

WASTE STREAM	2D38/C	Encapsulated Magnox Cladding
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SITE Sellafield

SITE OWNER Nuclear Decommissioning Authority

WASTE CUSTODIAN Sellafield Limited

WASTE TYPE ILW

Is the waste subject to Scottish Policy: No

WASTE VOLUMES

		Conditioned	Packaged
Stocks:	At 1.4.2022.....	10196.8 m ³	11931.0 m ³
Future arisings -	1.4.2022 - 31.3.2023.....	39.0 m ³	45.7 m ³
Total future arisings:		39.0 m ³	45.7 m ³
Total waste volume:		10235.8 m ³	11976.7 m ³
Number of waste packages in stock:	At 1.4.2022.....	20895 package(s)	

Comment on volumes: Encapsulation of fresh Magnox swarf; thereafter MEP will support FHP POCO and then its own POCO operations. Forecast volumes are expected to be within a factor of +/- 1.1. Total packages includes 8 Inactive drums.

Uncertainty factors on volumes: Stock (upper): x 1.1 Arisings (upper) x 1.1
Stock (lower): x 0.9 Arisings (lower) x 0.9

WASTE SOURCE Magnox swarf from fuel decanning at Fuel Handling Plant.

PHYSICAL CHARACTERISTICS

General description: The waste is swarf from Magnox fuel decanning. The waste is encapsulated in a grout matrix comprising ground granulated blast furnace slag and ordinary Portland cement. No items require special handling. Some of the waste may have undergone corrosion processes.

Physical components (%wt): Magnox swarf and associated debris which includes Sintox discs, Nimonic springs, etc. (16.5 wt%). Ground granulated blast furnace slag / ordinary Portland cement grout (82 wt%). Mild steel anti-flotation plate (1.5 wt%).

Sealed sources: The waste does not contain sealed sources.

Bulk density (t/m³): 1.85

Comment on density: -

CHEMICAL COMPOSITION

General description and components (%wt): (a) Cement grout matrix, which comprises 82% by weight of the waste, is composed of ground granulated blast furnace slag (57.4%), ordinary Portland cement (16.7%), and water (25.9%). (b) Encapsulated waste, which comprises 16.5% by weight of the waste, is composed of Magnox alloy (94.6%), aluminium (1.5%), stainless steel (0.15%), Nimonic (0.2%), uranium (3.5%). (c) Anti-flotation plate, which comprises 1.5% by weight of the waste, is composed of mild steel.

Chemical state: Alkali

Chemical form of radionuclides: Cl-36: Present as trace amounts of clathrate compounds of metallic salts readily lost to aqueous solution.
I-129: Present as trace amounts of clathrate compounds of metallic salts readily lost to aqueous solution.
U: Present as metal carry-over from the decanning process, with trace quantities of hydride and small amounts of oxide.
Pu: Associated with the uranium.

Metals and alloys (%wt): There is no sheet metal. The metal component of the waste comprises bits of fuel element can typically 100mm by 10mm. There may also be flow splitters present as crushed/twisted metal strips.

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	(%wt)	Type(s) / Grade(s) with proportions	% of total C14 activity
Stainless steel.....	0.03		
Other ferrous metals.....	1.2		100.0
Iron.....			
Aluminium.....	0.25		
Beryllium.....	<0.01		
Cobalt.....	0		
Copper.....	0		
Lead.....	0		
Magnox/Magnesium.....	15.0		
Nickel.....	~0.06		
Titanium.....	0		
Uranium.....	1.5		
Zinc.....	0		
Zircaloy/Zirconium.....	0		
Other metals.....	~0		

Organics (%wt): There are no organic materials present except for nylon and polyurethane or hydrogenated nitrile rubber (from grout pigs) in very small amounts in drums of encapsulated product.

	(%wt)	Type(s) and comment	% of total C14 activity
Total cellulose.....	0		
Paper, cotton.....	0		
Wood.....	0		
Halogenated plastics	0		
Total non-halogenated plastics.....	TR		
Condensation polymers.....	TR		
Others.....	TR		
Organic ion exchange materials....	0		
Total rubber.....	0		
Halogenated rubber	0		
Non-halogenated rubber.....	TR		
Hydrocarbons.....			
Oil or grease			
Fuel.....			
Asphalt/Tarmac (cont.coal tar)...			
Asphalt/Tarmac (no coal tar)....			
Bitumen.....			
Others.....			
Other organics.....	0		

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				
Soil.....	0				
Brick/Stone/Rubble.....	0				
Cementitious material.....	82.0				
Sand.....	0	There is no added sand in the encapsulation grout.			
Glass/Ceramics.....	0				
Graphite.....	0				
Desiccants/Catalysts.....	0				
Asbestos.....	0	There is no asbestos of any kind in this waste.			
Non/low friable.....					
Moderately friable.....					
Highly friable.....					
Free aqueous liquids.....	0				
Free non-aqueous liquids.....	0				
Powder/Ash.....					

