

WASTE STREAM**5C39****Solid Waste Complex Operational LLW**

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.....	21.2 m ³
Future arisings -	1.4.2022 - 31.3.2023.....	91.7 m ³
	1.4.2023 - 31.3.2028.....	598.8 m ³
Total future arisings:		690.5 m ³
Total waste volume:		711.7 m ³

Comment on volumes: Rates of arisings depend on operations carried out. Waste processing operations are programmed to cease before 2030. 141m³ transferred to 5C55 (New Stream - Miscellaneous Legacy LLW) to aid clarity. Disposals during 2013-2016 of 233m³.

Uncertainty factors on volumes: Stock (upper): x 1.2 Arisings (upper) x 1.2
 Stock (lower): x 0.8 Arisings (lower) x 0.8

WASTE SOURCE Operational waste from the Solid Waste Plant and waste generated from housekeeping, maintenance and refurbishment work.

PHYSICAL CHARACTERISTICS

General description: The vast majority of the waste arisings are soft, low activity wastes which are suitable for incineration. Maintenance, housekeeping and refurbishment work generates the next highest volume of waste consisting of small amounts of concrete/rubble, WEEE (VLLW), unreclaimable low grade metals and equipment suitable for disposal as VLLW. ILW retrieval operations create a small amount of higher activity wastes, such as paper swabs and soft wastes from maintenance and routine operations that require disposal to LLWR. None.

Physical components (%wt): Metal 20%, Concrete/rubble 24%, Soil 2%, biodegradables 19%, plastics 17%, rubber 15%, wood 2%, Others 1%;

Sealed sources: The waste does not contain sealed sources.

Bulk density (t/m³): ~1.03

Comment on density: Taken from WCH mass divided by volume

CHEMICAL COMPOSITION

General description and components (%wt): Metal 20%, Concrete/rubble 24%, Soil 2%, biodegradables 19%, plastics 17%, rubber 15%, wood 2%, Others 1%;

Chemical state: Neutral

Chemical form of radionuclides: H-3: Unknown
 Ra: Unknown
 Th: Probably metal, oxide or nitrate.
 U: Probably metal, oxide or nitrate.
 Np: Unknown
 Pu: Probably metal, oxide or nitrate.

Metals and alloys (%wt): Sheet metal may be present in a range of thicknesses.

	(%wt)	Type(s) / Grade(s) with proportions	% of total C14 activity
Stainless steel.....	~3.2	Alloy - drums, tools, pipe, etc	
Other ferrous metals.....	~15.6	Alloy - Outer packagings (Drums), dismantled equipment and machinery parts, tools, containers, safety shoes (toe caps)	
Iron.....	TR	Solid, small, pieces of unreclaimable	

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			metal	
Aluminium.....	TR		Alloy - unreclaimable pieces, tools, ladder parts, small containers, signage	
Beryllium.....				
Cobalt.....				
Copper.....	TR		Solid, small, pieces of unreclaimable metal	
Lead.....	~0.02		Various solid metal, sheets, pipes, containers	
Magnox/Magnesium.....	NE			
Nickel.....				
Titanium.....				
Uranium.....				
Zinc.....	TR			
Zircaloy/Zirconium.....	NE			
Other metals.....	1.0			
Organics (%wt):		Plastics and rubbers will be present but the split between halogenated or non-halogenated is unknown at present so 50/50 estimate made.		
	(%wt)	Type(s) and comment		% of total C14 activity
Total cellulosics.....	~2.0			
Paper, cotton.....				
Wood.....	~2.0			
Halogenated plastics	~9.0	Solid materials from decontamination ops, ex-pipework, furniture, PPE, PVC sheeting. Outer containers (Dolav type boxes)		
Total non-halogenated plastics....	~8.0			
Condensation polymers.....	~0			
Others.....	~8.0	Solid materials from decontamination ops, trunking, cabling, sheeting, PPE		
Organic ion exchange materials....	TR			
Total rubber.....	~15.0			
Halogenated rubber	~7.5	Neoprene and hypalon		
Non-halogenated rubber.....	~7.5			
Hydrocarbons.....	~0.64			
Oil or grease				
Fuel.....				
Asphalt/Tarmac (cont.coal tar)...	~0.32	Solid pieces from building fabric or old flooring materials		
Asphalt/Tarmac (no coal tar)....	~0.16	Drums containing solid ex-building or flooring materials		
Bitumen.....	~0.16	Drums containing solid ex-flooring sealing materials		
Others.....				
Other organics.....				
Other materials (%wt):	-			

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	(%wt)	Type(s) and comment	% of total C14 activity
Inorganic ion exchange materials..			
Inorganic sludges and flocs.....			
Soil.....	~2.0		
Brick/Stone/Rubble.....	~24.0		
Cementitious material.....			
Sand.....			
Glass/Ceramics.....			
Graphite.....	0		
Desiccants/Catalysts.....			
Asbestos.....	0		
Non/low friable.....			
Moderately friable.....			
Highly friable.....			
Free aqueous liquids.....	0		
Free non-aqueous liquids.....	0		
Powder/Ash.....	~0		

Inorganic anions (%wt): Anion content should be negligible, except as component of concrete.

