

WASTE STREAM	2D201	ILW Concrete Lined Drums from Harwell
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SITE Sellafield

SITE OWNER Nuclear Decommissioning Authority

WASTE CUSTODIAN Sellafield Limited

WASTE TYPE ILW; PFSD

Is the waste subject to Scottish Policy: No

WASTE VOLUMES

Stocks:	At 1.4.2022.....	Reported 622.9 m ³
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Total future arisings:		0 m ³
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Total waste volume:		622.9 m ³
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Comment on volumes: Arisings are not published in this return to avoid double counting, CLDs yet to be transferred to the Sellafield site are included in waste streams 5C08 and 5G10. It is anticipated that 2,328 CLDs will eventually be consigned to Sellafield from Harwell.

Uncertainty factors on volumes:	Stock (upper):	x 1.05	Arisings (upper)	x
	Stock (lower):	x 0.95	Arisings (lower)	x

WASTE SOURCE Wastes from various sites which were packaged for the abandoned 1982 sea disposal campaigns.

PHYSICAL CHARACTERISTICS

General description: Miscellaneous radioactive wastes held in mild steel drums within a concrete carcass. Internal packages contain absorbed liquid, precipitated sludge, incinerator ash, and laboratory trash. Type 1801 sea disposal drums contain an internal cardboard drum of 100 litres in an external drum of 200 litres and weigh up to 352 kg; these drums will be overpacked in a mild steel overdrum prior to consignment to Sellafield. Type 1802 sea disposal drums contain an internal drum of 200 litres in an external drum of 450 litres and weigh up to 1060 kg. Type 1803 sea disposal drums contain various inner drums from 10 litres to 200 litres in an external drum of 630 litres and weigh up to 2290 kg.

Physical components (%wt): Mild steel outer drums (~8%), inactive concrete carcasses (~38%), waste (including cemented wastes and inner cans/ liners) (~54%).

Sealed sources: The waste contains sealed sources. A number of Cs, Co and Am sources are known to exist within this waste stream.

Bulk density (t/m³): ~1.5

Comment on density: Total mass divided by total volume.

CHEMICAL COMPOSITION

General description and components (%wt): The waste consists of metals, glass, plastics, paper, sludges, ash etc. in mild steel drums within a concrete carcass. Concrete/ cemented wastes (37%), ferrous metals (24%), Al (7%), other metals including sources (9%), plastics (4%), cellulose (2%), others (17%).

Chemical state: Neutral

Chemical form of radionuclides:
H-3: Some tritiated D2O is present, remainder from activation of metals
C-14: Small proportion as labelled organic compounds. Bulk as activation product.
Cl-36: From activation of impurities in metals.
Ra: Some Ra and Ra/Be sources, remainder within fuel contamination.
Th: Metal and oxide.
U: Principally as bulk metal, with some as irradiated metal/ oxide fuel.
Pu: Probably principally as oxide or metal fuel.

Metals and alloys (%wt): The form of metals within the wastes varies. Uranium can be present as single items up to 50kg.

WASTE STREAM

2D201

ILW Concrete Lined Drums from Harwell

	(%wt)	Type(s) / Grade(s) with proportions	% of total C14 activity
Stainless steel.....	~8.0	Ferrous metals consist principally of mild steel; small amounts of cast iron are also present. Grades of stainless are generally unknown, and in many cases only "metal" is declared; taken to be mild steel. Other alloys may also be present, but none specifically declared. A proportion of the waste (~4%) consists of sources. The mass of these is assumed to be dominated by stainless.	
Other ferrous metals.....	~20.0		
Iron.....	P		
Aluminium.....	~7.0		
Beryllium.....	TR		
Cobalt.....	0		
Copper.....	<0.20		
Lead.....	<4.0		
Magnox/Magnesium.....	TR		
Nickel.....	0		
Titanium.....			
Uranium.....	~0.70		
Zinc.....	TR		
Zircaloy/Zirconium.....	TR		
Other metals.....	~0.73	Other metals principally U & Th. Also small amounts of cobalt, cadmium, titanium, tungsten, and beryllium; traces of scandium, tantalum, iridioplatinum, palladium.	

Organics (%wt):

The waste contains cellulose, halogenated plastic, non-halogenated plastic, halogenated rubber and non-halogenated rubber. There are only traces of organic ion exchange resin from Harwell MTRs (Materials Testing Reactors). The waste also contains traces of pharmaceutical compounds and other organics, small amounts of perspex and other plastics. Halogenated plastic is principally PVC, though PTFE may also be present. The non-halogenated plastic is principally polythene. Rubbers are expected to comprise neoprene and hypalon.

