

WASTE STREAM	2F06/C	Encapsulated Barium Carbonate Slurry/MEB Crud
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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		616.9	746.3
Future arisings:	1.4.2025 - 31.3.2026		3.8	4.6
			3.8	4.6
Total future arisings:			620.7	750.9
Total waste volume:				

Number of waste packages in stock: At 1.4.2025..... 1307 packages

Comment on arising rates: -

Additional information on quantities: Known stock levels, uncertainties surround future strategy of BaCO₃ generation in consigning plant.

Uncertainty factors on volumes:

Stock (upper):	x 1.00	Arisings (upper):	x 2.00
Stock (lower):	x 1.00	Arisings (lower):	x 1.00

WASTE SOURCE Slurry arising from storage and reprocessing operations in THORP.

PHYSICAL CHARACTERISTICS

General description: A slurry of barium carbonate principally, with mixed streams of MEB crud and feed pond filter solids at small percentages. This is then encapsulated in cementitious grout. No items require special handling.

Changes since waste generated: The waste does not undergo any physical or chemical process prior to conditioning.

Bulk density (t/m³): ~ 2.0

Comment on density: Density of conditioned waste. Raw waste density ~ 1.25 t/m³.

CHEMICAL COMPOSITION

General description and components (%wt): Grout (70%), water (19.6%), barium carbonate (7.8%), NaNO₂/NaNO₃ (2.1%), NaOH (0.5%), Ba(NO₃)₂, Ba(OH)₂, BaI₂ and Ba(IO₃)₂ are also present. MEB crud may replace up to one quarter of the barium carbonate on an irregular basis dependent on arisings.

Chemical state: -

Sheet metal proportion / thickness: There is no sheet or bulk metal present.

Metals and alloys (%wt):

	(%wt)	Type(s) / Grades(s) with proportions	% of total C14 activity
Stainless steel.....	= 0	-	
Other ferrous metals.....	TR	-	
Iron.....	-	-	
Aluminium.....	-	-	
Beryllium.....	TR	-	
Cobalt.....	= 0	-	
Copper.....	-	-	
Lead.....	-	-	
Magnox/Magnesium.....	= 0	-	
Nickel.....	-	-	
Titanium.....	TR	-	
Uranium.....	< 0.01	-	
Zinc.....	= 0	-	
Zircaloy/Zirconium.....	TR	-	
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...	= 0	-	
Condensation polymers...	= 0	-	
Others...	= 0	-	
Organic ion exchange materials...	= 0	-	
Total rubber...	= 0	-	
Halogenated rubber...	= 0	-	
Non-halogenated rubber...	= 0	-	
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	-	100.0
Inorganic sludges and flocs...	= 30.0	-	
Soil...	= 0	-	
Brick/Stone/Rubble...	= 0	-	
Cementitious material...	= 70.0	-	
Sand...	= 0	No added sand in encapsulation grout.	
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	-	

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

Inorganic anions (%wt):

	(%wt)	Type(s) and comment
Fluoride...	= 0	-
Chloride...	P	-
Iodide...	P	-
Cyanide...	= 0	-
Carbonate...	~ 2.3	-
Nitrate...	~ 1.5	-
Nitrite...	TR	-
Phosphate...	= 0	-
Sulphate...	= 0	-
Sulphide...	= 0	-

Materials of interest for waste acceptance criteria:

	(%wt)	Type(s) and comment
Combustible metals...	= 0	-
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...		-
Corrosive materials...	P	Encapsulation grout is alkaline.
Pyrophoric materials...	= 0	-
Generating toxic gases...	= 0	-
Reacting with water...	= 0	-
Higher activity particles...	= 0	-
Soluble solids as bulk chemical compounds...	P	Some calcium and sodium 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.....	< 8.0	-
Boron.....	= 0	-
Boron (in Boral).....		-
Boron (non-Boral).....		-
Cadmium.....	= 0	-
Caesium.....		-
Selenium.....	= 0	-
Chromium.....	P	Small amounts present in encapsulation grout OPC.
Molybdenum.....	= 0	-
Thallium.....		-
Tin.....	P	Trace present in encapsulation grout OPC.
Vanadium.....	= 0	-
Mercury compounds.....		-
Others.....	= 0	-

Complexing agents (%wt):

No		
	(%wt)	Type(s) and comment
EDTA.....		-
DPTA.....		-
NTA.....		-
Polycarboxylic acids.....		-
Other organic complexants.....	= 0	No organic complexing agents are 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:

Immobilisation with cementitious powders.

Conditioning method:

In-drum mix encapsulation of slurry with cement powders in Waste Encapsulation Plants.

