F-3.4.1-1 Rev 6

DOCUMENT COVER SHEET

TDC: ______ Permanent File: ______

DOCUMENT NO.	REVISION	PAGE	ASSIGNED TO	OPEN ITEMS (Y/N)
UKP-GW-GL-004	1	1 of 55	W-Russ	N

DOCUMENT STATUS: ☐ PRE ☐ CFC ☐ CAE ☒ DES

Westinghouse Acceptance of AP1000 Design Partner Document by:

Electronically Approved

(Name and Date)

ALTERNATE DOCUMENT NUMBER: N/A

WORK BREAKDOWN #: N/A

ORIGINATING ORGANIZATION: Westinghouse Electric Company LLC

TITLE: **Process Mass Balance for AP1000 Solid Waste**

ATTACHMENTS: N/A	DCP/DCA/SUPPLEMENTS/EDCR # INCORPORATED IN THIS DOCUMENT REVISION: N/A
CALCULATION/ANALYSIS REFERENCE: N/A	

ELECTRONIC FILENAME	ELECTRONIC FILE FORMAT	ELECTRONIC FILE DESCRIPTION
UKP-GW-GL-036	M/S Word	

All Class 3 Documents require the following two approvals in lieu of a Form 36.

LEGAL REVIEW L. A. Campagna	SIGNATURE / DATE (If processing electronic approval select option) **Electronically Approved*** **
PATENT REVIEW D. E. Ekeroth	SIGNATURE / DATE **Electronically Approved*** **

ORIGINATOR(S) WEC 6.1.pdf L. R. Eisenstatt	SIGNATURE / DATE (If processing electronic approval select option) **Electronically Approved*** **	
REVIEWER(S) WEC 6.1.pdf D. M. Popp	SIGNATURE / DATE **Electronically Approved*** **	
	SIGNATURE / DATE	
	SIGNATURE / DATE	
VERIFIER(S) WEC 6.1.pdf R. P. Vijuk	SIGNATURE / DATE **Electronically Approved*** **	Verification Method: Independent Review

Plant Applicability: ☐ All AP1000 plants except:
☒ Only the following plants: UKP

APPLICABILITY REVIEWER WEC 6.1.pdf N/ A	SIGNATURE / DATE
RESPONSIBLE MANAGER* WEC 6.1.pdf P. A. Russ	SIGNATURE / DATE **Electronically Approved*** **

* Approval of the responsible manager signifies that the document and all required reviews are complete, the appropriate proprietary class has been assigned, electronic file has been provided to the EDMS, and the document is released for use.

****** Electronically approved records are authenticated in the electronic document management system.***

****** Electronically approved records are authenticated in the electronic document management system. This record was final approved on Mar-29-2011. (This statement was added by the EDMS system to the quality record upon its validation.)***

Process Mass Balance for AP1000 Solid Waste

UKP-GW-GL-004, Revision 1

Westinghouse Electric Company LLC
1000 Westinghouse Drive
Cranberry Township, PA 16066

REVISION HISTORY

Revision	Description of Changes
0	Initial Submittal
1	Added radwaste building and spent fuel pool area LLW exhaust filters. HLW package calculation amended to include rod clusters stored within the fuel assemblies during dry storage. Incorporates Design Change Proposals APP-GW-GEE-2083, Rev. 0; APP-GW-GEE-2084, Rev. 0; APP-GW-GEE-2085, Rev. 0.

Process Mass Balance for AP1000 Solid Waste

Process Mass Balance for AP1000 Solid Waste, Aker Solutions Document Number 63000333-000-000-111-C-0001 provides information relating to the number of solid waste packages and annual volume of waste that will be produced over the 60 year operating life of an AP1000™ nuclear power plant. It supports the UK Generic Design Assessment of the AP1000 plant.

Phoenix House
Surtees Business Park
3 Surtees Way
Stockton-on-Tees
TS18 3HR

Westinghouse Electric Company

Process Mass Balance

for

AP1000 Solid Waste

AP1000 RADWASTE

AKER SOLUTIONS PROJECT NO: 63000333

CLIENT PROJECT NO:

9	S3	Radwaste building and Spent Fuel Pool exhaust LLW dry filters added. HLW packages calculation amended to include rod clusters within fuel assemblies in dry storage.	23/03/2011	P Watson-Jones	A Carson	G Stephenson	See Westinghouse Cover Sheet
8	S3	Update to make title appropriate for the scope of the calculations	08/02/2010	A Carson	D Mayes	J McLeary	See Westinghouse Cover Sheet
7	S3	Update in line with new waste values	16/11/2009	A Carson	D Mayes	J McLeary	See Westinghouse Cover Sheet
6	S3	Encapsulation drum volume updated from $3m^3$ to $2.2m^3$ in line with comments from NDA	16/04/2009	A Carson	D Mayes	J McLeary	
Rev	PEM Status	Description	Date	By	Checked	Approved	Approved
							Client
DOCUMENT NUMBER			63000333	000 -	000 -	111 - C -	0001

H & S File		Technical File		PER File			

REVISION SUMMARY

Revision	Description of Change
1	Preliminary Issue
2	Revision of calculations using waste arisings and activities values updated by Westinghouse on 10/07/08 (Client Doc Nu. 63000333-02-00244-RevB)
3	Revision of calculations to reflect revised waste arisings specification from WEC (Reference correspondence 63000333-02-000244) 10 July 2008, and included in Process Basis of Design document (Reference= 630000333-001-000-111-S-0001 Rev4)
4	No changes to calculation from Revision 3. Calculation raised to Revision 4, S3 PEM status for incorporation in E.R.
5	Contact names deleted from Tables 1 and 10. Glossary added
6	Encapsulation drum volume updated from 3m^3 to 2.2m^3 in line with comments from NDA
7	Updated in line with new waste values from Westinghouse. Calculation re-written and all unncessary calculation removed to provide consistency with other documents
8	Update to make title appropriate for the scope of the calculations
9	LLW dry filters from Radwaste building and Spent Fuel Pool exhausts added. LLW wet and dry filter volumes amended to be consistent with the Environment Report. HLW packages calculation amended in line with assumption that rod clusters will remain within fuel assemblies when loaded into MPCs.

Table of Contents

List of Tables

1.0 Purpose of Calculation

The purpose of this calculation is provide information relating to the number of solid waste packages and annual volume of waste that will be produced over the 60 year operating life of an AP1000 Electricity producing plant

This calculation will provide details of the annual volume of and number of LLW, ILW and HLW packages produced from the operation and maintenance activities over the lifetime of an AP1000 unit.

2.0 Design Basis

The Design Basis used to perform the following calculations are described below;

1.	Actual 3m^3 drum and box capacity is 2.2m^3 (waste capacity)	Ref 1
2.	ILW resin loading per drum is 25% by volume	Ref 2
3.	LLW resin loading per drum is 50% by volume	Ref 5
4.	Fault plant conditions occur 1 in every 5 years of operation	Ref 3
5.	LLW will be loaded into 200L drums	Ref 5
6.	HHISO has internal volume of 14.8m^3	Based on Croft Design No. 2910
7.	200L (39 of) drums can be loaded into 1 HHISO container	Based on experience
8.	Volume Reduction Factor from comapction is 3.6	Ref 4
9.	Density of wet carbon is 0.45Te/m3	Ref 6
10.	Density of Ion Exchange Resin is 1.12 Te/m3	Ref 7
11.	Filter length is 624mm and filter radius is 259mm	Ref 8
12.	ILW filter loading per box is 30%	Based on experience
13.	Fuel changed on 18 month equilibrium cycle (64 assemblies)	Ref 3
14.	Initial fuel assembly loading in reactor is 157 fuel rods, 53 Control Rod clusters and 16 Gray Rod clusters	Ref 3
15.	All Control Rod and Gray Rod clusters replaced at same time	Assumed
16.	All wastes will be kept separate from other wastes of the same categorisation	
17.	LLW Dry filters and Carbon are non-compactible i.e. do not have a volume reduction prior to disposal	
18.	Voidage when loading 200L drums has not been considered.	
19.	Control Rod and Gray Rod Custers will be loaded into Hotec Internationall MPC's with spent fuel	
20.	Holtec International MPC's can be loaded with up to 32 fuel assemblies	Ref 3
21.	Holtec International MPC's will be used for the final disposal of the spent fuel	
22.	LLW pumps and stacks are loaded directly into HHISO containers that are not loaded with 200L drums	

3.0 Method

The calculation method is outlined within the body of the calculation (pages 8 to 39). The wastes have been seperated into operational and maintenance wastes. In some cases where it has been applicable some waste streams have been further divided into compactible and non-compactible. In all cases the total number of waste packages and the type of waste package have been outlined in a table at the end of the waste stream calculation.

4.0 Results

Individual results are provided within the body of the calculation. The annual waste volume and number of waste packages produced per waste stream is calculated (taking into account the relevant assumptions outlined in section 2.0). These arisings are then summarised and split into the specific total number of LLW, ILW and HLW waste packages and volumes produced over the lifetime of the plant (See pages 40 and 43).

5.0 Conclusions

This calculation has demonstrated the number of solid waste containers generated over the operating lifetime of an AP1000 and has found that the following number of waste packages will be produced from operation and maintenance activities over the 60 year operating life of the AP1000;

LLW = 636 HHISO's
ILW = 1116 $3m^3$ boxes/drums
HLW = 83 Holtec International MPC's

The calculations used to determine these values can be seen on pages 8 to 39 of this calculation and the results from these calculations are summarised in Table 25 to Table 28 in section 12 (Solid Waste Summary) of this calculation.

This calculation has demonstrated the annual volume of waste generated over the operating lifetime of an AP1000 and has found that the following average volume of waste will be produced from operation and maintenance activities annually;

Raw LLW = 175.60 m^3
Raw ILW = 10.25 m^3

Packaged LLW = 82.43 m^3
Packaged ILW = 40.86 m^3

The calculations used to determine these values can be seen on pages 8 to 39 of this calculation and the results from these calculations are summarised in Table 29 to Table 33 in section 12 (Solid Waste Summary) of this calculation.

6.0 Calculation of the Number of Solid Radioactive Waste Packages Produced from Plant Operations

The number of waste packages of solid Radwaste produced annually and over the operation period of the plant is calculated in this section, and the results summarised in Table 25 and Table 27

6.1 Primary Resin

Spent primary resin is comprised of the following;

			Normal	Max		
1	CVCS Mixed Bed Resin	=	0.94	1.89	m^3 / year	Appendix 2
2	CVCS Cation Bed	=	0.47	0.94	m^3 / year	Appendix 2
3	SFS Demineralizer	=	1.42	2.83	m^3 / year	Appendix 2
4	WLS unit 1 INORGANIC resin	=	1.13	2.27	m^3 / year	Appendix 2
5	WLS units 2,3,4	=	3.82	7.65	m^3 / year	Appendix 2

The spent primary ILW resin will be encapsulated in 3m ^{3} drums.

Actual drum working capacity is = 2.2 m^3 Ref 1

The resin loading per drum (by volume) is = 25% Ref 2

Therefore volume of resin to be encapsulated per drum = Volume of Drum x resin loading per drum

= 2.2 x 25%

= 0.55 m^3

The expected normal volume of primary spent resin produced per year = 7.79 m^3/yr

Therefore the normal number of drums produced per year = Volume of resin per year / volume of resin per drum

= 7.79 \ 0.55

= 14.1603 ≤ 15 drums per year

The maximum volume of primary spent resin produced per year = 15.58 m^3/yr

Therefore the maximum number of drums produced per year = Volume of resin per year / volume of resin per drum

= 15.58 \ 0.55

= 28.3206 ≤ 29 drums per year

Maximum arisings result from fault plant conditions.

Fault plant conditions occur 1 in every 5 years Ref 3

Therefore the number of drums produced in 5 years of operation = (4 x normal arisings) + (1 x maximum arisings)

= (4 x 14.1603) + 28.3206

= 84.9618 ≤ 85 drums

The number of drums produced in 20, 40 and 60 years can be calculated in a similar way and are shown in Table 1 below;

No. of years operation	No. of drums produced
5	85
20	340
40	680
60	1020

Table 1 : Number of drums produced over LOP for ILW resin

6.2 Secondary Resin

Spent Secondary resin comprises of the following;

			Normal	Max	
1	Condensate polisher spent resin	=	3.85	7.70	m^3 / year Appendix 2
2	Steam Generator Blowdown Material (Resin and Membrane)	=	0.00	0.00	m^3 / year Appendix 2

The spent secondary LLW resin will be encapsulated in 200L drums.

