

WASTE STREAM	2D38/C	Encapsulated Magnox Cladding
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SITE Sellafield

SITE OWNER Nuclear Decommissioning Authority

WASTE CUSTODIAN Sellafield Ltd

WASTE TYPE ILW

WASTE VOLUMES

	Reported (m ³)	OR	Conditioned (m ³)	Packaged (m ³)
Stocks:	At 1.4.2025		10234.4	11975.1
Future arisings:				0.0
Total future arisings:			0.0	0.0
Total waste volume:			10234.4	11975.1

Number of waste packages in stock: At 1.4.2025..... 20972 packages

Comment on arising rates: There are no declared arisings.

Additional information on quantities: 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.

Uncertainty factors on volumes:

Stock (upper):	x 1.00	Arisings (upper):	x -
Stock (lower):	x 1.00	Arisings (lower):	x -

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.

Changes since waste generated: Some of the waste may have undergone corrosion processes.

Bulk density (t/m³): = 1.9

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

Sheet metal proportion / thickness: 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.

Metals and alloys (%wt):

	(%wt)	Type(s) / Grades(s) with proportions	% of total C14 activity
Stainless steel.....	= 0.03	-	100.0
Other ferrous metals.....	= 1.2	-	
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):

	(%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):

	(%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.....		-	

COMPONENTS OF MATERIALS, WASTE PROPERTIES, MATERIALS NOT CONTRIBUTING TO MASS

Inorganic anions (%wt):

	(%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:

	(%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	-
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	-

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	-

Physical components:

	Number	Type(s) and comment
Sources.....	= 0	-
Electronic & Electrical Equipment (EEE)		-
EEE Type 1.....	0	-
EEE Type 2.....	0	-
EEE Type 3.....	0	-
EEE Type 4.....	0	-
EEE Type 5.....	0	-

TREATMENT, PACKAGING AND DISPOSAL

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

Treatment	On-site / Off-site	Stream volume %
Size reduction		
Decay storage		
Low force compaction		
Supercompaction (HFC)		
Incineration		
Drying/dewatering/liquid separation		
Tie down/fixatives/strippable coating/painting application		
Decontamination		
Metal treatment		
Recycling / reuse		
Thermal treatment, including vitrification		
Encapsulation	On-site	= 100.0
Polymer encapsulation		
Other physical treatment		
Other chemical treatment		
Containerisation		
Treatment not yet determined		
None		

Comments on planned treatments:

-

Conditioning method:

Encapsulation in grout at Magnox Encapsulation Plant

Conditioning plants:

Plant Name	Location
Magnox Encapsulation Plant (MEP)	Sellafield

Likely conditioning matrix:

Non-standard

Further information on the conditioning matrix:

The first ~20,000 drums used grout formulation BFS/OPC: 7:3 to 9:1 (3.44:1) @ 0.33:1-0.37:1 (0.35:1) w/s.
Anything produced after Nov 2019 used grout formulation: 5:1 GGBS: CEM I @ 0.47-0.59 w/s.

Waste Packaging:

Likely container type:	Container	Waste packaged (vol%)	Waste loading (m³)	Payload (m³)	Number of packages	Estimated start date for packaging
	500 l drum	100.0	0.49	0.49	20973	-

Range in container waste loading: 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 packaging and conditioning: N/A

Conditioned density (t/m³): = 1.9
Conditioned density comment: -

Management Routes:

Disposal Route	Stream volume %	Raw density t/m³	Start date
Expected to be consigned to a Near Site, Near Surface Disposal Facility (Scotland)	= 100.0		
Expected to be Non-NSD HAW managed under Scottish Government's policy			
Expected to be disposed to LLW Vaults NRS Dounreay			
Expected to be consigned to the Geological Disposal Facility			
Expected to be consigned to a Near Surface Disposal Facility			
Expected to be consigned to the LLW Repository			
Expected to be consigned to a Landfill Facility			
Expected to be disposed On-Site			
Expected to be managed by In-Situ Disposal			
Expected to be consigned to an Incineration Facility			
Expected to be consigned to a Metal Treatment Facility			
Expected to be Out of Scope			
Expected to be recycled / reused			
Disposal route not known			

Classification codes for waste expected to be consigned to a landfill facility:

Opportunities for alternative disposal routing: No

Baseline Management Route	Opportunity Management Route	Stream volume (%)	Opportunity Confidence	Comment
-	-	-	-	-

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.

Measurement of radioactivities: -

Chemical form of radionuclides:

H-3: -
C-14: -
Cl-36: Present as trace amounts of clathrate compounds of metallic salts readily lost to aqueous solution.

Se-79: -
Tc-99: -
I-129: Present as trace amounts of clathrate compounds of metallic salts readily lost to aqueous solution.

Ra: -
Th: -
U: Present as metal carry-over from the decanning process, with trace quantities of hydride and small amounts of oxide.
Np: -
Pu: Associated with the uranium.