Inorganic anions (%wt): Chlorides, iodides and carbonates may be present in trace amounts. Chlorides, sulphates and sulphides are associated with the grout solids.

	(%wt)	Type(s) and comment
Fluoride.....	0	
Chloride.....	<0.05	
Iodide.....	TR	
Cyanide.....	NE	
Carbonate.....	TR	
Nitrate.....	0	
Nitrite.....	TR	
Phosphate.....	0	
Sulphate.....	<0.50	
Sulphide.....	<0.95	

Materials of interest for waste acceptance criteria: The waste contains uranium and magnesium alloy. Uranium hydride is also present in trace amounts. These materials are encapsulated and present no hazard.

	(%wt)	Type(s) and comment
Combustible metals.....	15.0	Magnox swarf considered combustible.
Low flash point liquids.....	0	
Explosive materials.....	0	
Phosphorus.....	0	
Hydrides.....	P	Trace amounts of uranium hydride may be present.
Biological etc. materials.....	0	
Biodegradable materials.....	0	

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Putrescible wastes.....	0	
Non-putrescible wastes.....		
Corrosive materials.....	P	The waste is strongly alkaline.
Pyrophoric materials.....	P	Trace amounts of uranium hydride may be present.
Generating toxic gases.....	P	Low levels of hydrogen will be generated.
Reacting with water.....	0	
Higher activity particles.....	P	Small fraction may be released from a dropped drum.
Soluble solids as bulk chemical compounds.....	P	Various sodium and magnesium compounds.

Hazardous substances /
non hazardous pollutants: -

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

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EEE Type 5.....

Complexing agents (%wt): No

	(%wt)	Type(s) and comment
EDTA.....		
DPTA.....		
NTA.....		
Polycarboxylic acids.....	0	
Other organic complexants.....	0	There are no complexing agents present in the waste.
Total complexing agents.....	0	

Potential for the waste to contain discrete items: No.

PACKAGING AND CONDITIONING

Container type:	Container	Waste packaged (%vol)	Waste loading (m ³)	Payload (m ³)	Number of packages
	500 l drum	100.0	0.488	0.488	20975

Container type comment: -

Range in container waste volume: This waste stream is already conditioned in stainless steel drums with a nominal capacity of 500 litres. The conditioned waste occupies 488 litres, plus or minus 5%.

Other information on containers: -

Conditioned density (t/m³): 1.85

Conditioned density comment: -

Other information on conditioning: -

RADIOACTIVITY

Source: Mixed fission products and reactor fuel carry-over. The main sources of activity are Ce-144, Pm-147, Ru-106, Nb-95, Zr-95, Cs-137 in proportions typical for outer layer of irradiated uranium fuel rods.

Uncertainty: Activities are derived best estimates within a factor of 3, and assume an average 1% fuel carry over.