Actual drum working capacity is = 0.2 m^3 Ref 5

The resin loading per drum (by volume) is = 50% Ref 5

Therefore volume of resin to be encapsulated per drum = Volume of Drum x resin loading per drum

= 0.2 x 50%

= 0.1 m^3

The normal volume of secondary spent resin produced per year = 3.85 m^3/yr

Therefore the normal number of drums produced per year = Volume of resin per year / volume of resin per drum

= 3.85 \ 0.1

= 38.516 ≤ 39 drums per year

The maximum volume of primary spent resin produced per year = 7.70 m^3/yr

Therefore the maximum number of drums produced per year = Volume of resin per year / volume of resin per drum

= 7.70 \ 0.1

= 77.032 ≤ 78 drums per year

Maximum arisings result from fault plant conditions.

Fault plant conditions occur 1 in every 5 years Ref 3

Therefore the number of drums produced in 5 years of operation = (4 x normal arisings) + (1 x maximum arisings)

= (4 x 38.516) + 77.032

= 231.096 ≤ 232 drums

The number of drums produced in 20, 40 and 60 years can be calculated in a similar way and are shown in Table 2 below;

No. of years operation	No. of drums produced
5	232
20	925
40	1849
60	2774

Table 2 : Number of drums produced over LOP for LLW resin

6.3 Wet Charcoal

Spent Wet Carbon comprises of the following;		Normal	Max		
WLS unit 1 charcoal	=	0.57	1.13	m^3 / year	Appendix 2

It is thought that the spent wet carbon could be encapsulated with the spent primary Ion Exchange Resin. However for the purposes of this calculation it will be assumed that the spent Wet Carbon is Encapsulated seperately.

The spent Wet Carbon will be encapsulated in 3m^3 drums.

Actual drum working capacity is	=	2.2	m^3	Ref 1
The carbon loading per drum (by volume) is	=	25%		Ref 2

Therefore volume of carbon to be encapsulated per drum = Volume of Drum x Carbon loading per drum
= 2.2 x 25%
= 0.55 m^3

The normal volume of spent Wet Carbon produced per year = 0.57 m^3/yr

Therefore the normal number of drums produced per year = Volume of carbon per year / volume of carbon per drum
= 0.57 \ 0.55
= 1.030 ≤ 2 drums per year

The maximum volume of spent Wet Carbon produced per year = 1.13 m^3/yr

Therefore the maximum number of drums produced per year = Volume of carbon per year / volume of carbon per drum
= 1.13 \ 0.55
= 2.060 ≤ 3 drums per year

Maximum arisings result from fault plant conditions.

Fault plant conditions occur 1 in every 5 years — Ref 3

Therefore the number of drums produced in 5 years of operation = (4 x normal arisings) + (1 x maximum arisings)
= (4 x 1.02984) + 2.05968
= 6.17904 ≤ 7 drums

The number of drums produced in 20, 40 and 60 years can be calculated in a similar way and are shown in Table 3 below;

No. of years operation	**No. of drums produced**
5	7
20	25
40	50
60	75

Table 3 : Number of drums produced over LOP for Wet Carbon (ILW)

6.4 ILW Filters

Spent ILW filters are comprised of the following;

			Normal	Max		
1	CVS RC filter cartridge	=	0.032	0.063	m^3 / year	Appendix 2
2	SFS filter cartridge	=	0.032	0.063	m^3 / year	Appendix 2
3	WLS inlet filter cartridge	=	0.063	0.127	m^3 / year	Appendix 2
4	WLS outlet filter cartridge	=	0.032	0.063	m^3 / year	Appendix 2
5	WSS resin fines filter cartridge	=	0.032	0.063	m^3 / year	Appendix 2

The spent ILW filters will be encapsulated in 3m^3 boxes.

Actual box working capacity is = 2.2 m^3 Ref 1

The filter loading per box (by volume) is = 30% Assumed

Therefore volume of filters to be encapsulated per box = Volume of Drum x filter loading per box

= 2.2 x 30%

= 0.66 m^3 of filter per box

No. of filters per box = Volume of filters per box / Volume of Filter

No. of filters per box = 0.66 / 0.011 (See Pg 30 for filter volume)

No. of filters per box = 59.2368 ≤ 59 per box

The normal volume of ILW Filters produced per year = 0.19 m^3/yr

Therefore the normal number of filters produced per year = Volume of filters per year / volume of a filter

= 0.19 \ 0.011

= 17.0812 ≤ 18 filters per year

The maximum volume of ILW filters produced per year = 0.38 m^3/yr

Therefore the maximum number of filters produced per year = Volume of filters per year / volume of filters per drum

= 0.38 \ 0.011

= 34.1625 ≤ 35 filters per year

Maximum arisings result from fault plant conditions.

Fault plant conditions occur 1 in every 5 years Ref 3

Therefore the number of filters produced in 5 years of operation = (4 x expected arisings) + (1 x maximum arisings)

= (4 x 17.0812) + 34.1625

= 102.487 ≤ 103 filters

Therefore the number of boxes produced in 5 years of operation = No. of filters / No. of Filters per box

= 103 \ 59

= 1.746 ≤ 2 boxes per 5 years

The number of boxes produced in 20, 40 and 60 years can be calculated in a similar way and are shown in Table 4 below;

No. of years operation	No. of boxes produced
5	2
20	7
40	14
60	21

Table 4 : Number of boxes produced over LOP for ILW filters

6.5 Dry Solids and Dry Charcoal

Dry Solid waste and Dry Carbon comprises of the following;

1. DAW - compactable
2. DAW - non-compactable
3. DAW - mixed
4. Strippable coatings
5. WGS guard bed charcoal
6. WGS delay beds charcoal

This waste stream is split into compactable and non compactable.
For the purposes of this calculation it has been assumed that that the carbon is a non-compactable waste

6.5.1 Compactable

Compactable waste from this stream comprises of the following;

			Normal	Max		
1	DAW - compactable	=	134.52	205.61	m^3 / year	Appendix 2
2	Strippable coatings	=	0	0	m^3 / year	Appendix 2

The compactible waste will be compacted in 200L drums.

Actual drum working capacity is	=	0.2	m^3	Ref 5
Volume reduction by compaction	=	3.6		Ref 4

The normal volume of compactible waste produced per year = 134.52 m^3/yr

The compacted volume of this waste is = Actual volume of waste / compaction factor
= 134.52 \ 3.6
= 37.37 m^3/yr

Therefore the normal number of drums produced per year = Volume of waste per year / volume of drum
= 37.37 \ 0.2
= 186.837 ≤ 187 drums per year

The maximum volume of compacted waste produced per year = 205.61 m^3/yr

The compacted volume of this waste is = Actual volume of waste / compaction factor
= 205.61 \ 3.6
= 57.11 m^3/yr

Therefore the maximum number of drums produced per year = Volume of waste per year / volume of drum
= 57.11 \ 0.2
= 285.566 ≤ 286 drums per year

Fault plant conditions occur 1 in every 5 years — Ref 3

Therefore the number of drums produced in 5 years of operation = (4 x expected arisings) + (1 x maximum arisings)
= (4 x 186.837) + 285.566
= 1032.91 ≤ 1033 drums

The number of drums produced in 20, 40 and 60 years can be calculated in a similar way and are shown in Table 5 below;

No. of years operation	No. of drums produced
5	1033
20	4132
40	8264
60	12395

Table 5 : Number of drums produced over LOP for compactible Dry waste (LLW)

6.5.2 Non - Compactable

Non - Compactable waste from this stream comprises of the following;

			Normal	Max		
1	DAW - non-compactable	=	6.63	10.56	m^3 / year	Appendix 2
2	DAW - mixed	=	0.14	0.28	m^3 / year	Appendix 2
3	WGS guard bed charcoal	=	0.15	0.30	m^3 / year	Appendix 2
4	WGS delay beds charcoal	=	0.15	3.02	m^3 / year	Appendix 2

The non - compactable waste will be compacted in 200L drums.

Actual drum working capacity is = 0.2 m^3 Ref 5

The normal volume of non - compactable waste produced per year = 7.07 m^3/yr

Therefore the normal number of drums produced per year = Volume of waste per year / volume of drum

= 7.07 \ 0.2

= 35.3441 ≤ 36 drums per year

The maximum volume of non - compacted waste produced per year = 14.17 m^3/yr

Therefore the maximum number of drums produced per year = Volume of waste per year / volume of drum

= 14.17 \ 0.2

= 70.8581 ≤ 71 drums per year

Fault plant conditions occur 1 in every 5 years Ref 3

Therefore the number of drums produced in 5 years of operation = (4 x expected arisings) + (1 x maximum arisings)

= (4 x 35.34) + 70.8581

= 212.234 ≤ 213 drums

The number of drums produced in 20, 40 and 60 years can be calculated in a similar way and are shown in Table 6 below;

No. of years operation	No. of drums produced
5	213
20	849
40	1698
60	2547

Table 6 : Number of drums produced over LOP for non-compactable Dry waste including Dry Carbon (LLW)

7.0 Calculation of the Number of Solid Radioactive Waste Packages Produced from Plant Maintenance

The number of waste packages of solid radwastes produced by maintenance of the plant is calculated in this section and is summarised in Table 25 and Table 26

7.1 LLW Wet Filters

Wet LLW filters comprise of the following;

1	Refuelling pool under water filtration system filter cartridge	=	3	filters / change	Appendix 2
2	Bag filter (Sludge)	=	1	filter / change	Appendix 2

The volumes of the wet LLW filters are;

1	Refuelling pool under water filtration system filter cartridge	=	2.95	ft^3	=	0.084	m^3 / change	Appendix 2
2	Bag filter (Sludge)	=	1.4	ft^3	=	0.040	m^3 / change	Appendix 2

Frequency of replacement is as follows;

1	Refuelling pool under water filtration system filter cartridge	=	1	per year	Appendix 2
2	Bag filter (Sludge)	=	1	per year	Appendix 2

The volume of wet LLW filters produced per year;

1	Refuelling pool under water filtration system filter cartridge	=	0.084	x	1	=	0.084	m^3 / year
2	Bag filter (Sludge)	=	0.040	x	1	=	0.040	m^3 / year
					Total	**=**	**0.123**	**m^3 / year**

It is assumed for the purposes of this calculation that these filters will be encapsulated in a similar way to that of the Secondary Ion Exchange Resin i.e. the volume of the waste package will be 50% filters.

The Wet LLW filters will be encapsulated in 200L drums.

Actual drum working capacity is	=	0.2	m^3	Ref 5
The filter loading per drum (by volume) is	=	50%		Ref 5

Therefore volume of filters to be encapsulated per drum	=	volume of drum x filter loading per drum			
	=	0.2	x	50%	
	=	0.1	m^3 of filter per drum		

The number of drums produced in one year of operation	=	Volume of filters per year / volume of filters per drum			
The number of drums produced in one year of operation	=	0.123	/	0.1	
The number of drums produced in one year of operation	=	1.232	≤	2	drums per year

The number of drums produced in 20, 40 and 60 years can be calculated in a similar way and are shown in Table 7 below;

No. of years operation	No. of drums produced
5	7
20	25
40	50
60	74

Table 7 : Number of drums produced over LOP for Wet LLW filters.