WASTE STREAM 2D38/C Encapsulated Magnox Cladding									
Nuclide	Mean radioactivity, TBq/m³				Nuclide	Mean radioactivity, TBq/m³			
	Waste at 1.4.2025	Bands and Code	Future Arisings	Bands and Code		Waste at 1.4.2025	Bands and Code	Future Arisings	Bands and Code
H 3	2.90E-02	B B 2	8.86E-02	B B 2	Gd 153				
Be 10	1.11E-07	B B 2	1.11E-07	B B 2	Ho 163				
C 14	1.07E-04	B B 2	1.07E-04	B B 2	Ho 166m				
Na 22					Tm 170				
Al 26					Tm 171				
Cl 36	4.23E-05	B B 2	4.23E-05	B B 2	Lu 174				
Ar 39					Lu 176				
Ar 42					Hf 178n				
K 40					Hf 182				
Ca 41	1.68E-04	B B 2	1.68E-04	B B 2	Pt 193				
Mn 53					Ti 204				
Mn 54	6.25E-05	B B 2	4.76E-02	B B 2	Pb 205				
Fe 55	8.90E-02	B B 2	2.94E+00	B B 2	Pb 210	1.02E-10	B B 2	8.92E-13	B B 2
Co 60	6.91E-01	A A 2	6.56E+00	A A 2	Bi 208				
Ni 59	5.73E-03	B B 2	5.73E-03	B B 2	Bi 210m				
Ni 63	6.40E-01	B B 2	7.44E-01	B B 2	Po 210	9.77E-11	B B 2	6.97E-13	B B 2
Zn 65	3.54E-04	A A 2	6.50E-01	A A 2	Ra 223	1.94E-09	B B 2		
Se 79	7.38E-06	B B 2	7.38E-06	B B 2	Ra 225	6.75E-12	B B 2		
Kr 81					Ra 226	3.74E-10	B B 2	1.53E-11	B B 2
Kr 85					Ra 228	2.21E-14	B B 2		
Rb 87					Ac 227	1.95E-09	B B 2		
Sr 90	5.74E+00	B B 2	9.49E+00	B B 2	Th 227	1.92E-09	B B 2		
Zr 93	4.24E-04	B B 2	4.24E-04	B B 2	Th 228	1.86E-14	B B 2		
Nb 91					Th 229	6.77E-12	B B 2	3.22E-12	B B 2
Nb 92					Th 230	5.64E-08	B B 2	1.18E-08	B B 2
Nb 93m	2.44E-04	B B 2	9.35E-07	B B 2	Th 232	3.32E-14	B B 2		
Nb 94	9.59E-10	B B 2	9.59E-10	B B 2	Th 234	2.57E-04	B B 2		
Mo 93	2.93E-06	B B 2	2.94E-06	B B 2	Pa 231	4.96E-09	B B 2	2.43E-09	B B 2
Tc 97					Pa 233	1.53E-05	B B 2		
Tc 99	2.09E-03	B B 2	2.09E-03	B B 2	U 232				
Ru 106	8.40E-02	A A 2	3.73E+01	A A 2	U 233	2.32E-09	B B 2	9.77E-10	B B 2
Pd 107				5	U 234	2.23E-04	B B 2	2.19E-04	B B 2
Ag 108m	3.62E-12	B B 2	3.75E-12	B B 2	U 235	5.45E-06	B B 2	5.45E-06	B B 2
Ag 110m	1.25E-14	B B 2			U 236	3.16E-05	B B 2	3.15E-05	B B 2
Cd 109					U 238	2.57E-04	B B 2	2.57E-04	B B 2
Cd 113m					Np 237	1.53E-05	B B 2	1.34E-05	B B 2
Sn 119m					Pu 236				
Sn 121m	9.74E-06	B B 2	1.30E-05	B B 2	Pu 238	7.23E-02	B B 2	7.80E-02	B B 2
Sn 123					Pu 239	1.18E-01	B B 2	1.18E-01	B B 2
Sn 126	4.13E-05	B B 2	4.13E-05	B B 2	Pu 240	1.76E-01	B B 2	1.76E-01	B B 2
Sb 125	4.01E-04	B B 2			Pu 241	5.87E+00	B B 2	1.55E+01	B B 2
Sb 126	5.78E-06	B B 2			Pu 242	1.56E-04	B B 2	1.56E-04	B B 2
Te 125m	1.00E-04	B B 2			Am 241	3.63E-01	B B 2	5.08E-02	B B 2
Te 127m					Am 242m	1.07E-03	B B 2	1.19E-03	B B 2
I 129	4.29E-06	B B 2	4.29E-06	B B 2	Am 243	4.13E-04	B B 2	4.14E-04	B B 2
Cs 134	8.62E-02	A A 2	5.34E+00	A A 2	Cm 242	1.04E-03	B B 2	1.50E+00	B B 2
Cs 135	8.07E-05	B B 2	8.07E-05	B B 2	Cm 243	2.48E-04	B B 2	4.04E-04	B B 2
Cs 137	8.80E+00	A A 2	1.43E+01	A A 2	Cm 244	6.37E-03	B B 2	1.40E-02	B B 2
Ba 133					Cm 245	3.59E-07	B B 2	3.59E-07	B B 2
La 137					Cm 246	4.61E-08	B B 2	4.63E-08	B B 2
La 138					Cm 248				
Ce 144	5.52E-02	A A 2	5.78E+01	A A 2	Cf 249				
Pm 145					Cf 250				
Pm 147	6.86E-01	B B 2	2.47E+01	B B 2	Cf 251				
Sm 147	5.95E-10	B B 2			Cf 252				
Sm 151	3.30E-02	B B 2	3.91E-02	B B 2	Unsp a	1.33E-03	B B 2	1.33E-03	B B 2
Eu 152	8.62E-03	A A 2	2.43E-02	A A 2	Unsp b/g	6.60E+01	B B 2	1.28E+02	B B 2
Eu 154	9.40E-02	A A 2	4.33E-01	A A 2	Total a	7.39E-01	*	1.94E+00	*
Eu 155	5.62E-02	B B 2	6.07E-01	B B 2	Total b/g	8.90E+01	*	3.05E+02	*

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 the 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
* Total calculated from the 114 declared radionuclides