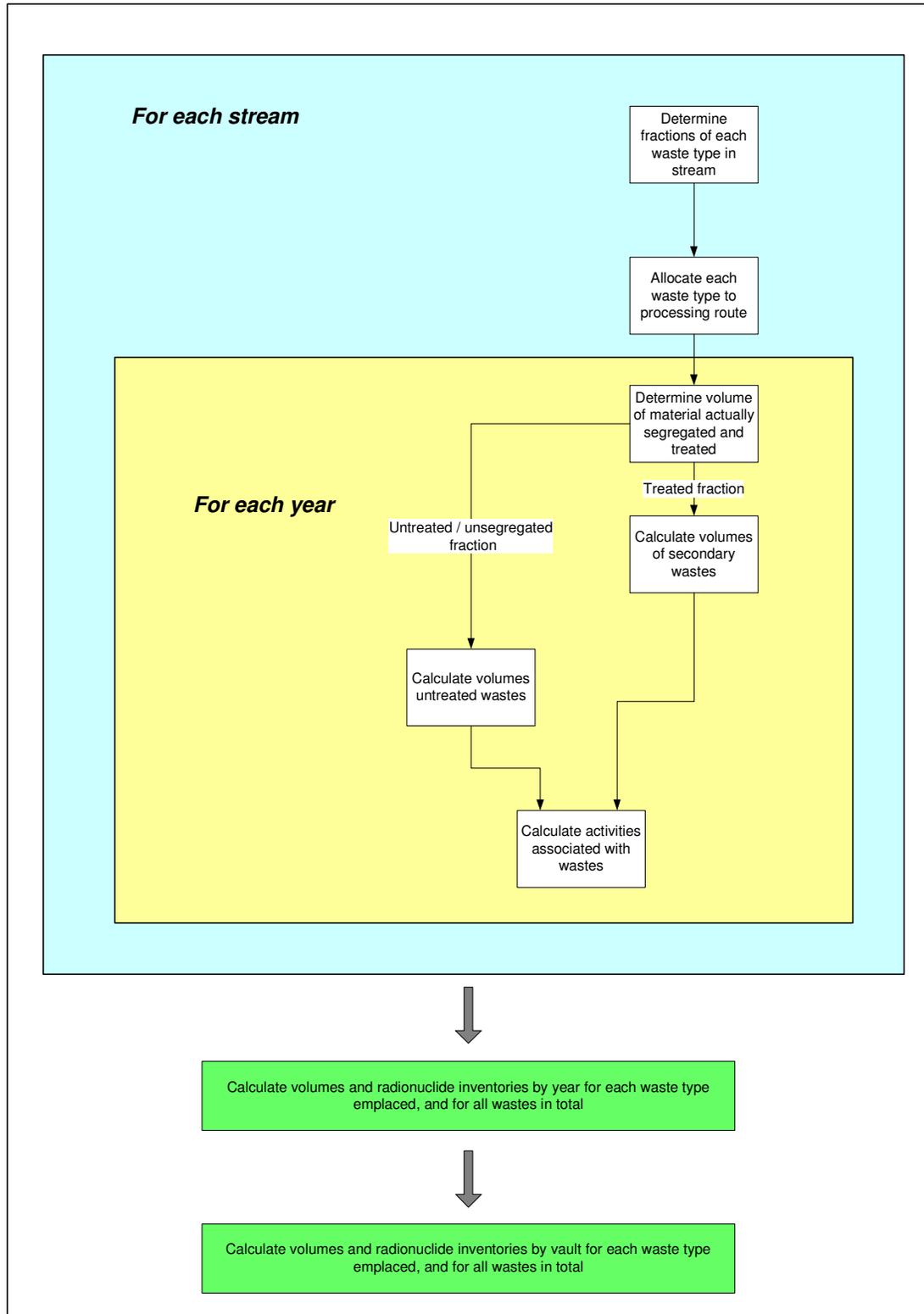
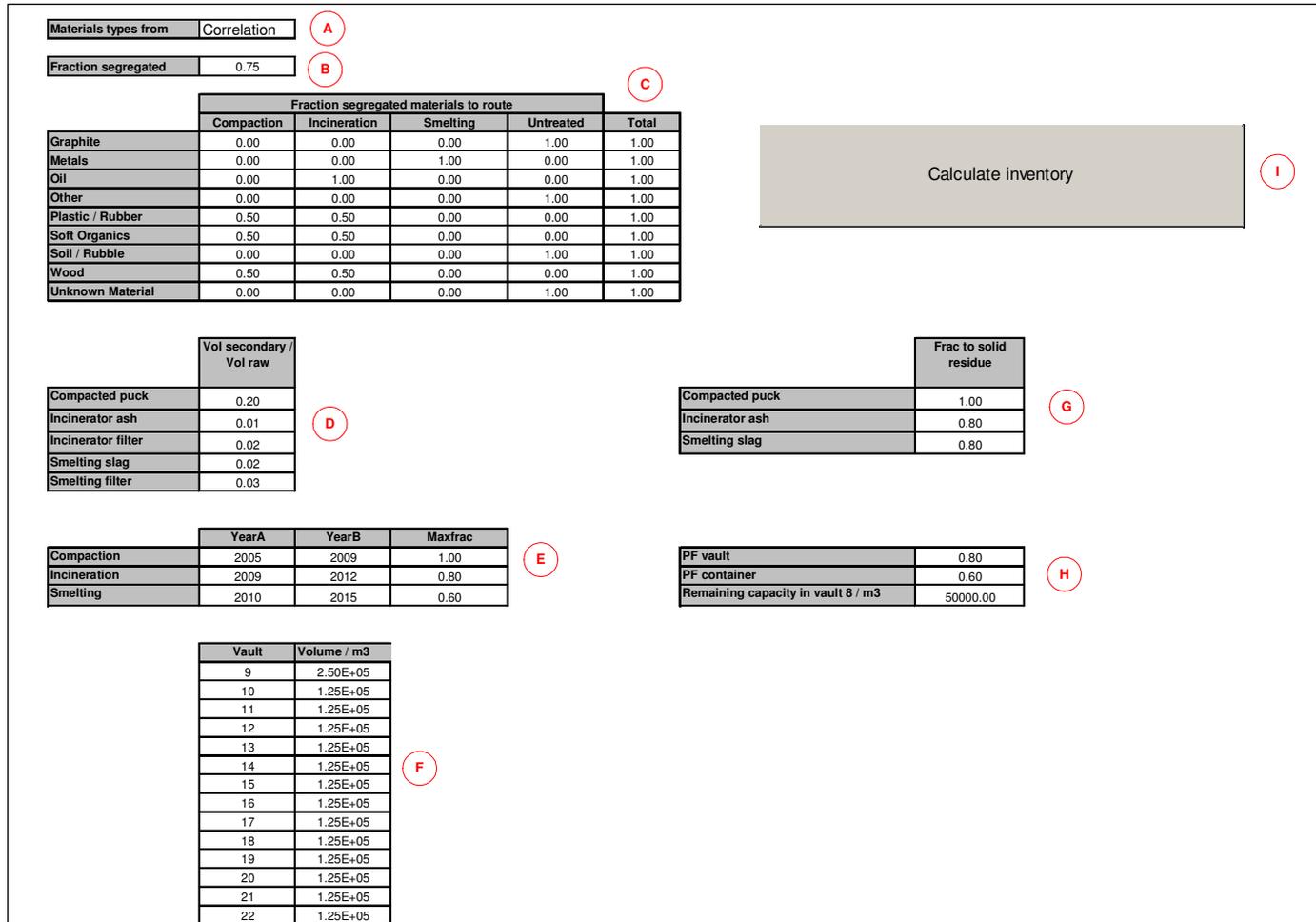**Figure 3:   Overview of inventory calculation**