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

Materials of interest for waste acceptance criteria: -

	(%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.....	~19.0	
Putrescible wastes.....	~5.0	
Non-putrescible wastes.....	~14.0	

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Corrosive materials.....		
Pyrophoric materials.....	0	
Generating toxic gases.....	0	
Reacting with water.....	P	6m2
Higher activity particles.....		
Soluble solids as bulk chemical compounds.....		

Hazardous substances / non hazardous pollutants: Lead (trace). Trace quantities of asbestos, barium compounds and uranium may be present.

	(%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.....	~0.19	Solid metal sheets (VLLW)
Caesium.....		
Selenium.....		
Chromium.....		
Molybdenum.....		
Thallium.....		
Tin.....		
Vanadium.....		
Mercury compounds.....		
Others.....		
Electronic Electrical Equipment (EEE)		
EEE Type 1.....	P	100 off computers and controls from remote retrieval machines
EEE Type 2.....	P	100 off Equipment from retrieval machines
EEE Type 3.....	P	50 off Maintenance equipment used to refurbish retrieval machines
EEE Type 4.....		
EEE Type 5.....		

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Complexing agents (%wt): No

	(%wt)	Type(s) and comment
EDTA.....		
DPTA.....		
NTA.....		
Polycarboxylic acids.....		
Other organic complexants.....		
Total complexing agents.....	0	

Potential for the waste to contain discrete items: Yes. Large Metal Items (LMIs)/"substantial" thickness items considered "durable" assumed DIs; Stainless items assumed DIs Large Concrete Items (LCIs) may be DIs; drummed (ungroued)/"rubbleised" wastes assumed not DIs

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	7.0
Incineration	Off-site	75.0
Solidification		
Decontamination		
Metal treatment		
Size reduction		
Decay storage		
Recycling / reuse		
Other / various		
None		19.0

Comment on planned treatments:

17% of this stream is expected to be disposed of as VLLW to landfill

Disposal Routes:

Disposal Route	Stream volume %	Disposal density t/m3
Expected to be consigned to the LLW Repository	9.0	1.0
Expected to be consigned to a Landfill Facility	17.0	1.0
Expected to be consigned to an On-Site Disposal Facility		
Expected to be consigned to an Incineration Facility	74.0	0.40
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		

Classification codes for waste expected to be consigned to a landfill facility: 17 04 05, 17 05 03*/04, 17 02 03

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			

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 ³	Number of packages
1/3 Height IP-1 ISO			
2/3 Height IP-2 ISO			
1/2 Height WAMAC IP-2 ISO	7.0	21.6	3
1/2 Height IP-2 Disposal/Re-usable ISO	2.0	10	2
2m box (no shielding)			
4m box (no shielding)			
Other			

Other information: 21.6m³ loading volume is calculated based on the fact that you can fit 36 off (200 litre/0.2m³) drums (7.2m³) 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 (21.6m³)

Waste Planned for Disposal at the LLW Repository:

Container voidage: -

Waste Characterisation Form (WCH): The waste meets the LLWR's Waste Acceptance Criteria (WAC).
The waste has a current WCH.
Inventory information is consistent with the current WCH.

Waste consigned for disposal to LLWR in year of generation: Yes.

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 range of waste management operations

Uncertainty: Arisings content will vary with building operations.

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: Activities measured/ estimated by a range of methods including sampling/analysis and radiation measurements. Data taken from WCH: 1MXN-2HAR-0-WCH-0-4662 V5 and decayed by two years from 2020 activity ref date.