	(%wt)	Type(s) and comment	% of total C14 activity
Total cellulotics.....	~2.1		
Paper, cotton.....	~2.0		
Wood.....	<0.10		
Halogenated plastics	~2.0		
Total non-halogenated plastics.....	~2.0		
Condensation polymers.....	TR		
Others.....	~2.0		
Organic ion exchange materials....	TR		
Total rubber.....	~0.10		
Halogenated rubber	~0.10		
Non-halogenated rubber.....	TR		

WASTE STREAM	2D201	ILW Concrete Lined Drums from Harwell
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Hydrocarbons.....	0
Oil or grease	0
Fuel.....	0
Asphalt/Tarmac (cont.coal tar)...	0
Asphalt/Tarmac (no coal tar).....	0
Bitumen.....	0
Others.....	0
Other organics.....	TR

Other materials (%wt): The percentage of sludges and flocs includes cemented sludges; it is not always clear from records whether these have been cemented or merely dried. A small number of drums contain only clinoptilolite. Assumed remaining mass is due to grout encapsulant.

	(%wt)	Type(s) and comment	% of total C14 activity
Inorganic ion exchange materials..	~0.10		
Inorganic sludges and flocs.....	<7.0		
Soil.....	0		
Brick/Stone/Rubble.....	TR		
Cementitious material.....	44.8		
Sand.....	0		
Glass/Ceramics.....	~1.2		
Graphite.....	<0.10		
Desiccants/Catalysts.....			
Asbestos.....	TR		
Non/low friable.....	NE		
Moderately friable.....	NE		
Highly friable.....	NE		
Free aqueous liquids.....	TR		
Free non-aqueous liquids.....	TR		
Powder/Ash.....	P		

Inorganic anions (%wt): Carbonate and sulphate are present in the cement matrices only. Four drums contain fire suppressant Eutectic chloride powders, likely to be in kg amounts. Single drums only contain trace amounts of HF, oxalic acid, HNO₃, U arsenide, carbide & selenide.

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

WASTE STREAM	2D201	ILW Concrete Lined Drums from Harwell
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Materials of interest for waste acceptance criteria: The waste contains small amounts of barium chloride, cadmium, uranium and beryllium. Lead is also present as bulk metal in which form it does not count as special.

	(%wt)	Type(s) and comment
Combustible metals.....	0	
Low flash point liquids.....	NE	
Explosive materials.....	0	
Phosphorus.....	0	
Hydrides.....	0	
Biological etc. materials.....	0	
Biodegradable materials.....	0	
Putrescible wastes.....	0	
Non-putrescible wastes.....	0	
Corrosive materials.....	NE	
Pyrophoric materials.....	0	
Generating toxic gases.....	0	
Reacting with water.....	0	
Higher activity particles.....	NE	
Soluble solids as bulk chemical compounds.....	TR	

Hazardous substances / non hazardous pollutants: Potentially combustible metals include uranium and zircaloy. However, there is no evidence that significant amounts are present in finely-divided forms. All liquids except trace amounts should be on absorbents. Powders will be present from degradation of plastics and cellulose and corrosion of metals in addition to the initial waste: floor sweepings, chemicals etc (<1%), incinerator ash (~1%).

	(%wt)	Type(s) and comment
Acrylamide.....	NE	
Benzene.....	NE	
Chlorinated solvents.....	NE	
Formaldehyde.....	NE	
Organometallics.....	NE	
Phenol.....	NE	
Styrene.....	NE	
Tri-butyl phosphate.....	NE	
Other organophosphates.....	NE	
Vinyl chloride.....	NE	
Arsenic.....	NE	
Barium.....	NE	
Boron.....	NE	
Boron (in Boral).....	NE	
Boron (non-Boral).....	NE	
Cadmium.....	NE	
Caesium.....	NE	
Selenium.....	NE	
Chromium.....	NE	

WASTE STREAM	2D201	ILW Concrete Lined Drums from Harwell
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Molybdenum.....	NE
Thallium.....	NE
Tin.....	P
Vanadium.....	NE
Mercury compounds.....	NE
Others.....	NE
Electronic Electrical Equipment (EEE)	
EEE Type 1.....	TR
EEE Type 2.....	TR
EEE Type 3.....	TR
EEE Type 4.....	TR
EEE Type 5.....	TR

Complexing agents (%wt): Yes

	(%wt)	Type(s) and comment
EDTA.....	NE	
DPTA.....	NE	
NTA.....	NE	
Polycarboxylic acids.....	NE	
Other organic complexants.....	TR	Trace oxalic acid in one drum.
Total complexing agents.....	TR	

Potential for the waste to contain discrete items: Yes.

PACKAGING AND CONDITIONING

Conditioning method: At present there is no treatment route available for CLDs; the high level assumption is that the CLD's will be loaded into 3m3 boxes and grouted.