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| Materials types from | Correlation | | | | | A |

| Fraction segregated | 0.75 | | | | | B |

C

	Fraction segregated materials to route				
	Compaction	Incineration	Smelting	Untreated	Total
Graphite	0.00	0.00	0.00	1.00	1.00
Metals	0.00	0.00	1.00	0.00	1.00
Oil	0.00	1.00	0.00	0.00	1.00
Other	0.00	0.00	0.00	1.00	1.00
Plastic / Rubber	0.50	0.50	0.00	0.00	1.00
Soft Organics	0.50	0.50	0.00	0.00	1.00
Soil / Rubble	0.00	0.00	0.00	1.00	1.00
Wood	0.50	0.50	0.00	0.00	1.00
Unknown Material	0.00	0.00	0.00	1.00	1.00

Calculate inventory   I

	Vol secondary / Vol raw			Frac to solid residue	
Compacted puck	0.20		Compacted puck	1.00	G
Incinerator ash	0.01	D	Incinerator ash	0.80	
Incinerator filter	0.02		Smelting slag	0.80	
Smelting slag	0.02				
Smelting filter	0.03				

	YearA	YearB	Maxfrac		
Compaction	2005	2009	1.00	E	
Incineration	2009	2012	0.80		
Smelting	2010	2015	0.60		

PF vault	0.80	
PF container	0.60	H
Remaining capacity in vault 8 / m3	50000.00	

Vault	Volume / m3
9	2.50E+05
10	1.25E+05
11	1.25E+05
12	1.25E+05
13	1.25E+05
14	1.25E+05
15	1.25E+05
16	1.25E+05
17	1.25E+05
18	1.25E+05
19	1.25E+05
20	1.25E+05
21	1.25E+05
22	1.25E+05