7.2 LLW Dry Filters

LLW Dry filters comprise of the following;

1	Containment Exh Upstream High Efficiency Filter A	=	4	filters / change	Appendix 2
2	Containment Exh Upstream High Efficiency Filter B	=	4	filters / change	Appendix 2
3	Containment Exh HEPA filter A	=	4	filters / change	Appendix 2
4	Containment Exh HEPA filter B	=	4	filters / change	Appendix 2
5	Cont Exh downstream high efficiency filter A	=	1	filters / change	Appendix 2
6	Cont Exh downstream high efficiency filter B	=	1	filters / change	Appendix 2
7	Machine Tool Exhaust Fan Filter	=	1	filters / change	Appendix 2
8	Radwaste Exh Upstream High Efficiency Filter	=	18	filters / change	Appendix 2
9	Radwaste Exh HEPA Filter	=	18	filters / change	Appendix 2
10	Spent Fuel Pool Exh Upstream High Efficiency F Total	=	12	filters / change	Appendix 2
11	Spent Fuel Pool Exh HEPA Filter	=	12	filters / change	Appendix 2

Frequency of replacement is as follows;

1	Containment Exh Upstream High Efficiency Filter A	=	0.33	per year	Appendix 2
2	Containment Exh Upstream High Efficiency Filter B	=	0.33	per year	Appendix 2
3	Containment Exh HEPA filter A	=	0.2	per year	Appendix 2
4	Containment Exh HEPA filter B	=	0.2	per year	Appendix 2
5	Cont Exh downstream high efficiency filter A	=	0.33	per year	Appendix 2
6	Cont Exh downstream high efficiency filter B	=	0.33	per year	Appendix 2
7	Machine Tool Exhaust Fan Filter	=	2	per year	Appendix 2
8	Radwaste Exh Upstream High Efficiency Filter	=	3	per year	Appendix 2
9	Radwaste Exh HEPA Filter	=	0.5	per year	Appendix 2
10	Spent Fuel Pool Exh Upstream High Efficiency Filter	=	3	per year	Appendix 2
11	Spent Fuel Pool Exh HEPA Filter	=	0.5	per year	Appendix 2

Therefore the No. of Dry LLW filters produced per year = No. of changes per year x No. of filters per change
This is calculated individually for each filter and the results are summarised in Table 8

	Filter source	Number per year		
1	Containment Exh Upstream High Efficiency Filter A	1.33	≤	2
2	Containment Exh Upstream High Efficiency Filter B	1.33	≤	2
3	Containment Exh HEPA filter A	0.80	≤	1
4	Containment Exh HEPA filter B	0.80	≤	1
5	Cont Exh downstream high efficiency filter A	0.33	≤	1
6	Cont Exh downstream high efficiency filter B	0.33	≤	1
7	Machine Tool Exhaust Fan Filter	2.00	≤	2
8	Radwaste Exh Upstream High Efficiency Filter	54.00	≤	54
9	Radwaste Exh HEPA Filter	9.00	≤	9
10	Spent Fuel Pool Exh Upstream High Efficiency Filter	36.00	≤	36
11	Spent Fuel Pool Exh HEPA Filter	6.00	≤	6
	Total	**111.93**	**≤**	**112**

Table 8 : Number of LLW dry filters per year

Volume of LLW dry filters = 4 ft^3 = 0.11 m^3 Ref 3

Volume of drums = 200 litres = 0.2 m^3

Number of filters per drum = 0.2 / 0.11
= 1.77
= 1 filter / drum

The number of drums produced in one year of operation = No. of filters per year / No. of filters per drum
The number of drums produced in one year of operation = 111.93 / 1
= 111.93 ≤ 112 drums per year

No. of years operation	No. of drums produced
5	560
20	2239
40	4478
60	6716

Table 9 : Number of drums produced over LOP for Dry LLW filters.

7.3 LLW Gaskets

LLW Gaskets comprise of the following;

1	Makeup miniflow hx A & B	=	0.004	m^3 / change	Appendix 2
2	Letdown hx	=	0.003	m^3 / change	Appendix 2
3	Reactor coolant drain tank hx	=	0.001	m^3 / change	Appendix 2
4	Residual heat removal hx	=	0.001	m^3 / change	Appendix 2
5	Reactor coolant drain tank	=	0.002	m^3 / change	Appendix 2
6	Waste holdup tank A	=	0.002	m^3 / change	Appendix 2
7	Waste holdup tank B	=	0.002	m^3 / change	Appendix 2
8	Waste monitor tank A	=	0.002	m^3 / change	Appendix 2
9	Waste monitor tank B	=	0.002	m^3 / change	Appendix 2
10	Waste monitor tank C	=	0.002	m^3 / change	Appendix 2
11	Waste monitor tank D	=	0.002	m^3 / change	Appendix 2
12	Waste monitor tank E	=	0.002	m^3 / change	Appendix 2
13	Waste monitor tank F	=	0.002	m^3 / change	Appendix 2
14	Effluent holdup tank A	=	0.002	m^3 / change	Appendix 2
15	Effluent holdup tank B	=	0.002	m^3 / change	Appendix 2
16	Effluent holdup tank C	=	0.002	m^3 / change	Appendix 3
17	Chemical waste tank	=	0.001	m^3 / change	Appendix 2
18	Spent fuel system filter B	=	0.001	m^3 / change	Appendix 2
19	Reactor coolant filter A	=	0.001	m^3 / change	Appendix 2
20	Reactor coolant filter B	=	0.001	m^3 / change	Appendix 2
21	Makeup filter	=	0.001	m^3 / change	Appendix 2
22	Spent fuel system filter A	=	0.001	m^3 / change	Appendix 2
23	Waste prefilter	=	0.001	m^3 / change	Appendix 2
24	Waste after filter	=	0.001	m^3 / change	Appendix 2
25	Resin fines filter	=	0.001	m^3 / change	Appendix 2
	Total	=	0.043	m^3 / change	

For the purposes of this calculation it is assumed that these gaskets are compactable.

The LLW gaskets will be disposed of in 200L drums.

Actual drum working capacity is	=	0.2	m^3	Ref 5
The gasket loading per drum (by volume) is	=	100%		assumed
Compaction factor	=	3.6		Ref 4

Therefore volume of gaskets to be compacted per drum = Volume of Drum x gasket loading per drum

= 0.2 x 100%

= 0.2 m^3 of gasket per drum

	Gasket Source	Frequency of Replacement of Gaskets (per year)
1	Makeup miniflow hx A & B	0.02
2	Letdown hx	0.02
3	Reactor coolant drain tank hx	0.02
4	Residual heat removal hx	0.02
5	Reactor coolant drain tank	0.05
6	Waste holdup tank A	0.05
7	Waste holdup tank B	0.05
8	Waste monitor tank A	0.05
9	Waste monitor tank B	0.05
10	Waste monitor tank C	0.05
11	Waste monitor tank D	0.05
12	Waste monitor tank E	0.05
13	Waste monitor tank F	0.05
14	Effluent holdup tank A	0.05
15	Effluent holdup tank B	0.05
16	Effluent holdup tank C	0.05
17	Chemical waste tank	0.67
18	Spent fuel system filter B	1.00
19	Reactor coolant filter A	1.00
20	Reactor coolant filter B	1.00
21	Makeup filter	1.00
22	Spent fuel system filter A	1.00
23	Waste prefilter	1.00
24	Waste after filter	1.00
25	Resin fines filter	1.00

Table 10 : Frequency of Replacement of Gaskets Appendix 2

Therefore the volume of gaskets produced per year = No. of changes per year x Volume of gaskets per change

This is calculated individually for each filter and the results are summarised in Table 11

Gasket Source		Volume of Gaskets per year (m^3)
1	Makeup miniflow hx A & B	6.14E-05
2	Letdown hx	5.19E-05
3	Reactor coolant drain tank hx	1.89E-05
4	Residual heat removal hx	1.42E-05
5	Reactor coolant drain tank	1.13E-04
6	Waste holdup tank A	1.13E-04
7	Waste holdup tank B	1.13E-04
8	Waste monitor tank A	1.13E-04
9	Waste monitor tank B	1.13E-04
10	Waste monitor tank C	1.13E-04
11	Waste monitor tank D	1.13E-04
12	Waste monitor tank E	1.13E-04
13	Waste monitor tank F	1.13E-04
14	Effluent holdup tank A	1.13E-04
15	Effluent holdup tank B	1.13E-04
16	Effluent holdup tank C	1.13E-04
17	Chemical waste tank	3.78E-04
18	Spent fuel system filter B	8.49E-04
19	Reactor coolant filter A	8.49E-04
20	Reactor coolant filter B	8.49E-04
21	Makeup filter	8.49E-04
22	Spent fuel system filter A	8.49E-04
23	Waste prefilter	8.49E-04
24	Waste after filter	8.49E-04
25	Resin fines filter	8.49E-04
	Total	8.68E-03

Table 11 : Volume of Gaskets per Year

Total compacted Volume per year = Total Volume per year / Compaction factor

= 0.009 / 3.6

= 0.002 m^3 / year

Therefore the number of drums produced per year = Total compacted volume / volume per drum

= 0.002 / 0.2

= 0.012 ≤ 1

The number of drums produced over 5 , 20 , 40 and 60 years can are calculated in a similar way and are shown in Table 12 below;

No. of years operation	No. of drums produced
5	1
20	1
40	1
60	1

Table 12 : Number of drums produced over LOP for Gaskets.

7.4 LLW Insulation

LLW Insulation comprises of the following;

1	Regenerative hx	=	1.661	m^3 / change	Appendix 2
2	Makeup miniflow hx A & B	=	0.608	m^3 / change	Appendix 2
3	Reactor coolant drain tank hx	=	0.405	m^3 / change	Appendix 2
4	Residual heat removal hx	=	5.695	m^3 / change	Appendix 2
5	Letdown hx	=	1.624	m^3 / change	Appendix 2
	Total	=	9.994	m^3	

For the purposes of this calculation it is assumed that LLW Insulation is compactable.

The insulation will be disposed of in 200L drums.

Actual drum working capacity is	=	0.2	m^3	Ref 5
The insulation loading per drum (by volume) is	=	100%		assumed
Compaction factor	=	3.6		Ref 4

Therefore volume of insulation to be compacted per drum = Volume of Drum x insulation loading per drum

= 0.2 x 100%

= 0.2 m^3 of insulation per drum

Frequency of replacement for each insulation is as follows;

1	Regenerative hx	=	0.017	per year	Appendix 2
2	Makeup miniflow hx A & B	=	0.017	per year	Appendix 2
3	Reactor coolant drain tank hx	=	0.017	per year	Appendix 2
4	Residual heat removal hx	=	0.017	per year	Appendix 2
5	Letdown hx	=	0.017	per year	Appendix 2

Therefore the volume of insulation produced per year = No. of changes per year x Volume of insulation per change

This is calculated individually for each filter;

1	Regenerative hx	=	0.017	x	1.661	=	0.028	m^3 per year
2	Makeup miniflow hx A & B	=	0.017	x	0.608	=	0.010	m^3 per year
3	Reactor coolant drain tank hx	=	0.017	x	0.405	=	0.007	m^3 per year
4	Residual heat removal hx	=	0.017	x	5.695	=	0.095	m^3 per year
5	Letdown hx	=	0.017	x	1.624	=	0.027	m^3 per year
					Total	=	0.167	m^3 per year

Total compacted Volume per year = Total Volume per year / Compaction factor

= 0.167 / 3.6

= 0.046 m3 / year

Therefore the number of drums produced per year = Total compacted volume / volume per drum

= 0.046 / 0.2

= 0.231 ≤ 1

The number of drums produced over 5 , 20 , 40 and 60 years can are calculated in a similar way and are shown in Table 13

No. of years operation	No. of drums produced
5	2
20	5
40	10
60	14

Table 13 : Number of drums produced over LOP for LLW Insulation.

7.5 LLW Packing

LLW packing comprises of the following;

1	Valves (potentially radioactive)	=	0.451	m^3 / change	Appendix 2
	Total	=	0.451		

For the purposes of this calculation it is assumed that LLW packing is compactable.

The LLW packing will be disposed of in a 200L drum.

Actual drum working capacity is	=	0.2	m^3	Ref 5
The packing loading per drum (by volume) is	=	100%		assumed
Compaction factor	=	3.6		Ref 4

Therefore volume of packing to be compacted per drum = Volume of Drum x packing loading per drum

= 0.2 x 100%

= 0.2 m^3 of packing per drum

Frequency of replacement for LLW packing is as follows;

1 Valves (potentially radioactive) = 0.200 per year — Appendix 2

Therefore the volume of packing produced per year = No. of changes per year x Volume of packing per change

This is calculated individually for each packing;

1 Valves (potentially radioactive = 0.200 x 0.451 = 0.090 m^3 per year

Total 0.090 m^3 per year

Total compacted Volume per year = Total Volume per year / Compaction factor

= 0.090 / 3.6

= 0.025 m^3 / year

Therefore the number of drums produced per year = Total compacted volume / volume per drum

= 0.025 / 0.2

= 0.125 ≤ 1

The number of drums produced over 5 , 20 , 40 and 60 years can are calculated in a similar way and are shown in Table 14

No. of years operation	No. of drums produced
5	1
20	3
40	6
60	8

Table 14 : Number of drums produced over LOP for LLW Packing.

7.6 LLW Seals

LLW Seals comprises of the following;

1	Component cooling water pump A	=	0.003	m^3 / change	Appendix 2
2	Component cooling water pump B	=	0.003	m^3 / change	Appendix 2
3	Makeup pump A	=	0.003	m^3 / change	Appendix 2
4	Makeup pump B	=	0.003	m^3 / change	Appendix 2
5	Residual heat removal pump A	=	0.003	m^3 / change	Appendix 2
6	Residual heat removal pump B	=	0.003	m^3 / change	Appendix 2
7	Spent fuel cooling pump A	=	0.003	m^3 / change	Appendix 2
8	Spent fuel cooling pump B	=	0.003	m^3 / change	Appendix 2
9	RCDT pump A	=	0.008	m^3 / change	Appendix 2
10	RCDT pump B	=	0.008	m^3 / change	Appendix 2
11	Degassifier vacuum pump A	=	0.003	m^3 / change	Appendix 2
12	Degassifier vacuum pump B	=	0.003	m^3 / change	Appendix 2
13	Containment sump pump A	=	0.003	m^3 / change	Appendix 2
14	Containment sump pump B	=	0.003	m^3 / change	Appendix 2
	Total	=	0.051		

For the purposes of this calculation it is assumed that LLW Seals are compactable.