Conditioning plants:

Plant Name	Location
Wastes Encapsulation Plant (WEP)	Sellafield

Likely conditioning matrix:

Non-standard

Further information on the conditioning matrix:

9:1 BFS/OPC powder blend (range 95:5 to 85:15)
 Barium carbonate
 (10% to 20% w/w solids)
 235 litres
 2.8 kg/litre (kg cement powder to litre slurry)
 2.45 to 3.0 kg/litre
 Barium carbonate/MEB crud
 (20% to 34% w/w solids)
 260.5 litres
 2.24 kg/litre (kg cement powder to litre slurry)
 2.08 to 2.39 kg/litre. This is the conditioning matrix that has been used for existing stocks, future arisings will be using a different formulation to be determined.

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	0.47	0.47	1315	-

Range in container waste loading:

Other information on packaging and conditioning: Waste is already conditioned.

Conditioned density (t/m³): = 2.0
 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		2077
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: The waste will be residue from C-14 scrubbers. Consequently, C-14 will be dominant, although there will be fission products present associated with some fuel carry-over. For MEB crud, the main source will be Co-60 activation product in steel corrosion product.

Uncertainty: -

Measurement of radioactivities: The activities are a combination of measurements and calculated activities, based on characteristics of fuel reprocessed to date for stocks and that still to be reprocessed for arisings.

Chemical form
of radionuclides:

H-3: Not estimated.
C-14: Barium carbonate.
Cl-36: Present in trace amounts as clathrate compounds of metallic salts readily lost to aqueous solution.

Se-79: Not estimated.
Tc-99: Not estimated.
I-129: Present in trace amounts as clathrate compounds of metallic salts readily lost to aqueous solution.

