

WASTE STREAM	2F06/C	Encapsulated Barium Carbonate Slurry/MEB Crud
---------------------	---------------	--

SITE Sellafield
SITE OWNER Nuclear Decommissioning Authority
WASTE CUSTODIAN Sellafield Limited
WASTE TYPE ILW

WASTE VOLUMES

		Conditioned	Packaged
Stocks:	At 1.4.2019.....	602.7 m ³	729.2 m ³
Future arisings -	1.4.2019 - 31.3.2020.....	11.3 m ³	13.7 m ³
	1.4.2020 - 31.3.2021.....	0 m ³	0 m ³
	1.4.2021 - 31.3.2022.....	0 m ³	0 m ³
	1.4.2022 - 31.3.2023.....	3.8 m ³	4.6 m ³
	1.4.2023 - 31.3.2024.....	0 m ³	0 m ³
	1.4.2024 - 31.3.2025.....	0 m ³	0 m ³
	1.4.2025 - 31.3.2026.....	3.8 m ³	4.6 m ³
	1.4.2026 - 31.3.2027.....	0 m ³	0 m ³
	1.4.2027 - 31.3.2028.....	0 m ³	0 m ³
	1.4.2028 - 31.3.2029.....	3.8 m ³	4.6 m ³
	1.4.2029 - 31.3.2030.....	0 m ³	0 m ³
	1.4.2030 - 31.3.2031.....	0 m ³	0 m ³
	1.4.2031 - 31.3.2032.....	3.8 m ³	4.6 m ³
	1.4.2032 - 31.3.2033.....	0 m ³	0 m ³
	1.4.2033 - 31.3.2034.....	0 m ³	0 m ³
1.4.2034 - 31.3.2035.....	3.8 m ³	4.6 m ³	
Total future arisings:		30.2 m ³	36.5 m ³
Total waste volume:		633.0 m ³	765.7 m ³
Number of waste packages in stock:	At 1.4.2019.....	1277 package(s)	

Comment on volumes: Quantities are linked with donor plant throughput. Dissolver Off Gas system operations in THORP continued post shearing completion. MEB Crud arisings to continue until FUNDA filter replacement for THORP Pond is implemented. No additional information available, processing of product is solely dependant on donor plant throughput. The uncertainty on the volumes is expected to be +/- a factor of 1.1

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 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 concrete. No items require special handling. The waste does not undergo any physical or chemical process prior to conditioning.

Physical components (%wt): Slurry 30%, grout 70% (by weight).

Sealed sources: The waste does not contain sealed sources.

Bulk density (t/m³): ~1.95

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.

WASTE STREAM**2F06/C****Encapsulated Barium Carbonate Slurry/MEB Crud**

Chemical state:	-
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.
Metals and alloys (%wt):	There is no sheet or bulk metal present. 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):	There are no organic materials in the waste. Total cellulosics..... 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):	-

WASTE STREAM

2F06/C

Encapsulated Barium Carbonate Slurry/MEB Crud

	Inorganic ion exchange materials.	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	
Inorganic anions (%wt):	Carbonates, nitrates, nitrites, chlorides, iodides and iodates are present in the waste.		
	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:	No hazardous materials are present.		
	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	

WASTE STREAM

2F06/C

Encapsulated Barium Carbonate Slurry/MEB Crud

	Active particles.....	0	
	Soluble solids as bulk chemical compounds.....	P	Some calcium and sodium compounds.
Hazardous substances / non hazardous pollutants:	Toxic metals are unlikely to be present in significant quantities. Barium compounds: BaCO ₃ , Ba(NO ₃) ₂ , Ba(OH) ₂ , BaI ₂ , Ba(IO ₃) ₂ . <8% by weight.		
	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	
	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	
	Electronic Electrical Equipment (EEE)		
	EEE Type 1.....		
	EEE Type 2.....		
	EEE Type 3.....		
	EEE Type 4.....		
	EEE Type 5.....		
Complexing agents (%wt):	No		
	EDTA.....		
	DPTA.....		
	NTA.....		
	Polycarboxylic acids.....		
	Other organic complexants.....	0	No organic complexing agents are present in the waste.
	Total complexing agents.....	0	

PACKAGING AND CONDITIONING

Container type:	Container	Waste packaged (%vol)	Waste loading (m ³)	Payload (m ³)	Number of packages
	500 l drum	100.0	0.472	0.472	1341

Container type comment: Conditioning factor is 1, packaging factor is 1.21.