The LLW seals will be disposed of in a 200L drum.

Actual drum working capacity is	=	0.2	m^3	Ref 5
The seal loading per drum (by volume) is	=	100%		assumed
Compaction factor	=	3.6		Ref 4

Therefore volume of seals to be compacted per drum = Volume of Drum x seal loading per drum

= 0.2 x 100%

= 0.2 m^3 of seal per drum

Frequency of replacement for each seal is as follows;

1	Component cooling water pump A	=	0.200	per year	Appendix 2
2	Component cooling water pump B	=	0.200	per year	Appendix 2
3	Makeup pump A	=	0.100	per year	Appendix 2
4	Makeup pump B	=	0.100	per year	Appendix 2
5	Residual heat removal pump A	=	0.200	per year	Appendix 2
6	Residual heat removal pump B	=	0.200	per year	Appendix 2
7	Spent fuel cooling pump A	=	0.200	per year	Appendix 2
8	Spent fuel cooling pump B	=	0.200	per year	Appendix 2
9	RCDT pump A	=	0.050	per year	Appendix 2
10	RCDT pump B	=	0.050	per year	Appendix 2
11	Degassifier vacuum pump A	=	0.050	per year	Appendix 2
12	Degassifier vacuum pump B	=	0.050	per year	Appendix 2
13	Containment sump pump A	=	0.033	per year	Appendix 2
14	Containment sump pump B	=	0.033	per year	Appendix 2

Therefore the volume of seals produced per year = No. of changes per year x Volume of seal per change

This is calculated individually for each seal;

1	Component cooling water pump A	=	0.200	x	0.003	=	0.0006	m^3 per year
2	Component cooling water pump B	=	0.200	x	0.003	=	0.0006	m^3 per year
3	Makeup pump A	=	0.100	x	0.003	=	0.0003	m^3 per year
4	Makeup pump B	=	0.100	x	0.003	=	0.0003	m^3 per year
5	Residual heat removal pump A	=	0.200	x	0.003	=	0.0006	m^3 per year
6	Residual heat removal pump B	=	0.200	x	0.003	=	0.0006	m^3 per year
7	Spent fuel cooling pump A	=	0.200	x	0.003	=	0.0006	m^3 per year
8	Spent fuel cooling pump B	=	0.200	x	0.003	=	0.0006	m^3 per year
9	RCDT pump A	=	0.050	x	0.008	=	0.0004	m^3 per year
10	RCDT pump B	=	0.050	x	0.008	=	0.0004	m^3 per year
11	Degassifier vacuum pump A	=	0.050	x	0.003	=	0.0001	m^3 per year
12	Degassifier vacuum pump B	=	0.050	x	0.003	=	0.0001	m^3 per year
13	Containment sump pump A	=	0.033	x	0.003	=	9.4E-05	m^3 per year
14	Containment sump pump B	=	0.033	x	0.003	=	9.4E-05	m^3 per year
					Total	=	0.005	m^3 per year

Total compacted Volume per year = Total Volume per year / Compaction factor

= 0.005 / 3.6

= 0.001 m3 / year

Therefore the number of drums produced per year = Total compacted volume / volume per drum

= 0.001 / 0.2

= 0.007 ≤ 1

The number of drums produced over 5 , 20 , 40 and 60 years can are calculated in a similar way and are shown in Table 15

No. of years operation	**No. of drums produced**
5	1
20	1
40	1
60	1

Table 15 : Number of drums produced over LOP for LLW Seals.

7.7 LLW pumps

LLW pumps comprises of the following;

1	Resin transfer pump	=	0.003	m^3 / change	Appendix 2
2	Degassifier seperator pump A	=	0.028	m^3 / change	Appendix 2
3	Degassifier seperator pump B	=	0.028	m^3 / change	Appendix 2
	Total	=	0.059		

LLW pumps will be disposed of in HHISO containers

HHISO capacity = 14.8 m^3 Assumption No. 6

Frequency of replacement for each pump is as follows;

1	Resin transfer pump	=	0.100	per year	Appendix 2
2	Degassifier seperator pump A	=	0.017	per year	Appendix 2
3	Degassifier seperator pump B	=	0.017	per year	Appendix 2

Therefore the volume of pumps produced per year = No. of changes per year x Volume of pump per change

This is calculated individually for each pump;

1	Resin transfer pump	=	0.100	x	0.003	=	0.00028	m^3 per year
2	Degassifier seperator pump A	=	0.017	x	0.028	=	0.00047	m^3 per year
3	Degassifier seperator pump B	=	0.017	x	0.028	=	0.00047	m^3 per year
					Total	=	0.00123	m^3 per year

LLW pumps will not be compacted prior to disposal

Therefore the number of HHISO produced per year = Total pump volume / volume per HHISO

= 0.001 / 14.8

= 8.3E-05 ≤ 1

The number of HHISO's produced over 5 , 20 , 40 and 60 years can are calculated in a similar way and are shown in Table 16

No. of years operation	No. of HHISO produced
5	1
20	1
40	1
60	1

Table 16 : Number of HHISO's produced over LOP for LLW pumps.

It is likely that these pumps would be placed in HHISO's that already contain drums of waste for disposal, however for the purposes of this calculation it is assumed that they are separate (Assumption 23).

7.8 LLW Diaphragms

LLW diaphragms comprises of the following;

1	Degassifier discharge pump A	=	0.003	m^3 / change	Appendix 2
2	Degassifier discharge pump B	=	0.003	m^3 / change	Appendix 2
3	Effluent holdup pump A	=	0.003	m^3 / change	Appendix 2
4	Effluent holdup pump B	=	0.003	m^3 / change	Appendix 2
5	Effluent holdup pump C	=	0.003	m^3 / change	Appendix 2
6	Waste holdup pump A	=	0.003	m^3 / change	Appendix 2
7	Waste holdup pump B	=	0.003	m^3 / change	Appendix 2
8	Monitor pump A	=	0.003	m^3 / change	Appendix 2
9	Monitor pump B	=	0.003	m^3 / change	Appendix 2
10	Monitor pump C	=	0.003	m^3 / change	Appendix 2
11	Monitor pump D	=	0.003	m^3 / change	Appendix 2
12	Monitor pump E	=	0.003	m^3 / change	Appendix 2
13	Monitor pump F	=	0.003	m^3 / change	Appendix 2
14	Chemical waste pump	=	0.003	m^3 / change	Appendix 2
	Total	=	0.040	m^3 / change	

For the purposes of this calculation it is assumed that LLW Diaphragms are compactable.

The LLW diaphragms will be disposed of in 200L drums.

Actual drum working capacity is	=	0.2	m^3	Ref 5
The Diaphragm loading per drum (by volume) is	=	100%		assumed
Compaction factor	=	3.6		Ref 4

Therefore volume of Diaphragms to be compacted per drun = Volume of Drum x Diaphragm loading per drum

= 0.2 x 100%

= 0.2 m^3 of diaphragm per drum

Frequency of replacement for each seal is as follows;

1	Degassifier discharge pump A	=	0.200	per year	Appendix 2
2	Degassifier discharge pump B	=	0.200	per year	Appendix 2
3	Effluent holdup pump A	=	0.200	per year	Appendix 2
4	Effluent holdup pump B	=	0.200	per year	Appendix 2
5	Effluent holdup pump C	=	0.200	per year	Appendix 2
5	Waste holdup pump A	=	0.200	per year	Appendix 2
6	Waste holdup pump B	=	0.200	per year	Appendix 2
7	Monitor pump A	=	0.200	per year	Appendix 2
8	Monitor pump B	=	0.200	per year	Appendix 2
9	Monitor pump C	=	0.200	per year	Appendix 2
10	Monitor pump D	=	0.200	per year	Appendix 2
11	Monitor pump E	=	0.200	per year	Appendix 2
12	Monitor pump F	=	0.200	per year	Appendix 2
13	Chemical waste pump	=	0.200	per year	Appendix 2

Therefore the volume of diaphragms produced per year = No. of changes per year x Volume of diaphragm per change

This is calculated individually for each Diaphragm;

1	Degassifier discharge pump A	=	0.200	x	0.003	=	0.00057	m^3 per year
2	Degassifier discharge pump B	=	0.200	x	0.003	=	0.00057	m^3 per year
3	Effluent holdup pump A	=	0.200	x	0.003	=	0.00057	m^3 per year
4	Effluent holdup pump B	=	0.200	x	0.003	=	0.00057	m^3 per year
5	Effluent holdup pump C	=	0.200	x	0.003	=	0.00057	m^3 per year
6	Waste holdup pump A	=	0.200	x	0.003	=	0.00057	m^3 per year
7	Waste holdup pump B	=	0.200	x	0.003	=	0.00057	m^3 per year
8	Monitor pump A	=	0.200	x	0.003	=	0.00057	m^3 per year
9	Monitor pump B	=	0.200	x	0.003	=	0.00057	m^3 per year
10	Monitor pump C	=	0.200	x	0.003	=	0.00057	m^3 per year
11	Monitor pump D	=	0.200	x	0.003	=	0.00057	m^3 per year
12	Monitor pump E	=	0.200	x	0.003	=	0.00057	m^3 per year
13	Monitor pump F	=	0.200	x	0.003	=	0.00057	m^3 per year
14	Chemical waste pump	=	0.200	x	0.003	=	0.00057	m^3 per year
					Total	=	0.00793	m^3 per year

Total compacted Volume per year = Total Volume per year / Compaction factor

= 0.008 / 3.6

= 0.002 m3 / year

Therefore the number of drums produced per year = Total compacted volume / volume per drum

= 0.002 / 0.2

= 0.01101 ≤ 1

The number of drums produced over 5 , 20 , 40 and 60 years can are calculated in a similar way and are shown in Table 17

No. of years operation	No. of drums produced
5	1
20	1
40	1
60	1

Table 17 : Number of drums produced over LOP for LLW Diaphragms.

7.9 LLW Charcoal

LLW Charcoal comprises of the following;

1	Cont exh charcoal filter A	=	2.427	m^3 / change	Appendix 2
2	Cont exh charcoal filter B	=	2.427	m^3 / change	Appendix 2
	Total	=	4.853		

It is assumed for the purposes of this calculation that LLW charcoal in non-compactable

The LLW charcoal will be disposed of in 200L drums.

Actual drum working capacity is = 0.2 m^3 Ref 1

The charcoal loading per drum (by volume) is = 100%

Therefore volume of charcoal to be encapsulated per drum = Volume of Drum x charcoal loading per drum

= 0.2 x 100%

= 0.2 m^3 of charcoal per drum

Frequency of replacement for LLW charcoal is as follows;

1	Cont exh charcoal filter A	=	0.100	per year	Appendix 2
2	Cont exh charcoal filter B	=	0.100	per year	Appendix 2

Therefore the volume of LLW Charcoal produced per year = No. of changes per year x Volume of charcoal per change

This is calculated individually for each charcoal stream;

1	Cont exh charcoal filter A	=	0.100	x	2.427	=	0.243	m^3 per year
2	Cont exh charcoal filter B	=	0.100	x	2.427	=	0.243	m^3 per year
						Total	0.485	m^3 per year

Therefore the number of drums produced per year = Total charcoal volume / volume per drum

= 0.485 / 0.2

= 2.427 ≤ 3

The number of drums produced over 5 , 20 , 40 and 60 years can are calculated in a similar way and are shown in Table 18

No. of years operation	No. of drums produced
5	13
20	49
40	98
60	146

Table 18 : Number of drums produced over LOP for LLW Charcoal.

7.10 LLW Stacks

LLW Stacks comprises of the following;

1	Electrodeionisation Units A&B	or	=	0.765	m^3 / change	Appendix 2
2	Electrodeionisation Units A&B (alternate supplier)		=	0.898	m^3 / change	Appendix 2
		Total	=	1.662		

It is assumed for the purposes of this calculation that LLW stacks in non-compactable.

The LLW stacks will be disposed of in a HHISO container.

HHISO capacity = 14.8 m^3 — Assumption No. 6

Frequency of replacement for each stack is as follows;

1	Electrodeionisation Units A&B	=	0.083	per year	Appendix 2
2	Electrodeionisation Units A&B (alternat	=	0.200	per year	Appendix 2

Therefore the volume of stacks produced per year = No. of changes per year x Volume of stack per change

This is calculated individually for each stack;

1	Electrodeionisation Units A&I	=	0.083	x	0.765	=	0.064	m^3 per year
2	Electrodeionisation Units A&I	=	0.200	x	0.898	=	0.180	m^3 per year

For the purposes of this calculation the Alternate supplier will be used on the basis that the amount of waste produced per year represents the worst case in terms of volume of waste.

