

<b>WASTE STREAM</b>	<b>5C303</b>	<b>Radiochemical Laboratory Decommissioning LLW</b>
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**SITE** Harwell

**SITE OWNER** Nuclear Decommissioning Authority

**WASTE CUSTODIAN** Magnox Limited

**WASTE TYPE** LLW

Is the waste subject to Scottish Policy: No

**WASTE VOLUMES**

		Reported
Stocks:	At 1.4.2022.....	246.2 m <sup>3</sup>
Future arisings -	1.4.2022 - 31.3.2023.....	10.0 m <sup>3</sup>
	1.4.2023 - 31.3.2025.....	688.9 m <sup>3</sup>
Total future arisings:		698.9 m <sup>3</sup>
Total waste volume:		945.1 m <sup>3</sup>

Comment on volumes: Volumes updated for 2016 RWI to reflect SMART Inventory Review. This stream originally included VLLW/LA-LLW but this is now included under stream 5C325.

Uncertainty factors on volumes: Stock (upper): x 1.3 Arisings (upper) x 1.3  
 Stock (lower): x 0.7 Arisings (lower) x 0.7

**WASTE SOURCE** Radiochemistry laboratory decommissioning waste.

**PHYSICAL CHARACTERISTICS**

General description: Material development and examination laboratory. Miscellaneous items from decommissioning of cells, gloveboxes, ventilation systems and pipework. Large items, e.g. gloveboxes, are size reduced for consignment as waste. Waste volumes will be minimised by a number of techniques (size reduction, segregation, packing efficiency, compaction of soft wastes, etc.).

Physical components (%vol): Concrete/brick/plaster (65.6%), bitumen (0.7%), AIB/ACM/MMMF (0.1%), Fibreboard (0.5%), wood (1%), Metals (29.5%), glass (0.07%), hard plastics (1.9%), ceramic (0.03%), lino (0.06%). This is a typical volume % breakdown but will vary according to the decommissioning process employed. Painted-in radioactivity and heavily contaminated structures will generate materials such as contaminated plaster and concrete.

Sealed sources: The waste does not contain sealed sources.

Bulk density (t/m<sup>3</sup>): ~3

Comment on density: The density of the waste stream varies between 0.6 and 11.3 t/m<sup>3</sup>.

**CHEMICAL COMPOSITION**

General description and components (%wt): Concrete/brick/plaster (65.6%), bitumen (0.7%), AIB/ACM/MMMF (0.1%), Fibreboard (0.5%), wood (1%), Metals (29.5%), glass (0.07%), hard plastics (1.9%), ceramic (0.03%), lino (0.06%).

Chemical state: Neutral

Chemical form of radionuclides: H-3: Unknown  
 C-14: C-14 is associated with organic compounds.  
 Cl-36: Unknown  
 Tc-99: Unknown  
 I-129: Unknown  
 Ra: Unknown  
 Th: The chemical form of thorium is unknown but probably comprises of mainly oxide with small amounts of nitrates.  
 U: The chemical form of uranium is unknown but probably comprises mainly oxide and metal with small amounts of nitrates.  
 Np: The chemical form of neptunium is unknown but will probably be present mainly in oxide or nitrate form.  
 Pu: The chemical form of plutonium is unknown but probably comprises of mainly oxide with small amounts of nitrates.

Metals and alloys (%wt): Metal is present in a large range of thicknesses.

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	(%wt)	Type(s) / Grade(s) with proportions	% of total C14 activity
Stainless steel.....			
Other ferrous metals.....			
Iron.....			
Aluminium.....			
Beryllium.....			
Cobalt.....			
Copper.....			
Lead.....			
Magnox/Magnesium.....			
Nickel.....			
Titanium.....			
Uranium.....			
Zinc.....			
Zircaloy/Zirconium.....			
Other metals.....	29.5	Metal type has not been determined	
Organics (%wt):		Cellulosics include wood. The total plastics content is about 2%. Halogenated plastics are PVC and PTFE. Condensation polymers are bakelite and others are perspex.	
	(%wt)	Type(s) and comment	% of total C14 activity
Total cellulosics.....	1.0		
Paper, cotton.....			
Wood.....	1.0		
Halogenated plastics .....	1.0	PVC and PTFE	
Total non-halogenated plastics.....	0.90		
Condensation polymers.....	0.50	bakelite	
Others.....	0.40	perspex	
Organic ion exchange materials....	0		
Total rubber.....	NE		
Halogenated rubber .....	NE		
Non-halogenated rubber.....	NE		
Hydrocarbons.....	0.70		
Oil or grease .....			
Fuel.....			
Asphalt/Tarmac (cont.coal tar)...			
Asphalt/Tarmac (no coal tar)....			
Bitumen.....	0.70		
Others.....			
Other organics.....	NE		
Other materials (%wt):	-		