Ra: -
Th: -
U: -
Np: -
Pu: -

WASTE STREAM		2F06/C		Encapsulated Barium Carbonate Slurry/MEB Crud					
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	5.02E-05	B B 1	1.56E-04	B B 1	Gd 153	3.86E-13	B B 2	1.82E-10	B B 2
Be 10	2.72E-11	B B 2	2.79E-11	B B 2	Ho 163	6.73E-15	B B 2	6.91E-15	B B 2
C 14	6.43E-02	B B 1	3.78E-02	B B 1	Ho 166m	3.99E-10	B B 2	4.88E-10	B B 2
Na 22					Tm 170	3.97E-20	B B 2	1.17E-16	B B 2
Al 26					Tm 171	4.70E-11	B B 2	2.35E-09	B B 2
Cl 36	6.07E-10	B B 2	4.57E-10	B B 2	Lu 174				8
Ar 39	9.30E-12	B B 2	7.42E-12	B B 2	Lu 176				5
Ar 42				8	Hf 178n				8
K 40	1.65E-14	B B 2	1.27E-14	B B 2	Hf 182				5
Ca 41	2.50E-10	B B 2	1.89E-10	B B 2	Pt 193				8
Mn 53	9.19E-18	B B 2	7.00E-18	B B 2	Tl 204				8
Mn 54	3.13E-13	B B 2	8.16E-11	B B 2	Pb 205				5
Fe 55	7.29E-05	B B 1	7.49E-04	B B 1	Pb 210	2.98E-08	B B 2	1.55E-14	B B 2
Co 60	6.72E-04	B B 1	2.59E-03	B B 1	Bi 208				8
Ni 59	2.50E-10	B B 2	1.39E-10	B B 2	Bi 210m				5
Ni 63	1.35E-03	B B 1	1.41E-04	B B 1	Po 210	2.84E-08	B B 2	1.48E-14	B B 2
Zn 65	2.55E-15	B B 2	1.16E-12	B B 2	Ra 223	2.50E-12	B B 2	1.21E-12	B B 2
Se 79	7.52E-09	B B 2	7.72E-09	B B 2	Ra 225	2.42E-14	B B 2	2.15E-14	B B 2
Kr 81	1.63E-14	B B 2	1.76E-14	B B 2	Ra 226	1.20E-07	B B 2	9.83E-14	B B 2
Kr 85	2.58E-04	B B 2	8.03E-04	B B 2	Ra 228	4.20E-10	B B 2	1.60E-17	B B 2
Rb 87	2.80E-12	B B 2	2.87E-12	B B 2	Ac 227	2.51E-12	B B 2	1.21E-12	B B 2
Sr 90	9.52E-04	B B 1	1.04E-03	B B 1	Th 227	2.47E-12	B B 2	1.19E-12	B B 2
Zr 93	2.38E-07	B B 2	2.45E-07	B B 2	Th 228	2.76E-08	B B 1	2.27E-09	B B 2
Nb 91				5	Th 229	2.42E-14	B B 2	2.15E-14	B B 2
Nb 92	1.00E-18	B B 2	1.00E-18	B B 2	Th 230	1.52E-05	B B 1	1.10E-05	B B 1
Nb 93m	1.71E-07	B B 2	1.02E-07	B B 2	Th 232	4.56E-10	B B 1	3.10E-17	B B 2
Nb 94	1.83E-11	B B 2	1.76E-11	B B 2	Th 234	6.14E-08	B B 2	5.54E-08	B B 2
Mo 93	2.47E-10	B B 2	1.61E-10	B B 2	Pa 231	5.05E-12	B B 2	4.32E-12	B B 2
Tc 97	2.25E-17	B B 2	2.30E-17	B B 2	Pa 233	2.84E-08	B B 2	2.84E-08	B B 2
Tc 99	2.32E-05	B B 1	1.99E-06	B B 2	U 232	1.88E-09	B B 2	2.39E-09	B B 2
Ru 106	7.90E-07	B B 2	1.45E-04	B B 2	U 233	5.59E-12	B B 2	3.36E-12	B B 2
Pd 107	1.20E-08	B B 2	1.23E-08	B B 2	U 234	2.11E-07	B B 2	2.06E-07	B B 2
Ag 108m	1.67E-12	B B 2	1.77E-12	B B 2	U 235	3.36E-09	B B 2	3.03E-09	B B 2
Ag 110m	6.10E-11	B B 2	2.63E-08	B B 2	U 236	4.39E-08	B B 2	4.71E-08	B B 2
Cd 109	3.20E-15	B B 2	3.67E-13	B B 2	U 238	6.14E-08	B B 2	5.54E-08	B B 2
Cd 113m	8.36E-07	B B 2	2.09E-06	B B 2	Np 237	2.84E-08	B B 2	2.84E-08	B B 2
Sn 119m	2.97E-12	B B 2	8.91E-10	B B 2	Pu 236	1.22E-10	B B 2	2.75E-09	B B 2
Sn 121m	2.22E-06	B B 2	2.88E-06	B B 2	Pu 238	1.73E-04	B B 2	2.34E-04	B B 2
Sn 123	2.78E-15	B B 2	8.06E-12	B B 2	Pu 239	4.32E-05	B B 2	3.70E-05	B B 2
Sn 126	4.00E-08	B B 2	4.12E-08	B B 2	Pu 240	7.62E-05	B B 2	7.68E-05	B B 2
Sb 125	4.89E-06	B B 2	1.22E-04	B B 2	Pu 241	3.30E-03	B B 2	7.46E-03	B B 2
Sb 126	5.60E-09	B B 2	1.33E-08	B B 2	Pu 242	1.74E-07	B B 2	1.91E-07	B B 2
Te 125m	1.22E-06	B B 2	2.85E-05	B B 2	Am 241	2.56E-04	B B 1	1.88E-04	B B 2
Te 127m	4.72E-16	8	2.59E-12	B B 2	Am 242m	5.26E-07	B B 2	6.37E-07	B B 2
I 129	4.54E-04	B B 1	3.50E-04	B B 1	Am 243	1.12E-06	B B 2	1.32E-06	B B 2
Cs 134	1.09E-05	B B 1	4.72E-04	B B 2	Cm 242	4.34E-07	B B 2	5.32E-07	B B 2
Cs 135	6.17E-08	B B 2	6.80E-08	B B 2	Cm 243	5.72E-07	B B 2	1.03E-06	B B 2
Cs 137	6.57E-04	B B 1	6.87E-04	B B 1	Cm 244	3.59E-05	B B 2	8.50E-05	B B 2
Ba 133	1.46E-13	B B 2	4.60E-13	B B 2	Cm 245	9.06E-09	B B 2	1.19E-08	B B 2
La 137	3.71E-13	B B 2	3.79E-13	B B 2	Cm 246	1.40E-09	B B 2	1.99E-09	B B 2
La 138	3.15E-17	B B 2	3.20E-17	B B 2	Cm 248	7.75E-15	B B 2	1.24E-14	B B 2
Ce 144	1.15E-07	B B 2	3.67E-05	B B 2	Cf 249	6.87E-14	B B 2	1.18E-13	B B 2
Pm 145	3.28E-14	B B 2	7.27E-14	B B 2	Cf 250	1.13E-13	B B 2	4.00E-13	B B 2
Pm 147	6.95E-05	B B 2	1.90E-03	B B 2	Cf 251	2.52E-15	B B 2	4.42E-15	B B 2
Sm 147	9.76E-13	B B 2	9.42E-13	B B 2	Cf 252	9.61E-16	B B 2	2.63E-14	B B 2
Sm 151	3.20E-05	B B 2	3.58E-05	B B 2	Unsp a	1.87E-07	B B 2	1.97E-07	B B 2
Eu 152	1.66E-07	B B 2	4.37E-07	B B 2	Unsp b/g	5.23E-05	B B 2	4.19E-05	B B 2
Eu 154	1.35E-04	B B 1	6.36E-04	B B 1	Total a	6.02E-04	*	6.36E-04	*
Eu 155	7.86E-06	B B 2	6.90E-05	B B 2	Total b/g	7.24E-02	*	5.53E-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