Other information: -

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Nuclide	Mean radioactivity, TBq/m ³				Nuclide	Mean radioactivity, TBq/m ³			
	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	5.12E-07	CC 2	5.12E-07	CC 2	Gd 153		8		8
Be 10		8		8	Ho 163		8		8
C 14	2.27E-09	CC 2	2.27E-09	CC 2	Ho 166m		8		8
Na 22		8		8	Tm 170		8		8
Al 26		8		8	Tm 171		8		8
Cl 36		8		8	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	6.71E-08	CC 2	6.71E-08	CC 2	Pb 210	1.58E-07	CC 2	1.58E-07	CC 2
Co 60	1.99E-06	CC 2	1.99E-06	CC 2	Bi 208		8		8
Ni 59	1.27E-07	CC 2	1.27E-07	CC 2	Bi 210m		8		8
Ni 63	9.79E-06	CC 2	9.79E-06	CC 2	Po 210	1.57E-07	CC 2	1.57E-07	CC 2
Zn 65	1.68E-09	CC 2	1.68E-09	CC 2	Ra 223	1.01E-07	CC 2	1.01E-07	CC 2
Se 79		8		8	Ra 225		8		8
Kr 81		8		8	Ra 226	1.7E-07	CC 2	1.7E-07	CC 2
Kr 85	2.56E-07	CC 2	2.56E-07	CC 2	Ra 228	2E-08	CC 2	2E-08	CC 2
Rb 87		8		8	Ac 227	1.01E-07	CC 2	1.01E-07	CC 2
Sr 90	3.19E-05	CC 2	3.19E-05	CC 2	Th 227	9.96E-08	CC 2	9.96E-08	CC 2
Zr 93	1.73E-09	CC 2	1.73E-09	CC 2	Th 228	1.76E-08	CC 2	1.76E-08	CC 2
Nb 91		8		8	Th 229		8		8
Nb 92		8		8	Th 230	1.33E-08	CC 2	1.33E-08	CC 2
Nb 93m	4.77E-09	CC 2	4.77E-09	CC 2	Th 232	2E-08	CC 2	2E-08	CC 2
Nb 94	6.8E-09	CC 2	6.8E-09	CC 2	Th 234	2.01E-08	CC 2	2.01E-08	CC 2
Mo 93	6.66E-09	CC 2	6.66E-09	CC 2	Pa 231	9.56E-08	CC 2	9.56E-08	CC 2
Tc 97		8		8	Pa 233	1.67E-09	CC 2	1.67E-09	CC 2
Tc 99	1.47E-09	CC 2	1.47E-09	CC 2	U 232	1.63E-09	CC 2	1.63E-09	CC 2
Ru 106		8		8	U 233	6.67E-09	CC 2	6.67E-09	CC 2
Pd 107		8		8	U 234	6.8E-09	CC 2	6.8E-09	CC 2
Ag 108m	1.75E-08	CC 2	1.75E-08	CC 2	U 235	6.67E-09	CC 2	6.67E-09	CC 2
Ag 110m		8		8	U 236	1.67E-09	CC 2	1.67E-09	CC 2
Cd 109	4.46E-09	CC 2	4.46E-09	CC 2	U 238	2.01E-08	CC 2	2.01E-08	CC 2
Cd 113m	1.72E-06	CC 2	1.72E-06	CC 2	Np 237	1.67E-09	CC 2	1.67E-09	CC 2
Sn 119m		8		8	Pu 236		8		8
Sn 121m	2.05E-07	CC 2	2.05E-07	CC 2	Pu 238	7.14E-07	CC 2	7.14E-07	CC 2
Sn 123		8		8	Pu 239	2.79E-07	CC 2	2.79E-07	CC 2
Sn 126		8		8	Pu 240	2.34E-07	CC 2	2.34E-07	CC 2
Sb 125	3.47E-09	CC 2	3.47E-09	CC 2	Pu 241	6.03E-06	CC 2	6.03E-06	CC 2
Sb 126		8		8	Pu 242	6.67E-09	CC 2	6.67E-09	CC 2
Te 125m		8		8	Am 241	8.48E-07	CC 2	8.48E-07	CC 2
Te 127m		8		8	Am 242m		8		8
I 129	6.67E-09	CC 2	6.67E-09	CC 2	Am 243		8		8
Cs 134	1.16E-09	CC 2	1.16E-09	CC 2	Cm 242		8		8
Cs 135		8		8	Cm 243	6.37E-09	CC 2	6.37E-09	CC 2
Cs 137	2.9E-05	CC 2	2.9E-05	CC 2	Cm 244	1.04E-07	CC 2	1.04E-07	CC 2
Ba 133		8		8	Cm 245	6.67E-09	CC 2	6.67E-09	CC 2
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	5.27E-09	CC 2	5.27E-09	CC 2	Cf 251		8		8
Sm 147		8		8	Cf 252		8		8
Sm 151	1.15E-07	CC 2	1.15E-07	CC 2	Other a				
Eu 152	6.74E-06	CC 2	6.74E-06	CC 2	Other b/g				
Eu 154	4.22E-06	CC 2	4.22E-06	CC 2	Total a	2.92E-06	CC 2	2.92E-06	CC 2
Eu 155	1.16E-07	CC 2	1.16E-07	CC 2	Total b/g	9.32E-05	CC 2	9.32E-05	CC 2

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