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	(%wt)	Type(s) and comment	% of total C14 activity
Inorganic ion exchange materials..	0		
Inorganic sludges and flocs.....	0.60		
Soil.....	0		
Brick/Stone/Rubble.....	65.6		
Cementitious material.....	0		
Sand.....			
Glass/Ceramics.....	0.10	0.03% ceramic, 0.07% glass	
Graphite.....	0		
Desiccants/Catalysts.....			
Asbestos.....	~0.10		
Non/low friable.....	~0.10		
Moderately friable.....			
Highly friable.....			
Free aqueous liquids.....	0		
Free non-aqueous liquids.....	TR		
Powder/Ash.....	0		

Inorganic anions (%wt):      None present.

	(%wt)	Type(s) and comment
Fluoride.....	0	
Chloride.....	0	
Iodide.....	0	
Cyanide.....	0	
Carbonate.....	0	
Nitrate.....	0	
Nitrite.....	0	
Phosphate.....	0	
Sulphate.....	0	
Sulphide.....	0	

Materials of interest for waste acceptance criteria:      Asbestos may be present as pipe lagging. Combustible metals comprise uranium.

	(%wt)	Type(s) and comment
Combustible metals.....	TR	
Low flash point liquids.....	0	
Explosive materials.....	0	
Phosphorus.....	0	
Hydrides.....	0	
Biological etc. materials.....	0	
Biodegradable materials.....	0	
Putrescible wastes.....	0	
Non-putrescible wastes.....		

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Corrosive materials.....	0
Pyrophoric materials.....	0
Generating toxic gases.....	0
Reacting with water.....	0
Higher activity particles.....	
Soluble solids as bulk chemical compounds.....	

Hazardous substances / non hazardous pollutants:      Lead is present as metal. Antimony and cadmium may be present and asbestos is likely to be present in the waste.

	(%wt)	Type(s) and comment
Acrylamide.....		
Benzene.....		
Chlorinated solvents.....		
Formaldehyde.....		
Organometallics.....		
Phenol.....		
Styrene.....		
Tri-butyl phosphate.....		
Other organophosphates.....		
Vinyl chloride.....		
Arsenic.....		
Barium.....		
Boron.....	0	
Boron (in Boral).....		
Boron (non-Boral).....		
Cadmium.....		
Caesium.....		
Selenium.....		
Chromium.....		
Molybdenum.....		
Thallium.....		
Tin.....		
Vanadium.....		
Mercury compounds.....		
Others.....		
Electronic Electrical Equipment (EEE)		
EEE Type 1.....		
EEE Type 2.....		
EEE Type 3.....		
EEE Type 4.....		
EEE Type 5.....		

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Complexing agents (%wt): Yes

	(%wt)	Type(s) and comment
EDTA.....		
DPTA.....		
NTA.....		
Polycarboxylic acids.....		
Other organic complexants.....		
Total complexing agents.....	TR	

Potential for the waste to contain discrete items: Not yet determined. In & of itself not a DI; waste stream may include DIs (notably any stainless steel components)

**TREATMENT, PACKAGING AND DISPOSAL**

Planned on-site / off-site treatment(s):

Treatment	On-site / Off site	Stream volume %
Low force compaction		
Supercompaction (HFC)	Off-site	~5.0
Incineration	Off-site	~5.0
Solidification		~1.0
Decontamination		
Metal treatment	Off-site	~18.0
Size reduction		
Decay storage		
Recycling / reuse		
Other / various		
None		71.0