Therefore the number of HHISO produced per year = Total stack volume / volume per HHISO

= 0.180 / 14.8

= 0.012 ≤ 1

The number of drums produced over 5 , 20 , 40 and 60 years can are calculated in a similar way and are shown in Table 19

No. of years operation	No. of HHISO produced
5	1
20	1
40	1
60	1

Table 19 : Number of HHISO's produced over LOP for LLW stacks.

8.0 Fuel assemblies and Rod Clusters

This section will calculate the number of Multi-purpose Canisters (MPC's) required to store the fuel produced over the lifetime of operation of an AP1000 plant.

Appendix 2 which is reproduced from Ref 3 states volumes of fuel rods, control rods and gray rods that are removed from the reactor.

Initial assembly loading within the reactor includes;

Fuel Assemblies	=	157	Ref 3
Control Rod Clusters	=	53	Ref 3
Gray Rod Clusters	=	16	Ref 3

For the purposes of this calculation it is assumed that Control Rod Clusters and Gray Rod Clusters will remain with the fuel assemblies once removed from the core.

The refuelling cycle is on an 18month equilibrium cycle basis, with a feed enrichment of 4.9 Weight-percent. 64 fuel assemblies are replaced every 18 months (Ref 3).

Number of fuel assemblies replaced per refuelling cycle	=	64	
Refuelling cycle	=	18	months
Operating life of plant	=	60	years

The total number of cycles can be calculated as follows;

Total number of refuelling cycles $= \frac{Operating\ Life\ of\ Plant}{Refuelling\ Cycle}$

$$= \frac{60 \times 12}{18}$$

$$= 40$$

Therefore the total number of fuel Assemblies used throughout the lifetime of the plant can be calculated as follows;

Total number of Fuel Assemblies = Initial Assembly loading + (No. of fuel assemblies per change x No. of outages)

Total Number of Fuel Assemblies = 157 + (64 x 39)

= 2653 Fuel Assemblies

The number of fuel assemblies generated over 5, 20, 40 and 60 years of operation are calculated in the same way (by assuming a different operating life i.e. 5, 20 or 40 years). The results of these calculations are shown in Table 20 below;

No. of years operation	Number of Fuel assemblies
5	214
20	854
40	1707
60	2653

Table 20 : Number of fuel assemblies produced over LOP

It should be noted that in table 20 the initial assembly loading in the reactor is not accounted for until the end of of life of the plant.

The frequency of change for the Control Rod and Gray Rod clusters are shown below;

1	Control Rod Clusters	=	1	in	20	yrs
2	Gray Rod Clusters	=	1	in	20	yrs

Therefore the number of cycles over the operating LOP = LOP / frequency of change

1	Total number of cycles	=	60	/	20	=	3
2	Total number of cycles	=	60	/	20	=	3

Therefore the number of clusters over the lifetime of the plant = number of cycles x number of Rods changed per cycle

1	Number of Control Rod clusters	=	3	x	53	=	159
2	Number of Gray Rod clusters	=	3	x	16	=	48

Therefore the combined number of Control Rod and Gray Rod clusters = No. of Control Rod Clusters + No. of Gray Rod Clusters

Combined Number of Clusters = 207

The number of Rod Clusters generated over 5, 20, 40 and 60 years of operation are calculated in the same way (by assuming a different operating life i.e. 5, 20 or 40 years). The results of these calculations are shown in Table 21 below;

No. of years operation	Number of Rod Clusters
5	18
20	69
40	138
60	207

Table 21 : Number of Rod Clusters produced over LOP

N.B The value for 5 years in Table 21 is averaged to provide consistency with the rest of this calculation

The total number of fuel assemblies and Rod clusters = No. of fuel assemblies + No. of Rod Clusters

Results of this calculation over 5, 20, 40 and 60 years are shown below in Table 22

No. of years operation	No. of Fuel assemblies and Rod Clusters
5	232
20	923
40	1845
60	2860

Table 22 : Total number of Fuel Assemblies and Rod Clusters produced over LOP

N.B. It should be noted that the number of Control and Gray Rod clusters produced over 5 years has been pro-rated form 60 year data. Also the initial reactor loading is taken into account after 60 years of operation. This is considered to be an operational waste not a decommissioning waste.

It is assumed that the fuel assemblies and Rod clusters will be loaded into Holtec International MPC's for storage on-site (Ref 3)

It is also assumed that the Rod Clusters will remain within the fuel assemblies when they are loaded into the MPCs

Therefore the No.of MPC's required = Total number of Fuel assemblies / No. of Assemblies per MPC

Number of Fuel assemblies per MPC = 32 Ref 3

The results of this calculation for 20, 40 and 60 years of operation is displayed in Table 23 below;

No. of years operation	No. of MPC's
20	27
40	54
60	83

Table 23 : Total number of MPCs produced over LOP

The value for after 5 years operation has not been included in Table 23 because it is irrevelant as the fuel assemblies will remain in the cooling pond for up to 18 years (Ref 3) prior to being loaded into Holtec International MPC's

It should also be noted that the MPC values outlined in Table 23 assume that the MPC's will be used for final disposal.

9.0 LLW Dry Filter Dimensions

Filter length = 0.624 m = 1.902 ft Ref 8
Filter radius = 0.259 m = 0.789 ft Ref 8

These have been converted using the conversion factors in Appendix 1

Filter volume = 4 ft^3 = 0.11327 m^3 Ref 3

For the purposes of this calculation it is assumed that all LLW dry filters have these dimensions and are non-compactable

9.1 200l Drum Dimensions

Drum length = 0.886 m = 2.701 ft Ref 3
Drum radius = 0.308 m = 0.937 ft Ref 3

Drum volume = 0.2 m^3 Ref 3

Number of filters per drum = 0.2 / 0.11327
= 1.76573
= 1 filter / drum

The filter loading per drum (by volume) = 0.11327 / 0.2
= 57%

9.2 ILW Filter Cartridge Dimensions

Filter Length = 19 Inch = 0.483 m Ref 9
Filter radius = 3.375 Inch = 0.086 m Ref 9

These have been converted using the conversion factors in Appendix 1

Volume = π x radius^2 x length

Filter Volume = π x 0.00735 x 0.4826

Filter Volume = 0.011 m^3

10.0 Calculation of the Annual Volume of waste produced from plant Operations

The annual volume of solid Radwaste produced annually over the operation period of the plant is calculated in this section, and the results summarised in Table 25 and Table 27

10.1 Primary Resin

Spent primary resin is comprised of the following;

			Normal	Max		
1	CVCS Mixed Bed Resin	=	0.94	1.89	m^3 / year	Appendix 2
2	CVCS Cation Bed	=	0.47	0.94	m^3 / year	Appendix 2
3	SFS Demineralizer	=	1.42	2.83	m^3 / year	Appendix 2
4	WLS unit 1 INORGANIC resin	=	1.13	2.27	m^3 / year	Appendix 2
5	WLS units 2,3,4	=	3.82	7.65	m^3 / year	Appendix 2
	Total	**=**	**7.79**	**15.58**	**m^3 / year**	

Maximum arisings result from fault plant conditions.

Fault plant conditions occur 1 in every 5 years — Ref 3

Therefore the average raw volume of waste produced per year =

$$\frac{(4 \times Normal\,Arisings) + (1 \times Max\,Arisings)}{5}$$

= 9.35 m^3 / year

It is intended to encapsulate the primary resins in $3m^3$ drums.

Actual drum working capacity is = 2.2 m^3 — Ref 1

The resin loading per drum (by volume) is = 25% — Ref 2

Therefore the annual average volume of packaged waste = Average raw volume of waste / Waste loading per drum

= 9.35 / 25%

= 37.3832 m^3 / year

10.2 Secondary Resin

Spent Secondary resin comprises of the following;

			Normal	Max		
1	Condensate polisher spent resin	=	3.85	7.70	m^3 / year	Appendix 2
2	Steam Generator Blowdown Material (Resin and Membrane)	=	0.00	0.00	m^3 / year	Appendix 2
	Total	**=**	**3.85**	**7.70**	**m^3 / year**	

Maximum arisings result from fault plant conditions.

Fault plant conditions occur 1 in every 5 years

Therefore the average raw volume of waste produced per year =

$$\frac{(4 \times Normal\,Arisings) + (1 \times Max\,Arisings)}{5}$$

= 4.62 m^3 / year

The spent secondary LLW resin will be encapsulated in 200L drums.

Actual drum working capacity is	=	0.2	m^3	Ref 5
The resin loading per drum (by volume) is	=	50%		Ref 5

Therefore the annual average volume of packaged waste = Average raw volume of waste / Waste loading per drum

= 4.62 / 50%

= 9.24 m^3 / year

10.3 Wet Charcoal

Spent Wet Carbon comprises of the following;

		Normal	Max		
WLS unit 1 charcoal	=	**0.57**	**1.13**	**m^3 / year**	Appendix 2

Maximum arisings result from fault plant conditions.

Fault plant conditions occur 1 in every 5 years

Therefore the average raw volume of waste produced per year =

$$\frac{(4\times Normal\ Arisings)+(1\times Max\ Arisings)}{5}$$

= 0.68 m^3 / year

The spent Wet Carbon will be encapsulated in $3m^3$ drums.

Actual drum working capacity is	=	2.2	m^3	Ref 1
The resin loading per drum (by volume) is	=	25%		Ref 2

Therefore the annual average volume of packaged waste = Average raw volume of waste / Waste loading per drum

= 0.68 / 25%

= 2.72 m^3 / year

10.4 ILW Filters

Spent ILW filters are comprised of the following;

			Normal	Max		
1	CVS RC filter cartridge	=	0.032	0.063	m^3 / year	Appendix 2
2	SFS filter cartridge	=	0.032	0.063	m^3 / year	Appendix 2
3	WLS inlet filter cartridge	=	0.063	0.127	m^3 / year	Appendix 2
4	WLS outlet filter cartridge	=	0.032	0.063	m^3 / year	Appendix 2
5	WSS resin fines filter cartridge	=	0.032	0.063	m^3 / year	Appendix 2
	Total	=	**0.19031**	**0.38063**	**m^3 / year**	

Maximum arisings result from fault plant conditions.

Fault plant conditions occur 1 in every 5 years

Therefore the average raw volume of waste produced per year =

$$\frac{(4\times Normal\ Arisings)+(1\times Max\ Arisings)}{5}$$

= 0.23 m^3 / year

The spent ILW filters will be encapsulated in 3m^3 boxes.

Actual box working capacity is	=	2.2	m^3	Ref 1
The filter loading per box (by volume) is	=	30%		Assumed

Therefore the annual average volume of packaged waste = Average raw volume of waste / Waste loading per box

= 0.23 / 30%

= 0.76 m^3 / year

10.5 Dry Solids and Dry Charcoal

Dry Solid waste and Dry Carbon comprises of the following;

			Normal	Max		
1	DAW - compactable	=	134.52	205.61	m^3 / year	Appendix 2
2	DAW - non-compactable	=	6.63	10.56	m^3 / year	Appendix 2
3	DAW - mixed	=	0.14	0.28	m^3 / year	Appendix 2
4	Strippable coatings	=	0.00	0.00	m^3 / year	Appendix 2
5	WGS guard bed charcoal	=	0.15	0.30	m^3 / year	Appendix 2
6	WGS delay beds charcoal	=	0.15	3.02	m^3 / year	Appendix 2

Due to the differing natures of the wastes the average volumes will be calculated seperately for clarity

10.5.1 DAW - compactable

Maximum arisings result from fault plant conditions.

Fault plant conditions occur 1 in every 5 years — Ref 3

Therefore the average raw volume of waste produced per year =

$$\frac{(4 \times Normal\ Arisings) + (1 \times Max\ Arisings)}{5}$$

= 148.74 m^3 / year

It is intended to dispose of this waste in 200L drums.

Actual drum working capacity is	=	0.2	m^3	Ref 5
Volume reduction by compaction	=	3.6		Ref 4

Therefore the annual average volume of packaged waste = Average raw volume of waste / compaction factor

= 148.74 / 3.6

= 41.3166 m^3 / year

10.5.2 DAW - non-compactable

Maximum arisings result from fault plant conditions.

Fault plant conditions occur 1 in every 5 years — Ref 3

Therefore the average raw volume of waste produced per year =

$$\frac{(4 \times Normal\ Arisings) + (1 \times Max\ Arisings)}{5}$$

= 7.41 m^3 / year

It is intended to dispose of this waste in 200L drums.