Range in container waste volume: -

Other information on containers: Stainless steel drum with indrum mixing paddle. Drum is fitted with a lid that contains a filter.

Conditioned density (t/m³): 1.95

Conditioned density comment: -

Other information on conditioning: Waste is already conditioned.

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: -

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: 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.

Other information: -

WASTE STREAM

2F06/C

Encapsulated Barium Carbonate Slurry/MEB Crud

Nuclide	Mean radioactivity, TBq/m ³				Nuclide	Mean radioactivity, TBq/m ³			
	Waste at 1.4.2019	Bands and Code	Future arisings	Bands and Code		Waste at 1.4.2019	Bands and Code	Future arisings	Bands and Code
H 3	6.59E-05	BB 1	1.56E-04	BB 1	Gd 153	4.78E-12	BB 2	1.82E-10	BB 2
Be 10	2.71E-11	BB 2	2.79E-11	BB 2	Ho 163	6.72E-15	BB 2	6.91E-15	BB 2
C 14	6.54E-02	BB 1	3.78E-02	BB 1	Ho 166m	3.96E-10	BB 2	4.88E-10	BB 2
Na 22					Tm 170	1.65E-18	BB 2	1.17E-16	BB 2
Al 26					Tm 171	1.79E-10	BB 2	2.35E-09	BB 2
Cl 36	6.13E-10	BB 2	4.57E-10	BB 2	Lu 174		8		8
Ar 39	9.53E-12	BB 2	7.42E-12	BB 2	Lu 176		5		5
Ar 42		8		8	Hf 178n		8		8
K 40	1.67E-14	BB 2	1.27E-14	BB 2	Hf 182		5		5
Ca 41	2.53E-10	BB 2	1.89E-10	BB 2	Pt 193		8		8
Mn 53	9.28E-18	BB 2	7.00E-18	BB 2	Tl 204		8		8
Mn 54	2.77E-12	BB 2	8.16E-11	BB 2	Pb 205		5		5
Fe 55	2.89E-04	BB 1	7.49E-04	BB 1	Pb 210	1.61E-08	BB 2	1.55E-14	BB 2
Co 60	1.40E-03	BB 1	2.59E-03	BB 1	Bi 208		8		8
Ni 59	2.54E-10	BB 2	1.39E-10	BB 2	Bi 210m		5		5
Ni 63	1.46E-03	BB 1	1.41E-04	BB 1	Po 210	1.50E-08	BB 2	1.48E-14	BB 2
Zn 65	3.09E-14	BB 2	1.16E-12	BB 2	Ra 223	2.05E-12	BB 2	1.21E-12	BB 2
Se 79	7.51E-09	BB 2	7.72E-09	BB 2	Ra 225	2.12E-14	BB 2	2.15E-14	BB 2
Kr 81	1.63E-14	BB 2	1.76E-14	BB 2	Ra 226	8.49E-08	BB 2	9.83E-14	BB 2
Kr 85	3.58E-04	BB 2	8.03E-04	BB 2	Ra 228	3.97E-10	BB 2	1.60E-17	BB 2
Rb 87	2.79E-12	BB 2	2.87E-12	BB 2	Ac 227	2.06E-12	BB 2	1.21E-12	BB 2
Sr 90	1.10E-03	BB 1	1.04E-03	BB 1	Th 227	2.03E-12	BB 2	1.19E-12	BB 2
Zr 93	2.38E-07	BB 2	2.45E-07	BB 2	Th 228	2.34E-07	BB 1	2.27E-09	BB 2
Nb 91		5		5	Th 229	2.13E-14	BB 2	2.15E-14	BB 2
Nb 92	1.00E-18	BB 2	1.00E-18	BB 2	Th 230	1.53E-05	BB 1	1.10E-05	BB 1
Nb 93m	1.56E-07	BB 2	1.02E-07	BB 2	Th 232	4.75E-10	BB 1	3.10E-17	BB 2
Nb 94	1.84E-11	BB 2	1.76E-11	BB 2	Th 234	6.16E-08	BB 2	5.54E-08	BB 2