F

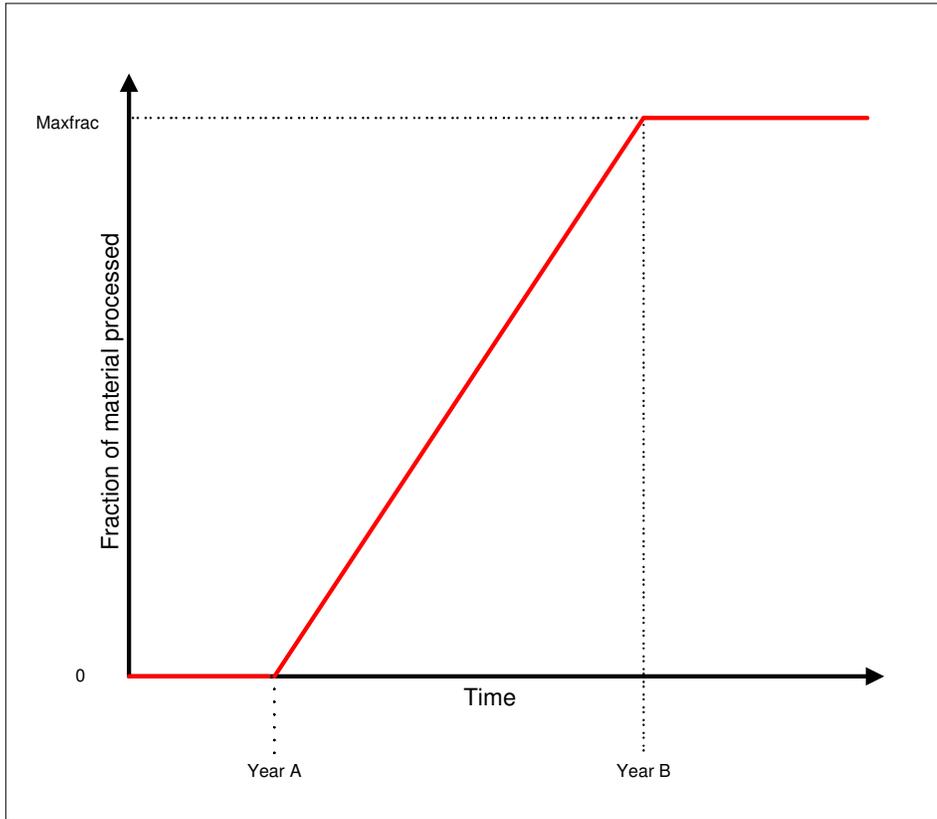**Figure 4:   Sheet 'Process data'**

Figure 5:   Model for availability of processing capacity

6 Output datasheets

The datasheets output from the inventory calculation are outlined in Section 2. Some further details of their structure are given here for convenience.

The following sheets provide information on the inventories of primary wastes (i.e. those wastes that have not been subjected to any processing beyond packaging and placement in a HHISO):
- Graphite
- Metals
- Oils
- Other
- Plastic rubber
- Soft organics
- Soil rubble
- Wood
- Unknown material.

The sheets provide inventory data by year and by vault. The structure of the sheets is shown in Figure 6.

Data on secondary wastes are shown in the following sheets. Their structure of the sheets is the same as that for unprocessed wastes:
- Compacted puck
- Incinerator ash
- Incinerator filter
- Smelting slag
- Smelting filter.

Vault closure dates are given in the sheet 'Vault dates'. The closure date is defined as indicating the end of the financial year in which the vault fills. Also given are the cumulative volume of processed waste at the end of the financial year in which the vault closes, and the cumulative volume of processed wastes accommodated to the closure of an individual vaults.

Total radionuclide data for the facility are given in sheet 'Total' which has the structure shown in Figure 6.

Data on the non-radioactive inventory of the facility are given in two datasheets. 'Nonrad raw' shows the arisings of raw wastes on a yearly basis and takes no account of waste processing. 'Nonrad processed' provides the non-radioactive inventory on an annual basis and vault-by vault, but takes account of waste processing and therefore shoes data on waste volumes of unprocessed and secondary wastes. The structure of this sheet is analogous to that given in Figure 6.

Year / vault	Volume	Isotope 1	Isotope 2	………..
Year 1				
Year 2	Volume of waste emplaced in year (m3)	Inventory emplaced in year (TBq)		
.				
.				
.				
.				

Vault 1				
Vault 2	Volume of waste in vault (m3)	Inventory emplaced in vault (TBq)		
.				
.				
.				

Figure 6:   Output format for radionuclide data

7   References

1   The 2007 UK Radioactive Waste Inventory – Main Report, Defra/RAS/08.002, NDA/RWMD/004, March 2008.

2   UK Management of Solid Low-Level Radioactive Waste from the Nuclear Industry: LLW Management Plan, LLWR Repository Ltd, NLWS/LLWR/05-Rev 1, December 2009.

3   Waste Inventory Disposition Route Assessment Model (WIDRAM) database, National Nuclear Laboratory, NDA02790/06/11/06, September 2008.

4   Excel spreadsheet: 2009LLWRBaselineOutput_LLWR04208061102_Issue 3.xls, National Nuclear Laboratory, dated 13 April 2010.

5   SW Swanton et al, Improvements to the radionuclide inventory of the LLWR, SERCO/TAS/003756/010 Issue 1, April 2011.

6   F. Taylor, Low Level Waste (LLW) Management: LLW from Nuclear New Build, Strategic Brief NWLS/LLWR/STB05, LLWR repository Ltd, August 2009.

7   D. Rossiter. LLWR Segregated Waste Management Services. LLWR Lifecycle Cost Model Analysis. Issue 1. March 2009.