Actual drum working capacity is	=	0.2	m^3	Ref 5
Volume reduction by compaction	=	1	(Indicates non-compactable waste)	

Therefore the annual average volume of packaged waste = Average raw volume of waste / compaction factor

= 7.41 / 1

= 7.41 m^3 / year

10.5.3 DAW - mixed

Maximum arisings result from fault plant conditions.

Fault plant conditions occur 1 in every 5 years — Ref 3

Therefore the average raw volume of waste produced per year =

$$\frac{(4 \times Normal\ Arisings) + (1 \times Max\ Arisings)}{5}$$

= 0.17 m^3 / year

It is intended to dispose of this waste in 200L drums.

Actual drum working capacity is	=	0.2	m^3	Ref 5
Volume reduction by compaction	=	1	(Indicates non-compactable waste)	

Therefore the annual average volume of packaged waste = Average raw volume of waste / compaction factor

= 0.17 / 1

= 0.17 m^3 / year

10.5.4 Strippable coatings

Maximum arisings result from fault plant conditions.

Fault plant conditions occur 1 in every 5 years — Ref 3

Therefore the average raw volume of waste produced per year =

$$\frac{(4 \times Normal\ Arisings) + (1 \times Max\ Arisings)}{5}$$

= 0.00 m^3 / year

It is intended to dispose of this waste in 200L drums.

Actual drum working capacity is	=	0.2	m^3	Ref 5
Volume reduction by compaction	=	1	(Indicates non-compactable waste)	

Therefore the annual average volume of packaged waste = Average raw volume of waste / compaction factor

= 0.00 / 1

= 0.00 m^3 / year

10.5.5 WGS guard bed charcoal

Maximum arisings result from fault plant conditions.

Fault plant conditions occur 1 in every 5 years Ref 3

Therefore the average raw volume of waste produced per year = $\frac{(4 \times Normal\,Arisings) + (1 \times Max\,Arisings)}{5}$

= 0.18 m^3 / year

It is intended to dispose of this waste in 200L drums.

Actual drum working capacity is = 0.2 m^3 Ref 5

Volume reduction by compaction = 1 (Indicates non-compactable waste)

Therefore the annual average volume of packaged waste = Average raw volume of waste / compaction factor

= 0.18 / 1

= 0.18 m^3 / year

10.5.6 WGS delay beds charcoal

Maximum arisings result from fault plant conditions.

Fault plant conditions occur 1 in every 5 years Ref 3

Therefore the average raw volume of waste produced per year = $\frac{(4 \times Normal\,Arisings) + (1 \times Max\,Arisings)}{5}$

= 0.72 m^3 / year

It is intended to dispose of this waste in 200L drums.

Actual drum working capacity is = 0.2 m^3 Ref 5

Volume reduction by compaction = 1 (Indicates non-compactable waste)

Therefore the annual average volume of packaged waste = Average raw volume of waste / compaction factor

= 0.72 / 1

= 0.72 m^3 / year

11.0 Calculation of the Average annual volume of Solid Radioactive Waste Produced from Plant Maintenance

The average annual volume of solid radwastes produced by maintenance of the plant is calculated in this section and is summarised in Table 29 to Table 33

11.1 LLW Wet Filters

Wet LLW filters comprised of the following;

1	Refuelling pool under water filtration system filter cartridge	=	0.084	m^3 / change	Appendix 2
2	Bag filter (Sludge)	=	0.040	m^3 / change	Appendix 2

Frequency of replacement is as follows;

1	Refuelling pool under water filtration system filter cartridge	=	1	per year	Appendix 2
2	Bag filter (Sludge)	=	1	per year	Appendix 2

Therefore the Volume of Wet LLW filters produced per year = No. of changes per year x Vol of filters per change

This is calculated individually for each filter;

1	Refuelling pool under water filtration system filter cartridge		=	1	x	0.083532
			=	0.084	m^3 / year	
2	Bag filter (Sludge)		=	1	x	0.039642
			=	0.03964	m^3 / year	
		Total	**=**	**0.12317**	**m^3 / year**	

The Wet LLW filters will be encapsulated in 200L drums.

The filter loading per drum (by volume) is = 50% Ref 5

Therefore the annual average volume of packaged waste = Average raw volume of waste / loading per drum

= 0.12 / 0.5

= 0.25 m^3 / year

11.2 LLW Dry Filters

LLW Dry filters comprise of the following;

1	Containment Exh Upstream High Efficiency Filter A	=	0.453	m^3 / change	Appendix 2
2	Containment Exh Upstream High Efficiency Filter B	=	0.453	m^3 / change	Appendix 2
3	Containment Exh HEPA filter A	=	0.453	m^3 / change	Appendix 2
4	Containment Exh HEPA filter B	=	0.453	m^3 / change	Appendix 2
5	Cont Exh downstream high efficiency filter A	=	0.113	m^3 / change	Appendix 2
6	Cont Exh downstream high efficiency filter B	=	0.113	m^3 / change	Appendix 2
7	Machine Tool Exhaust Fan Filter	=	0.113	m^3 / change	Appendix 2
8	Radwaste Exh Upstream High Efficiency Filter	=	2.039	m^3 / change	Appendix 2
9	Radwaste Exh HEPA Filter	=	2.039	m^3 / change	Appendix 2
10	Spent Fuel Pool Exh Upstream High Efficiency F Total	=	1.359	m^3 / change	Appendix 2
11	Spent Fuel Pool Exh HEPA Filter	=	1.359	m^3 / change	Appendix 2

Frequency of replacement is as follows;

1	Containment Exh Upstream High Efficiency Filter A	=	0.333	per year	Appendix 2
2	Containment Exh Upstream High Efficiency Filter B	=	0.333	per year	Appendix 2
3	Containment Exh HEPA filter A	=	0.200	per year	Appendix 2
4	Containment Exh HEPA filter B	=	0.200	per year	Appendix 2
5	Cont Exh downstream high efficiency filter A	=	0.333	per year	Appendix 2
6	Cont Exh downstream high efficiency filter B	=	0.333	per year	Appendix 2
7	Machine Tool Exhaust Fan Filter	=	2.000	per year	Appendix 2
8	Radwaste Exh Upstream High Efficiency Filter	=	3.000	per year	Appendix 2
9	Radwaste Exh HEPA Filter	=	0.500	per year	Appendix 2
10	Spent Fuel Pool Exh Upstream High Efficiency Filter	=	3.000	per year	Appendix 2
11	Spent Fuel Pool Exh HEPA Filter	=	0.500	per year	Appendix 2

Therefore the Volume of Dry LLW filters produced per year = No. of changes per year x Volume of filters per change

This is calculated individually for each filter and the results are summarised in Table 24

Filter source		**Volume per year (m^3)**
1	Containment Exh Upstream High Efficiency Filter A	0.15
2	Containment Exh Upstream High Efficiency Filter B	0.15
3	Containment Exh HEPA filter A	0.09
4	Containment Exh HEPA filter B	0.09
5	Cont Exh downstream high efficiency filter A	0.04
6	Cont Exh downstream high efficiency filter B	0.04
7	Machine Tool Exhaust Fan Filter	0.23
8	Radwaste Exh Upstream High Efficiency Filter	6.12
9	Radwaste Exh HEPA Filter	1.02
10	Spent Fuel Pool Exh Upstream High Efficiency Filter	4.08
11	Spent Fuel Pool Exh HEPA Filter	0.68
Table 24	**: Vol. of LLW dry filters per year** **Total**	**12.68**

The Dry LLW filters will be disposed of in 200L drums.

The filter loading per drum (by volume) is = 57%

Therefore the annual average volume of packaged waste = Average raw volume of waste / compaction factor

= 12.68 / 57%

= 22.39 m^3 / year

11.3 LLW Gaskets

The volume of gaskets produced per year	=	0.009	m^3/yr	See Page 19
The packaged volume of gaskets per year	=	0.002	m^3/yr	See Page 19

11.4 LLW Insulation

The volume of insulation produced per year	=	0.167	m^3/yr	See Page 20
The packaged volume of insulation per year	=	0.046	m^3/yr	See Page 20

11.5 LLW Packing

The volume of packing produced per year	=	0.090	m^3/yr	See Page 21
The packaged volume of packing per year	=	0.025	m^3/yr	See Page 21

11.6 LLW Seals

The volume of seals produced per year	=	0.005	m^3/yr	See Page 23
The packaged volume of seals per year	=	0.001	m^3/yr	See Page 23

11.7 LLW pumps

The volume of pumps produced per year	=	0.001	m^3/yr	See Page 24
The packaged volume of pumps per year	=	0.001	m^3/yr	See Page 24

11.8 LLW Diaphragms

The volume of diaphragms produced per year	=	0.008	m^3/yr	See Page 25
The packaged volume of diaphragms per year	=	0.002	m^3/yr	See Page 25

11.9 LLW Charcoal

The volume of charcoal produced per year	=	0.485	m^3/yr	See Page 26
The packaged volume of charcoal per year	=	0.485	m^3/yr	See Page 26

11.10 LLW Stacks

The volume of stacks produced per year	=	0.180	m^3/yr	See Page 27
The packaged volume of stacks per year	=	0.180	m^3/yr	See Page 27

12 Summary

This section will summarise the amount of LLW, ILW and HLW generated from the operation of one AP1000 plant over the Lifetime of the plant (LOP) and the average annual arisings of raw and packages wastes.

12.1 Packages over Lifetime of Plant

12.1.1 LLW

The volume of LLW generated in terms of 200L drums is summarised in Table 25 below, this divides the waste into operational and maintenace waste. The calculation of these values can be found on pages 7 to 30 of this calculation.

Waste Stream	Years of Operation	5	20	40	60
Secondary Resin		232	925	1849	2774
DRY SOLIDS and DRY CHARCOAL	Compactable	1033	4132	8264	12395
	Non - Compactable	213	849	1698	2547
	Total	***1478***	***5906***	***11811***	***17716***
Maintenance Waste					
LLW Wet Filters		7	25	50	74
LLW Dry Filters		560	2239	4478	6716
LLW Gaskets		1	1	1	1
LLW Insulation		2	5	10	14
LLW Packing		1	3	6	8
LLW Seals		1	1	1	1
LLW Diaphragms		1	1	1	1
LLW Charcoal		13	49	98	146
	Total	***586***	***2324***	***4645***	***6961***
Overall Total		**2064**	**8230**	**16456**	**24677**

Table 25 : Total number of LLW drums produced

12.1.1.1 Calculation of Number of HHISO from LLW drums

Assumption 7 states that 39, 200L drums can be loaded into 1 HHISO

The numbers of HHISO containers stated in Table 26 below, are based on this assumption; i.e;

Total Number of HHISO = Total Number of drums / 39

Years of Operation	5	20	40	60
Operational Waste	38	152	303	455
Maintenance Waste	18	62	122	181
Total	**56**	**214**	**425**	**636**

Table 26 : Total number of HHISO produced

N.B. The values in Table 26 for maintenance waste include the number of HHISO calculated on pages 22 and 26 for LLW pumps and LLW stacks respectively. These pieces of equipment will not be put into 200L drums but will instead be placed directly into HHISO containers. Due to the small quantity of these items over the lifetime of the plant it is likely that they would be loaded into a HHISO container that already contains a number of other waste packages. However for conservatism the values obtained from tables 16 and 19 have been maintained for LLW pumps and LLW stacks respectively.