Mo 93	2.51E-10	BB 2	1.61E-10	BB 2	Pa 231	4.64E-12	BB 2	4.32E-12	BB 2
Tc 97	2.25E-17	BB 2	2.30E-17	BB 2	Pa 233	2.79E-08	BB 2	2.84E-08	BB 2
Tc 99	2.41E-05	BB 1	1.99E-06	BB 2	U 232	1.96E-09	BB 2	2.39E-09	BB 2
Ru 106	5.79E-06	BB 2	1.45E-04	BB 2	U 233	4.93E-12	BB 2	3.36E-12	BB 2
Pd 107	1.20E-08	BB 2	1.23E-08	BB 2	U 234	2.08E-07	BB 2	2.06E-07	BB 2
Ag 108m	1.69E-12	BB 2	1.77E-12	BB 2	U 235	3.37E-09	BB 2	3.03E-09	BB 2
Ag 110m	7.16E-10	BB 2	2.63E-08	BB 2	U 236	4.38E-08	BB 2	4.71E-08	BB 2
Cd 109	1.84E-14	BB 2	3.67E-13	BB 2	U 238	6.16E-08	BB 2	5.54E-08	BB 2
Cd 113m	1.08E-06	BB 2	2.09E-06	BB 2	Np 237	2.79E-08	BB 2	2.84E-08	BB 2
Sn 119m	2.84E-11	BB 2	8.91E-10	BB 2	Pu 236	3.30E-10	BB 2	2.75E-09	BB 2
Sn 121m	2.37E-06	BB 2	2.88E-06	BB 2	Pu 238	1.79E-04	BB 2	2.34E-04	BB 2
Sn 123	1.14E-13	BB 2	8.06E-12	BB 2	Pu 239	4.34E-05	BB 2	3.70E-05	BB 2
Sn 126	3.99E-08	BB 2	4.12E-08	BB 2	Pu 240	7.62E-05	BB 2	7.68E-05	BB 2
Sb 125	1.36E-05	BB 2	1.22E-04	BB 2	Pu 241	4.25E-03	BB 2	7.46E-03	BB 2
Sb 126	5.60E-09	BB 2	1.33E-08	BB 2	Pu 242	1.73E-07	BB 2	1.91E-07	BB 2
Te 125m	3.40E-06	BB 2	2.85E-05	BB 2	Am 241	2.24E-04	BB 1	1.88E-04	BB 2
Te 127m		8	2.59E-12	BB 2	Am 242m	5.37E-07	BB 2	6.37E-07	BB 2
I 129	4.58E-04	BB 1	3.50E-04	BB 1	Am 243	1.12E-06	BB 2	1.32E-06	BB 2
Cs 134	3.84E-05	BB 1	4.72E-04	BB 2	Cm 242	4.43E-07	BB 2	5.32E-07	BB 2
Cs 135	6.14E-08	BB 2	6.80E-08	BB 2	Cm 243	6.40E-07	BB 2	1.03E-06	BB 2
Cs 137	7.56E-04	BB 1	6.87E-04	BB 1	Cm 244	4.32E-05	BB 2	8.50E-05	BB 2
Ba 133	2.04E-13	BB 2	4.60E-13	BB 2	Cm 245	8.95E-09	BB 2	1.19E-08	BB 2
La 137	3.71E-13	BB 2	3.79E-13	BB 2	Cm 246	1.38E-09	BB 2	1.99E-09	BB 2
La 138	3.15E-17	BB 2	3.20E-17	BB 2	Cm 248	7.56E-15	BB 2	1.24E-14	BB 2
Ce 144	1.14E-06	BB 2	3.67E-05	BB 2	Cf 249	6.75E-14	BB 2	1.18E-13	BB 2
Pm 145	4.00E-14	BB 2	7.27E-14	BB 2	Cf 250	1.43E-13	BB 2	4.00E-13	BB 2
Pm 147	2.02E-04	BB 2	1.90E-03	BB 2	Cf 251	2.45E-15	BB 2	4.42E-15	BB 2
Sm 147	9.72E-13	BB 2	9.42E-13	BB 2	Cf 252	2.74E-15	BB 2	2.63E-14	BB 2
Sm 151	3.34E-05	BB 2	3.58E-05	BB 2	Other a	1.87E-07	BB 2	1.97E-07	BB 2
Eu 152	2.15E-07	BB 2	4.37E-07	BB 2	Other b/g	5.23E-05	BB 2	4.19E-05	BB 2
Eu 154	1.97E-04	BB 1	6.36E-04	BB 1	Total a	5.84E-04	BB 2	6.35E-04	BB 2
Eu 155	1.53E-05	BB 2	6.90E-05	BB 2	Total b/g	7.61E-02	BB 2	5.53E-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