Comment on planned treatments: -

**Disposal Routes:**

Disposal Route	Stream volume %	Disposal density t/m3
Expected to be consigned to the LLW Repository	45.0	3.0
Expected to be consigned to a Landfill Facility	32.0	3.0
Expected to be consigned to an On-Site Disposal Facility		
Expected to be consigned to an Incineration Facility	5.0	0.40
Expected to be consigned to a Metal Treatment Facility	18.0	1.4
Expected to be consigned as Out of Scope		
Expected to be recycled / reused		
Disposal route not known		

Classification codes for waste expected to be consigned to a landfill facility: 17 04 07, 17 02 01, 17 02 02, 17 02 03, 17 01 07, 17 06 01\*/17 06 04

**Upcoming (2022/23-2024/25) Waste Routing (if expected to change from above):**

Disposal Route	Stream volume %		
	2022/23	2023/24	2024/25
Expected to be consigned to the LLW Repository			
Expected to be consigned to a Landfill Facility			
Expected to be consigned to an On-Site Disposal Facility			
Expected to be consigned to an Incineration Facility			
Expected to be consigned to a Metal Treatment Facility			
Expected to be consigned as Out of Scope			
Expected to be recycled / reused			
Disposal route not known			

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Opportunities for alternative disposal routing: -

Baseline Management Route	Opportunity Management Route	Stream volume (%)	Estimated Date that Opportunity will be realised	Opportunity Confidence	Comment
-	-	-	-	-	-

**Waste Packaging for Disposal:**

Container	Stream volume %	Waste loading m <sup>3</sup>	Number of packages
1/3 Height IP-1 ISO			
2/3 Height IP-2 ISO			
1/2 Height WAMAC IP-2 ISO	5.0	21.6	3
1/2 Height IP-2 Disposal/Re-usable ISO	40.0	10	38
2m box (no shielding)			
4m box (no shielding)			
Other			

Other information: 21.6m<sup>3</sup> loading volume is calculated based on the fact that you can fit 36 off (200 litre/0.2m<sup>3</sup>) drums (7.2m<sup>3</sup>) into a 1/2 height ISO, each drum can be super-compacted to a 1/3 of its original volume so therefore we can get 3 x the amount of un-compacted drums into the final disposal container (21.6m<sup>3</sup>).

**Waste Planned for Disposal at the LLW Repository:**

Container voidage: <10%

Waste Characterisation Form (WCH): The waste meets the LLWR's Waste Acceptance Criteria (WAC).  
The waste does not have a current WCH.

Waste consigned for disposal to LLWR in year of generation: -

**Non-Containerised Waste for In-Vault Grouting:** (Not applicable to this waste stream)

Stream volume (%): -

Waste stream variation: -

Bounding cuboidal volume:

Inaccessible voidage: -

Other information: -

**RADIOACTIVITY**

Source: Contamination from wide range of historic operations. Some additional contamination will be introduced from planned waste management operations.

Uncertainty: -

Definition of total alpha and total beta/gamma: Where totals are shown on the table of radionuclide activities they are the sums of the listed alpha or beta/gamma emitting radionuclides plus 'other alpha' or 'other beta/gamma'.

Measurement of radioactivities: Individual fingerprints for each facility created from combination of measurements and assessment/ modelling. These have been combined to provide an overall estimate of future arisings, based on past experience.