12.1.2 ILW

The volume of ILW generated in terms of $3m^3$ drums and boxes is summarised in Table 27 below;

Waste Stream / Years of Operation	5	20	40	60
Primary Resin	85	340	680	1020
Wet Charcoal	7	25	50	75
ILW Filters	2	7	14	21
Total Drums	92	365	730	1095
Total Boxes	2	7	14	21
Overall Total Waste packages	**94**	**372**	**744**	**1116**

Table 27 : Number of $3m^3$ boxes/drums produced over LOP

12.1.3 HLW

The number of fuel assemblies, Control rods, Gray rods and hence Holtec International MPC's that are generated over the operating life of the plant is summarised in Table 28 below;

Waste Stream / Years of Operation	5	20	40	60
Fuel Assemblies	214	854	1707	2653
Control Rod Clusters	14	53	106	159
Gray Rod Clusters	4	16	32	48
Total number of Fuel assemblies and Rod Clusters	232	923	1845	2860
Total Number of MPC's required	n/a	27	54	83

Table 28 : Number of MPC's produced over LOP

12.2 Raw waste volumes

12.2.1 LLW

The raw volumes of operational LLW produced per year are shown in Table 29

Waste stream	Average Volume per Year (m^3)
Secondary Resin	4.62
DAW - compactable	148.74
DAW - non-compactable	7.41
DAW - mixed	0.17
Strippable coatings	0.00
WGS guard bed charcoal	0.18
WGS delay beds charcoal	0.72
Total	**161.85**

Table 29 : Raw volumes of operational LLW

The raw volumes of maintenance LLW produced per year are shown in Table 30

Waste stream	Average Volume per Year (m^3)
LLW Wet Filters	0.123
LLW Dry Filters	12.678
LLW Gaskets	0.009
LLW Insulation	0.167
LLW Packing	0.090
LLW Seals	0.005
LLW pumps	0.001
LLW Diaphragms	0.008
LLW Charcoal	0.485
LLW Stacks	0.180
Total	**13.746**

Table 30 : Raw volumes of maintenace LLW

The average total raw volume of LLW produced per year= 175.60 m^3

12.2.2 ILW

The raw volumes of ILW produced per year are shown in Table 31

Waste stream	Average Volume per Year (m^3)
Primary Resin	9.35
Wet Charcoal	0.68
ILW Filters	0.23
Total	**10.25**

Table 31 : Raw annual volumes of ILW

The average total raw volume of ILW produced per year = 10.25 m^3

12.3 Packaged Annual Waste Volumes

This section will summarise the average volumes of packaged wastes, type of packages used and corresponding number of packages

12.3.1 LLW

Table 32 below summarises the average annual packaged volumes of LLW and type of package used

Waste stream	Average Packaged Volume per Year (m^3)	Waste container used
Secondary Resin	9.244	200L Drum
DAW - compactable	41.317	200L Drum
DAW - non-compactable	7.414	200L Drum
DAW - mixed	0.170	200L Drum
Strippable coatings	0.000	200L Drum
WGS guard bed charcoal	0.181	200L Drum
WGS delay beds charcoal	0.724	200L Drum
LLW Wet Filters	0.246	200L Drum
LLW Dry Filters	22.386	200L Drum
LLW Gaskets	0.002	200L Drum
LLW Insulation	0.046	200L Drum
LLW Packing	0.025	200L Drum
LLW Seals	0.001	200L Drum
LLW pumps	0.001	HHISO
LLW Diaphragms	0.002	200L Drum
LLW Charcoal	0.485	200L Drum
LLW Stacks	0.180	HHISO
Total	**82.426**	**N/A**

Table 32 : Summary of LLW annual packaged waste volumes

The total average packaged volume of LLW to be disposed of per year is = 82.43 m^3

The total average packaged volume of LLW to be disposed of in 200 L drums per year is = 82.24 m^3

This corresponds to an average of 412 drums per year

Please note that LLW stacks and LLW pumps are too large to be disposed of in 200L drums and will be directly placed into HHISO Containers

12.3.2 ILW

Table 33 below summarises the average annual packaged volumes of ILW and type of package used

Waste stream	Average Volume per Year (m^3)
Primary Resin	37.38
Wet Charcoal	2.72
ILW Filters	0.76
Total	**40.86**

Table 33 : Summary of annual packaged volumes of ILW

The total average packaged volume of ILW to be disposed of per year is = 40.86 m^3

This corresponds to an average number of ILW waste packages per year of 19

13.0 References

1. Email from Gavin Marsden to eisenslr@westinghouse.com on 03 Feb 2009. Email details the actual working volume
2. The 2004 UK Radioactive Waste Inventory, Detailed Information for BEG(UK) Ltd and BEG Ltd Wastes, DEFRA/ RAS/ 05,005. Nirex Report N/093 October 2005. Sizewell ‘B’ Waste Stream 3S12 CVCS Resin and Spent Resins (ILW). (Page 712 – 0.125m3 waste loading in a 0.5m3 Payload).
3. UKP-GW-GL-790, Rev 4, “UK AP1000 Environment Report,” Westinghouse Electric Company LLC, 2011.
4. AP1000 WEC Design Control Document Revision 16 - Section 11 - Radioactive Waste Management
5. The 2007 Uk Radioactive Waste Inventory. Sizewell 'B' Waste stream 3S06
6. Granulated Carbon provider specsheet: www.targetproducts.com/catalog/specsheets/granular.pdf
7. PNNL-11121. Assessment of Commercially Available Ion Exchange Materials for Cesium Removal from Highly Alkaline Wastes. Lewatit DN, KR bead form data sheet
8. EMCEL Filters Type 1 Cylindrical HEPA Filter Inserts Specification
9. MV9A-VI-001 Low Pressure 250 Gal cartridge Filter outline.dwg

14.0 Glossary

HHISO	Half Height Isofreight
HLW	High Level Radioactive Waste
Hx	Heat Exchanger
ILW	Intermediate Level Radioactive Waste
LLW	Low Level Radioactive Waste
LOP	Lifetime of Plant
MPC	Multi-purpose Canister
RCDT	Reactor Coolant Drain Tank

Appendix 1 Conversion Factors

1) Prefixes

Kilo 1.E+03

Mega 1.E+06

Giga 1.E+09

Tera 1.E+12

2) ft^3 to m^3

1 ft^3 = 0.028316846 m^3

1ft = 0.3048 m

3) Pounds to kg

1lb = 0.453592 kg

4) Inches to metres

1 inch = 0.0254m

Appendix 2 **Solid Radioactive Waste Arisings from an AP1000**

Key

Cells highlighted in yellow are as per reference data

Conversion factors used are taken from Appendix 1.

PART A - SOLID RADWASTE ARISINGS FROM SYSTEM OPERATIONS

Waste Type	System	Waste Description	Rad/ Nonrad	Waste Category	Physical/Chemical Description	Estimated Quantity normal/ yr ft³/yr	Estimated Quantity normal/ yr m³/yr	Estimated Quantity normal/ yr %vol of total*	Estimated Quantity maximum/ yr ft³/yr	Estimated Quantity maximum/ yr m³/yr	Arisings/ lifetime of plant (lop) ft³/lop	Arisings/ lifetime of plant (lop) m³/lop	Reference/basis of information
Primary Resin	CVS	CVCS Mixed Bed Resin	R	ILW	spherical bead / resin compound	33.3	0.94	12%	66.7	1.89	2,399	67.94	Reference 3
	CVS	CVCS Cation Bed	R	ILW	spherical bead / resin compound	16.7	0.47	6%	33.3	0.94	1,201	34.01	Reference 3
	SFS	SFS Demineralizer	R	ILW	spherical bead / resin compound	50	1.42	18%	100	2.83	3,600	101.95	Reference 3
	WLS	WLS unit 1 INORGANIC resin	R	ILW	spherical bead / resin compound	40	1.13	15%	80	2.27	2,880	81.56	Reference 3
	WLS	WLS units 2,3,4	R	ILW	spherical bead / resin compound	135	3.82	49%	270	7.65	9,720	275.28	Reference 3
					Total Volume Primary Resin	**275.0**	**7.79**	**100%**	**550**	**15.58**	**19,800**	**560.75**	
Secondary Resin	CPS	Condensate polisher spent resin	R	LLW	replace resin	136	3.85		272	7.70	2,448	69.33	Reference 3. Normal replacement 1 vessel per cycle max 2 per cycle each vessel contains 204 cf.
		Steam Generator Blowdown Material (Resin and Membrane)				0			0				Reference 3
					Total Volume Secondary Resin	**136.0**	**3.85**		**272**	**7.70**	**2,448**	**69.33**	
Wet Charcoal	WLS	WLS unit 1 charcoal	R	ILW	wet granular carbon	20	0.57		40	1.13	1,440	40.78	Reference 3
ILW Filters	CVS	CVS RC filter cartridge	R	ILW	metallic cylinder	1.12	0.032		2.24	0.063	81.00	2.29	Reference 3
	SFS	SFS filter cartridge	R	ILW	metallic cylinder	1.12	0.032		2.24	0.063	81.00	2.29	Reference 3
	WLS	WLS inlet filter cartridge	R	ILW	metallic cylinder	2.24	0.063		4.48	0.127	161.00	4.56	Reference 3
	WLS	WLS outlet filter cartridge	R	ILW	metallic cylinder	1.12	0.032		2.24	0.063	81.00	2.29	Reference 3
	WSS	WSS resin fines filter cartridge	R	ILW	metallic cylinder	1.12	0.032		2.24	0.063	81.00	2.29	Reference 3
					Total Volume Primary Filters	**6.7**	**0.19**		**13**	**0.38**	**485**	**13.74**	
	WSS	DAW - compactable	R	LLW	compactable paper, tape, clothing	4,750	134.52		7,260	205.61	315,120	8,924	Reference 3

Dry Solids	WSS	DAW - non-compactable	R/N	LLW	other non-compactable	234	6.63		373	10.56	15,708	444.86	Reference 3
	WSS	DAW - mixed	R/N	Mixed	small batteries/corrosive	5	0.14		10	0.28	360	10.20	Reference 3
	WSS	Strippable coatings	R	LLW	latex paint peelings								
Dry Charcoal	WGS	WGS guard bed charcoal	R	LLW	dry granular carbon	5.3	0.15		10.7	0.30	383	10.85	Ref. 3 - 2 replaced every 10 yrs
	WGS	WGS delay beds charcoal	R	LLW	dry granular carbon	5.3	0.15		106.7	3.02	1,535	43.47	Ref. 3 - 1 replace every refuelling
					Total Volume Dry Carbon	**10.6**	**0.30**		**117**	**3.32**	**1,918**	**54.32**	

PART B - SOLID RADWASTE ARISINGS FROM SYSTEM MAINTENANCE

All values highlighted in yellow are taken from reference 3

Note: a) Wastes from reference 3 marked as 'minimal waste' or those given no waste quantity are neglected

b) Inactive wastes listed in reference 3 are not included

Waste Type	System	Waste Description	Rad/ Nonrad	Waste Category	Physical/Chemical Description	Waste Cause	Estimated Quantity					Source/basis of information
							Frequency	ft^3 each change	m^3 each change	ft^3/ lop	m^3/lop	
Fuel assemblies	RXS	Fuel assembly	R	HLW	spent fuel rods	burnup	40%/18mos	485	13.733	19400	549.33	Reference 3. Spent fuel rods, control rods and Gray rod clusters all disposed of together as fuel assembly.
	RXS	Control rod cluster (Type53)	R	ILW	metallic rod assemblies		once/ 20yrs	198.75	5.628	596.25	16.88	
	RXS	Gray control rod cluster (Type16)	R	ILW	metallic rod assemblies		once/ 20yrs	60	1.699	180	5.10	
							Total Volume Fuel Assembly	**n/a**	**n/a**	**20176.25**	**571.31**	
LLW Wet Filters	FHS	Refuelling pool under water filtration system filter cartridge	R	LLW	pleated polyester	replace 3 filters	once/yr	2.95	0.084	177	5.01	Reference 3. Two 260gpm underwater
	SGS	Bag filter (Sludge)	R	LLW	Wet granular particles	replace 1 filter	once/yr	1.4	0.040	84	2.38	Reference 3. Note 2
							Total volume LLW Wet Filters	**n/a**	**n/a**	**261**	**7.39**	
LLW Dry Filters	VFS	Containment Exh Upstream High Efficiency Filter A	R	LLW	uncompacted fibreglass/metal	replace filter 4 filters	once/ 3yrs	16.00	0.453	320	9.06	Reference 3
	VFS	Containment Exh Upstream High Efficiency Filter B	R	LLW	uncompacted fibreglass/metal	replace filter 4 filters	once/ 3yrs	16.00	0.453	320	9.06	Reference 3
	VFS	Containment Exh HEPA filter A	R	LLW	uncompacted fibreglass/metal	replace filter 4 filters	once/ 5yrs	16.00	0.453	192	5.44	Reference 3
	VFS	Containment Exh HEPA filter B	R	LLW	uncompacted fibreglass/metal	replace filter 4 filters	once/ 5yrs	16.00	0.453	192	5.44	Reference 3
	VFS	Cont Exh downstream high efficiency filter A	R	LLW	uncompacted fibreglass/metal	replace 1 filter	once/ 3yrs	4.00	0.113	80	2.27	Reference 3
	VFS	Cont Exh downstream high efficiency filter B	R	LLW	uncompacted fibreglass/metal	replace 1 filter	once/ 3yrs	4.00	0.113	80	2.27	Reference 3
	VHS	Machine Tool Exhaust Fan Filter	R	LLW	uncompacted fibreglass/metal	replace 1 filter	twice/yr	4.00	0.113	480	13.59	Reference 3
	VRS	Radwaste Exh Upstream High Efficiency Filter	R	LLW	uncompacted fibreglass/metal	replace filter 18 filters	every 4 months	72.00	2.039	12,960	366.98	Reference 3