Plant Name: TBC

Location: TBC

Plant startup date: TBC

Total capacity (m³/y incoming waste): -

Target start date for packaging this stream: -

Throughput for this stream (m³/y incoming waste): -

Other information: -

Likely container type:	Container	Waste packaged (%vol)	Waste loading (m³)	Payload (m³)	Number of packages
	3m³ box (square corners)	100.0	~0.902	~2.8	691

WASTE STREAM**2D201****ILW Concrete Lined Drums from Harwell**

Likely container type comment: Final waste container has not been selected yet. Early assumption is that 3m3 box will be used.

Range in container waste volume: Range of CLD volumes exists. It is assumed 2 CLD per box will be loaded regardless of size. Volumes above represent an average across the population.

Other information on containers: -

Likely conditioning matrix: Not Specified

Other information: Encapsulation matrix currently unknown, however it is assumed that a simialr matrix to what is used in other encapsulation plants at the time will be deployed.

Conditioned density (t/m³): -

Conditioned density comment: Density unknown due to uncertainty over conditioning matrix.

Other information on conditioning: -

Opportunities for alternative disposal routing: No

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

RADIOACTIVITY

Source: Predominantly contamination from fuel handling facilities. Also some activated items from MTR operations and sealed sources and bulk uranium from small users' facilities.

Uncertainty: The accuracy depends on the original declarations from the consignor.

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: Measurements are from the original declarations from the consignor and were often based upon gamma measurements, with some neutron counting.

Other information: -

WASTE STREAM 2D201 ILW Concrete Lined Drums from Harwell

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	1.62E-01	BB 2			Gd 153				
Be 10					Ho 163				
C 14	2.18E-05	BB 2			Ho 166m				
Na 22	7.19E-10	BB 2			Tm 170				
Al 26					Tm 171				
Cl 36	5.38E-05	BB 2			Lu 174				
Ar 39					Lu 176				
Ar 42					Hf 178n				
K 40					Hf 182				
Ca 41					Pt 193				
Mn 53					Tl 204	3.32E-08	BB 2		
Mn 54					Pb 205				
Fe 55	7.62E-07	BB 2			Pb 210				
Co 60	2.25E-05	BB 2			Bi 208				
Ni 59	4.15E-06	BB 2			Bi 210m				
Ni 63	3.69E-04	BB 2			Po 210	2.06E-27	BB 2		
Zn 65	7.85E-18	BB 2			Ra 223				
Se 79					Ra 225				
Kr 81					Ra 226				
Kr 85	3.04E-05	BB 2			Ra 228	1.06E-08	BB 2		
Rb 87					Ac 227	7.85E-06	BB 2		
Sr 90	1.16E-03	BB 2			Th 227				
Zr 93					Th 228	2.27E-09	BB 2		
Nb 91					Th 229				
Nb 92					Th 230				
Nb 93m	4.45E-06	BB 2			Th 232	1.08E-08	BB 2		
Nb 94	5.14E-07	BB 2			Th 234				
Mo 93	1.68E-06	BB 2			Pa 231	1.28E-05	BB 2		
Tc 97					Pa 233				
Tc 99	4.77E-06	BB 2			U 232				
Ru 106	2.62E-14	BB 2			U 233				
Pd 107					U 234	4.49E-07	BB 2		
Ag 108m					U 235	2.13E-08	BB 2		
Ag 110m					U 236	1.63E-09	BB 2		
Cd 109	6.10E-13	BB 2			U 238	3.87E-07	BB 2		
Cd 113m					Np 237	2.06E-05	BB 2		
Sn 119m					Pu 236				
Sn 121m	8.19E-07	BB 2			Pu 238	1.23E-03	BB 2		
Sn 123					Pu 239	4.33E-03	BB 2		
Sn 126					Pu 240	3.06E-03	BB 2		
Sb 125	1.40E-08	BB 2			Pu 241	6.32E-02	BB 2		
Sb 126					Pu 242	1.82E-06	BB 2		
Te 125m	8.98E-63	BB 2			Am 241	9.03E-03	BB 2		
Te 127m					Am 242m	2.46E-06	BB 2		
I 129	1.45E-11	BB 2			Am 243	6.64E-06	BB 2		
Cs 134	9.97E-09	BB 2			Cm 242	3.76E-26	BB 2		
Cs 135					Cm 243	1.11E-06	BB 2		
Cs 137	1.69E-03	BB 2			Cm 244	1.80E-05	BB 2		
Ba 133					Cm 245				
La 137					Cm 246				
La 138					Cm 248				
Ce 144	8.10E-17	BB 2			Cf 249				
Pm 145					Cf 250				
Pm 147	2.12E-07	BB 2			Cf 251				
Sm 147					Cf 252	2.32E-09	BB 2		
Sm 151	9.25E-06	BB 2			Other a	1.96E-05	BB 2		
Eu 152	6.92E-08	BB 2			Other b/g	1.38E-05	BB 2		
Eu 154	6.36E-06	BB 2			Total a	1.77E-02	BB 2	0	
Eu 155	2.24E-07	BB 2			Total b/g	2.29E-01	BB 2	0	

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