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: -

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	3.41E-02	BB 2	8.86E-02	BB 2	Gd 153				
Be 10	1.11E-07	BB 2	1.11E-07	BB 2	Ho 163				
C 14	1.07E-04	BB 2	1.07E-04	BB 2	Ho 166m				
Na 22					Tm 170				
Al 26					Tm 171				
Cl 36	4.23E-05	BB 2	4.23E-05	BB 2	Lu 174				
Ar 39					Lu 176				
Ar 42					Hf 178n				
K 40					Hf 182				
Ca 41	1.68E-04	BB 2	1.68E-04	BB 2	Pt 193				
Mn 53					Tl 204				
Mn 54	4.45E-04	BB 2	4.76E-02	BB 2	Pb 205				
Fe 55	1.79E-01	BB 2	2.94E+00	BB 2	Pb 210	7.96E-11	BB 2	8.92E-13	BB 2
Co 60	1.00E+00	AA 2	6.56E+00	AA 2	Bi 208				
Ni 59	5.73E-03	BB 2	5.73E-03	BB 2	Bi 210m				
Ni 63	6.53E-01	BB 2	7.44E-01	BB 2	Po 210	7.60E-11	BB 2	6.97E-13	BB 2
Zn 65	3.79E-03	AA 2	6.50E-01	AA 2	Ra 223	1.66E-09	BB 2		
Se 79	7.38E-06	BB 2	7.38E-06	BB 2	Ra 225	6.14E-12	BB 2		
Kr 81					Ra 226	3.06E-10	BB 2	1.53E-11	BB 2
Kr 85					Ra 228	1.82E-14	BB 2		
Rb 87					Ac 227	1.67E-09	BB 2		
Sr 90	6.15E+00	BB 2	9.49E+00	BB 2	Th 227	1.64E-09	BB 2		
Zr 93	4.24E-04	BB 2	4.24E-04	BB 2	Th 228	1.50E-14	BB 2		
Nb 91					Th 229	6.15E-12	BB 2	3.22E-12	BB 2
Nb 92					Th 230	5.04E-08	BB 2	1.18E-08	BB 2
Nb 93m	2.21E-04	BB 2	9.35E-07	BB 2	Th 232	2.87E-14	BB 2		
Nb 94	9.59E-10	BB 2	9.59E-10	BB 2	Th 234	2.57E-04	BB 2		
Mo 93	2.93E-06	BB 2	2.94E-06	BB 2	Pa 231	4.62E-09	BB 2	2.43E-09	BB 2
Tc 97					Pa 233	1.49E-05	BB 2		
Tc 99	2.09E-03	BB 2	2.09E-03	BB 2	U 232				
Ru 106	4.67E-01	AA 2	3.73E+01	AA 2	U 233	2.12E-09	BB 2	9.77E-10	BB 2
Pd 107		5		5	U 234	2.23E-04	BB 2	2.19E-04	BB 2
Ag 108m	3.63E-12	BB 2	3.75E-12	BB 2	U 235	5.45E-06	BB 2	5.45E-06	BB 2
Ag 110m	2.62E-13	BB 2			U 236	3.16E-05	BB 2	3.15E-05	BB 2
Cd 109					U 238	2.57E-04	BB 2	2.57E-04	BB 2
Cd 113m					Np 237	1.49E-05	BB 2	1.34E-05	BB 2
Sn 119m					Pu 236				
Sn 121m	1.01E-05	BB 2	1.30E-05	BB 2	Pu 238	7.40E-02	BB 2	7.80E-02	BB 2
Sn 123					Pu 239	1.18E-01	BB 2	1.18E-01	BB 2
Sn 126	4.13E-05	BB 2	4.13E-05	BB 2	Pu 240	1.76E-01	BB 2	1.76E-01	BB 2
Sb 125	8.54E-04	BB 2			Pu 241	6.75E+00	BB 2	1.55E+01	BB 2
Sb 126	5.78E-06	BB 2			Pu 242	1.56E-04	BB 2	1.56E-04	BB 2
Te 125m	2.14E-04	BB 2			Am 241	3.35E-01	BB 2	5.08E-02	BB 2
Te 127m					Am 242m	1.09E-03	BB 2	1.19E-03	BB 2
I 129	4.29E-06	BB 2	4.29E-06	BB 2	Am 243	4.14E-04	BB 2	4.14E-04	BB 2
Cs 134	2.14E-01	AA 2	5.34E+00	AA 2	Cm 242	4.35E-03	BB 2	1.50E+00	BB 2
Cs 135	8.07E-05	BB 2	8.07E-05	BB 2	Cm 243	2.65E-04	BB 2	4.04E-04	BB 2
Cs 137	9.41E+00	AA 2	1.43E+01	AA 2	Cm 244	7.12E-03	BB 2	1.40E-02	BB 2
Ba 133					Cm 245	3.59E-07	BB 2	3.59E-07	BB 2
La 137					Cm 246	4.62E-08	BB 2	4.63E-08	BB 2
La 138					Cm 248				
Ce 144	4.56E-01	AA 2	5.78E+01	AA 2	Cf 249				
Pm 145					Cf 250				
Pm 147	1.42E+00	BB 2	2.47E+01	BB 2	Cf 251				
Sm 147	5.77E-10	BB 2			Cf 252				
Sm 151	3.38E-02	BB 2	3.91E-02	BB 2	Other a	1.33E-03	BB 2	1.33E-03	BB 2
Eu 152	1.00E-02	AA 2	2.43E-02	AA 2	Other b/g	6.60E+01	BB 2	1.28E+02	BB 2
Eu 154	1.19E-01	AA 2	4.33E-01	AA 2	Total a	7.17E-01	BB 2	1.94E+00	BB 2
Eu 155	8.43E-02	BB 2	6.07E-01	BB 2	Total b/g	9.30E+01	BB 2	3.05E+02	BB 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