	VRS	Radwaste Exh HEPA Filter	R	LLW	uncompacted fibreglass/metal	replace filter 18 filters	once/ 2yrs	72.00	2.039	2,160	61.16	Reference 3
	VAS	Spent Fuel Pool Exh Upstream High Efficiency Filter	R	LLW	uncompacted fibreglass/metal	replace filter 12 filters	every 4 months	48.00	1.359	8,640	244.65	Reference 3
	VAS	Spent Fuel Pool Exh HEPA Filter	R	LLW	uncompacted fibreglass/metal	replace filter 12 filters	once/ 2yrs	48.00	1.359	1,440	40.78	Reference 3
							Total Volume LLW Dry filters	**n/a**	**n/a**	**26,864**	**760.68**	
	CVS	Makeup miniflow hx A & B	R	LLW	compressible rigid plastic	gasket replace	1/lop	0.13	0.004	0.13	0.004	Reference 3. 4" wide 1/4" thick gasket
	CVS	Letdown hx	R	LLW	compressible rigid plastic	gasket replace	1/lop	0.11	0.003	0.11	0.003	Reference 3.
	WLS	Reactor coolant drain tank hx	R	LLW	compressible rigid plastic	gasket replace	1/lop	0.04	0.001	0.04	0.001	Reference 3. 2" wide 1/4" thick gasket
	RHR	Residual heat removal hx	R	LLW	compressible rigid plastic	gasket replace	1/lop	0.03	0.001	0.03	0.001	Reference 3. 4" thickness insulation
	WLS	Reactor coolant drain tank	R	LLW	compressible rigid plastic	gasket replace	3/lop	0.08	0.002	0.24	0.007	Reference 3
	WLS	Waste holdup tank A	R	LLW	compressible rigid plastic	gasket replace	3/lop	0.08	0.002	0.24	0.007	Reference 3
	WLS	Waste holdup tank B	R	LLW	compressible rigid plastic	gasket replace	3/lop	0.08	0.002	0.24	0.007	Reference 3
	WLS	Waste monitor tank A	R	LLW	compressible rigid plastic	gasket replace	3/lop	0.08	0.002	0.24	0.007	Reference 3
	WLS	Waste monitor tank B	R	LLW	compressible rigid plastic	gasket replace	3/lop	0.08	0.002	0.24	0.007	Reference 3
	WLS	Waste monitor tank C	R	LLW	compressible rigid plastic	gasket replace	3/lop	0.08	0.002	0.24	0.007	Reference 3
	WLS	Waste monitor tank D	R	LLW	compressible rigid plastic	gasket replace	3/lop	0.08	0.002	0.24	0.007	Reference 3
LLW Gaskets	WLS	Waste monitor tank E	R	LLW	compressible rigid plastic	gasket replace	3/lop	0.08	0.002	0.24	0.007	Reference 3
	WLS	Waste monitor tank F	R	LLW	compressible rigid plastic	gasket replace	3/lop	0.08	0.002	0.24	0.007	Reference 3
	WLS	Effluent holdup tank A	R	LLW	compressible rigid plastic	gasket replace	3/lop	0.08	0.002	0.24	0.007	Reference 3
	WLS	Effluent holdup tank B	R	LLW	compressible rigid plastic	gasket replace	3/lop	0.08	0.002	0.24	0.007	Reference 3
	WLS	Effluent holdup tank C	R	LLW	compressible rigid plastic	gasket replace	3/lop	0.08	0.002	0.24	0.007	Reference 3
	WLS	Chemical waste tank	R	LLW	compressible rigid plastic	gasket replace	once/18 mo	0.02	0.001	0.8	0.023	Reference 3
	CCS	Spent fuel system filter B	R	LLW	compressible rigid plastic	gasket replace	once/yr	0.03	0.001	1.8	0.05	Reference 3
	CVS	Reactor coolant filter A	R	LLW	compressible rigid plastic	gasket replace	once/yr	0.03	0.001	1.8	0.05	Reference 3
	CVS	Reactor coolant filter B	R	LLW	compressible rigid plastic	gasket replace	once/yr	0.03	0.001	1.8	0.05	Reference 3
	CVS	Makeup filter	R	LLW	compressible rigid plastic	gasket replace	once/yr	0.03	0.001	1.8	0.05	Reference 3
	SFS	Spent fuel system filter A	R	LLW	compressible rigid plastic	gasket replace	once/yr	0.03	0.001	1.8	0.05	Reference 3
	WLS	Waste prefilter	R	LLW	compressible rigid plastic	gasket replace	once/yr	0.03	0.001	1.8	0.05	Reference 3
	WLS	Waste after filter	R	LLW	compressible rigid plastic	gasket replace	once/yr	0.03	0.001	1.8	0.05	Reference 3
	WLS	Resin fines filter	R	LLW	compressible rigid plastic	gasket replace	once/yr	0.03	0.001	1.8	0.05	Reference 3
							Total Volume LLW Gaskets	**n/a**	**n/a**	**18.39**	**0.521**	
Effluent holdup tank A												
	CVS	Regenerative hx	R	LLW	insulation	insulation replace	1/lop	58.67	1.661	58.67	1.661	Reference 3. 4" thickness insulation (assumed all replaced once per life of plant, lop)
LLW Insulation	CVS	Makeup miniflow hx A & B	R	LLW	insulation	insulation replace	1/lop	21.47	0.608	21.47	0.608	Reference 3. 4" thickness insulation
	WLS	Reactor coolant drain tank hx	R	LLW	insulation	insulation replace	1/lop	14.31	0.405	14.31	0.405	Reference 3.
	RHR	Residual heat removal hx	R	LLW	insulation	insulation replace	1/lop	201.12	5.695	201.12	5.695	Reference 3. 4" thickness insulation
	CVS	Letdown hx	R	LLW	compressible rigid plastic	insulation replace	1/lop	57.36	1.624	57.36	1.624	Reference 3.
							Total Volume LLW Insulation	**n/a**	**n/a**	**352.93**	**9.994**	
LLW Packing	All Systems	Valves (potentially radioactive)	R	LLW	compressible rigid plastic	packing replace	once/5yrs	15.94	0.451	191.28	5.42	Reference 3.
							Total Volume LLW Packing	**n/a**	**n/a**	**191.28**	**5.42**	
	CCS	Component cooling water pump A	R	LLW	carbon/SiC	mech seals 2/pmp	once/5yrs	0.1	0.003	2.4	0.07	Reference 3.
	CCS	Component cooling water pump B	R	LLW	carbon/SiC	mech seals 2/pmp	once/5yrs	0.1	0.003	2.4	0.07	Reference 3.
	CVS	Makeup pump A	R	LLW	carbon/SiC	mech seals 2/pmp	once/10 yr	0.1	0.003	1.2	0.03	Reference 3.
	CVS	Makeup pump B	R	LLW	carbon/SiC	mech seals 2/pmp	once/10 yr	0.1	0.003	1.2	0.03	Reference 3.
	RNS	Residual heat removal pump A	R	LLW	carbon/SiC	mech seals 2/pmp	once/5yrs	0.1	0.003	2.4	0.07	Reference 3.
	RNS	Residual heat removal pump B	R	LLW	carbon/SiC	mech seals 2/pmp	once/5yrs	0.1	0.003	2.4	0.07	Reference 3.
	SFS	Spent fuel cooling pump A	R	LLW	carbon/SiC	mech seals 2/pmp	once/5yrs	0.1	0.003	2.4	0.07	Reference 3.
LLW Seals	SFS	Spent fuel cooling pump B	R	LLW	carbon/SiC	mech seals 2/pmp	once/5yrs	0.1	0.003	2.4	0.07	Reference 3.

	WLS	RCDT pump A	R	LLW	carbon/SiC	mech seal 1/pmp	3/lop	0.3	0.008	0.9	0.03	Reference 3.
	WLS	RCDT pump B	R	LLW	carbon/SiC	mech seal 1/pmp	3/lop	0.3	0.008	0.9	0.03	Reference 3.
	WLS	Degassifier vacuum pump A	R	LLW	carbon/SiC	mech seal 2/pmp	3/lop	0.1	0.003	0.3	0.01	Reference 3.
	WLS	Degassifier vacuum pump B	R	LLW	carbon/SiC	mech seal 2/pmp	3/lop	0.1	0.003	0.3	0.01	Reference 3.
	WLS	Containment sump pump A	R	LLW	carbon/SiC	mech seal 1/pmp	2/lop	0.1	0.003	0.2	0.01	Reference 3.
	WLS	Containment sump pump B	R	LLW	carbon/SiC	mech seal 1/pmp	2/lop	0.1	0.003	0.2	0.01	Reference 3.
							Total Volume LLW Seals	**n/a**	**0.051**	**19.6**	**0.55**	
LLW pumps	WSS	Resin transfer pump	R	LLW	screw pump	replace pump	once/10 yr	0.1	0.003	0.6	0.02	Reference 3.
	WLS	Degassifier seperator pump A	R	LLW	canned pump	replace pump	once/lop	1	0.028	1	0.03	Reference 3.
	WLS	Degassifier seperator pump B	R	LLW	canned pump	replace pump	once/lop	1	0.028	1	0.03	Reference 3.
							Total Volume LLW pumps	**n/a**	**n/a**	**2.6**	**0.07**	
LLW Diaphragms	WLS	Degassifier discharge pump A	R	LLW	buna n	replace diaphragms	once/5yrs	0.1	0.003	1.2	0.03	Reference 3.
	WLS	Degassifier discharge pump B	R	LLW	buna n	replace diaphragms	once/5yrs	0.1	0.003	1.2	0.03	Reference 3.
	WLS	Effluent holdup pump A	R	LLW	buna n	replace diaphragms	once/5yrs	0.1	0.003	1.2	0.03	Reference 3.
	WLS	Effluent holdup pump B	R	LLW	buna n	replace diaphragms	once/5yrs	0.1	0.003	1.2	0.03	Reference 3.
	WLS	Effluent holdup pump C	R	LLW	buna n	replace diaphragms	once/5yrs	0.1	0.003	1.2	0.03	Reference 3.
	WLS	Waste holdup pump A	R	LLW	buna n	replace diaphragms	once/5yrs	0.1	0.003	1.2	0.03	Reference 3.
	WLS	Waste holdup pump B	R	LLW	buna n	replace diaphragms	once/5yrs	0.1	0.003	1.2	0.03	Reference 3.
	WLS	Monitor pump A	R	LLW	buna n	replace diaphragms	once/5yrs	0.1	0.003	1.2	0.03	Reference 3.
	WLS	Monitor pump B	R	LLW	buna n	replace diaphragms	once/5yrs	0.1	0.003	1.2	0.03	Reference 3.
	WLS	Monitor pump C	R	LLW	buna n	replace diaphragms	once/5yrs	0.1	0.003	1.2	0.03	Reference 3.
	WLS	Monitor pump D	R	LLW	buna n	replace diaphragms	once/5yrs	0.1	0.003	1.2	0.03	Reference 3.
	WLS	Monitor pump E	R	LLW	buna n	replace diaphragms	once/5yrs	0.1	0.003	1.2	0.03	Reference 3.
	WLS	Monitor pump F	R	LLW	buna n	replace diaphragms	once/5yrs	0.1	0.003	1.2	0.03	Reference 3.
	WLS	Chemical waste pump	R	LLW	buna n	replace diaphragms	once/5yrs	0.1	0.003	1.2	0.03	Reference 3.
							Total volume LLW diaphragms	**n/a**	**n/a**	**16.8**	**0.48**	
LLW Charcoal	VFS	Cont exh charcoal filter A	R	LLW	granulated charcoal	replace charcoal	once/10yrs	85.7	2.427	514.2	14.56	Reference 3.
	VFS	Cont exh charcoal filter B	R	LLW	granulated charcoal	replace charcoal	once/10yrs	85.7	2.427	514.2	14.56	Reference 3.
							Total Volume LLW Charcoal	**n/a**	**n/a**	**1028.4**	**29.12**	
LLW Stacks	BDS	Electrodeionisation Units A&B	R	LLW	Resin/membrane Module	Replace stack	once/12yrs	27	0.765	135	3.82	Reference 3.
	BDS	Electrodeionisation Units A&B (alternate supplier)	R	LLW	Resin/membrane Module	Replace stack	once/5yrs	31.7	0.898	380	10.76	Reference 3.
							Total Volume LLW Stacks	**n/a**	**n/a**	**380**	**10.76**	Note 3

Notes:

1 Calculations page 4 to page 26

2 Filter used to collect sludge (limescale buildup, leaks from primary circuit etc) from Steam generator. This is considered to be a maintenance activity. Volume is based on an average of 4 years arisings of 1 ft^3 cu and 1 year maximum arisings of 3 ft^3

3 Electrodiionisation Units from the alternative supllier used in calculatuion as this represents the worst case in terms of waste generated

4 In part B of this table, due to differences in time between required maintenance on equipment on totals per change are not applicable.