Other information: -

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Nuclide	Mean radioactivity, TBq/m <sup>3</sup>				Nuclide	Mean radioactivity, TBq/m <sup>3</sup>			
	Waste at 1.4.2022	Bands and Code	Future arisings	Bands and Code		Waste at 1.4.2022	Bands and Code	Future arisings	Bands and Code
H 3	2.68E-09	BC 2	2.68E-09	BC 2	Gd 153		8		8
Be 10		8		8	Ho 163		8		8
C 14		8		8	Ho 166m		8		8
Na 22		8		8	Tm 170		8		8
Al 26		8		8	Tm 171		8		8
Cl 36	3.4E-09	BB 2	3.4E-09	BB 2	Lu 174		8		8
Ar 39		8		8	Lu 176		8		8
Ar 42		8		8	Hf 178n		8		8
K 40		8		8	Hf 182		8		8
Ca 41		8		8	Pt 193		8		8
Mn 53		8		8	Tl 204		8		8
Mn 54		8		8	Pb 205		8		8
Fe 55	6.31E-08	BC 2	6.31E-08	BC 2	Pb 210	1.39E-08	BB 2	1.39E-08	BB 2
Co 60	3.13E-09	BC 2	3.13E-09	BC 2	Bi 208		8		8
Ni 59		8		8	Bi 210m		8		8
Ni 63	2.1E-06	BB 2	2.1E-06	BB 2	Po 210	1.39E-08	BB 2	1.39E-08	BB 2
Zn 65		8		8	Ra 223		8		8
Se 79		8		8	Ra 225		8		8
Kr 81		8		8	Ra 226	1.55E-08	BB 2	1.55E-08	BB 2
Kr 85	4.01E-08	BB 2	4.01E-08	BB 2	Ra 228	1.89E-08	BB 2	1.89E-08	BB 2
Rb 87		8		8	Ac 227		8		8
Sr 90	2.44E-04	BB 2	2.44E-04	BB 2	Th 227		8		8
Zr 93		8		8	Th 228	1.61E-08	BB 2	1.61E-08	BB 2
Nb 91		8		8	Th 229		8		8
Nb 92		8		8	Th 230		8		8
Nb 93m		8		8	Th 232	2.47E-08	BB 2	2.47E-08	BB 2
Nb 94		8		8	Th 234	8.32E-09	BB 2	8.32E-09	BB 2
Mo 93		8		8	Pa 231		8		8
Tc 97		8		8	Pa 233		8		8
Tc 99	5.53E-09	BB 2	5.53E-09	BB 2	U 232		8		8
Ru 106		8		8	U 233		8		8
Pd 107		8		8	U 234	3.81E-08	BB 2	3.81E-08	BB 2
Ag 108m		8		8	U 235	1.23E-09	BB 2	1.23E-09	BB 2
Ag 110m		8		8	U 236		8		8
Cd 109		8		8	U 238	8.32E-09	BB 2	8.32E-09	BB 2
Cd 113m		8		8	Np 237		8		8
Sn 119m		8		8	Pu 236		8		8
Sn 121m		8		8	Pu 238	1.53E-04	BB 2	1.53E-04	BB 2
Sn 123		8		8	Pu 239	2.63E-04	BB 2	2.63E-04	BB 2
Sn 126		8		8	Pu 240	2.04E-04	BB 2	2.04E-04	BB 2
Sb 125		8		8	Pu 241	6.17E-03	BB 2	6.17E-03	BB 2
Sb 126		8		8	Pu 242	1.03E-07	BB 2	1.03E-07	BB 2
Te 125m		8		8	Am 241	5.86E-04	BB 2	5.86E-04	BB 2
Te 127m		8		8	Am 242m		8		8
I 129		8		8	Am 243		8		8
Cs 134		8		8	Cm 242		8		8
Cs 135		8		8	Cm 243		8		8
Cs 137	2.03E-06	BC 2	2.03E-06	BC 2	Cm 244	2.9E-08	BB 2	2.9E-08	BB 2
Ba 133		8		8	Cm 245		8		8
La 137		8		8	Cm 246		8		8
La 138		8		8	Cm 248		8		8
Ce 144		8		8	Cf 249		8		8
Pm 145		8		8	Cf 250		8		8
Pm 147		8		8	Cf 251		8		8
Sm 147		8		8	Cf 252		8		8
Sm 151	5.11E-09	BB 2	5.11E-09	BB 2	Other a				
Eu 152		8		8	Other b/g				
Eu 154	9.34E-09	BB 2	9.34E-09	BB 2	<b>Total a</b>	<b>1.21E-03</b>	<b>BB 2</b>	<b>1.21E-03</b>	<b>BB 2</b>
Eu 155		8		8	<b>Total b/g</b>	<b>6.42E-03</b>	<b>BB 2</b>	<b>6.42E-03</b>	<b>BB 2</b>

**Bands (Upper and Lower)**

- A a factor of 1.5
- B a factor of 3
- C a factor of 10
- D a factor of 100
- E a factor of 1000

Note: Bands quantify uncertainty in mean radioactivity.

**Code**

- 1 Measured activity
- 2 Derived activity (best estimate)
- 3 Derived activity (upper limit)
- 4 Not present
- 5 Present but not significant
- 6 Likely to be present but not assessed
- 7 Present in significant quantities but not determined
- 8 Not expected to be present in significant quantity