WASTE STREAM 2F10/C Encapsulated Centrifuge Cake

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.....	476.2 m³	576.1 m³
Future arisings -	1.4.2022 - 31.3.2023.....	54.3 m³	65.7 m³
	1.4.2023 - 31.3.2024.....	59.0 m³	71.4 m³
	1.4.2024 - 31.3.2025.....	59.0 m³	71.4 m³
	1.4.2025 - 31.3.2026.....	25.4 m³	30.8 m³
	1.4.2026 - 31.3.2027.....	25.0 m³	30.3 m³
	1.4.2027 - 31.3.2028.....	11.3 m³	13.7 m³
	1.4.2028 - 31.3.2029.....	11.3 m³	13.7 m³
Total future arisings:		245.4 m³	296.9 m³
Total waste volume:		721.6 m³	873.0 m³
Number of waste packages in stock:	At 1.4.2022.....	1009 package(s)	

Comment on volumes:	Arisings are related to tonnes reprocessed, fuel types and related plant operations. THORP stocks of Centrifuge Cake upon completion of shearing in 2018 still to be processed. Throughput process is solely dependant on donor plant. The uncertainty on the volumes is expected to be +/- a factor of 1.1. Plan is to complete processing of centrifuge cake over two year period.			
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 reprocessing operations in THORP.

PHYSICAL CHARACTERISTICS

General description:	The waste is slurry comprised of centrifuge cake. This waste is then encapsulated in grout. No items require special handling. This waste stream does not undergo any physical or chemical change prior to conditioning.
Physical components (%wt):	Slurry containing insoluble particles 30%, grout 70% (by weight).
Sealed sources:	The waste does not contain sealed sources.
Bulk density (t/m³):	~1.8
Comment on density:	Density of conditioned waste. Raw waste density ~1.0 t/m³.

CHEMICAL COMPOSITION

General description and components (%wt):	Water (28.8%), insoluble fission products (1.2%) and grout (70%). Minor components of the slurry include insoluble plutonium, crud, fuel (in solution), Zircaloy fines, stainless steel fines.
Chemical state:	Alkali
Chemical form of radionuclides:	H-3: Not estimated. C-14: Not estimated. 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 readilty lost to aqueous solution. Ra: Not estimated. Th: Not estimated. U: UO2. Np: Not estimated. Pu: PuO2.

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Metals and alloys (%wt): There is no sheet or bulk metal present.

	(%wt)	Type(s) / Grade(s) with proportions	% of total C14 activity
Stainless steel	0.50		
Other ferrous metals	0.10		
Iron			
Aluminium	0		
Beryllium	<0.01		
Cobalt	0		
Copper	0		
Lead			
Magnox/Magnesium	0		
Nickel	0		
Titanium	NE		
Uranium	0.20		
Zinc	0		
Zircaloy/Zirconium	0.40		
Other metals	0		

Organics (%wt): No organic materials are present.

	(%wt)	Type(s) and comment	% of total C14 activity
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): -

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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.....	98.8	Includes centrifuge cake carrier liquor.	
Sand.....	0	No added sand in encapsulation grout.	
Glass/Ceramics.....	0		
Graphite.....	0		
Desiccants/Catalysts.....	0		
Asbestos.....	0	No asbestos present.	
Non/low friable.....			
Moderately friable.....			
Highly friable.....			
Free aqueous liquids.....	0		
Free non-aqueous liquids.....	0		
Powder/Ash.....	0		

Inorganic anions (%wt): Nitrates will be present.

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

Materials of interest for waste acceptance criteria: Zircaloy fines are present.

	(%wt)	Type(s) and comment
Combustible metals.....	0	
Low flash point liquids.....	0	
Explosive materials.....	0	
Phosphorus.....	0	
Hydrides.....		
Biological etc. materials.....	0	
Biodegradable materials.....	0	
Putrescible wastes.....	0	

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Non-putrescible wastes.....	0	
Corrosive materials.....	0	
Pyrophoric materials.....	0	
Generating toxic gases.....	0	
Reacting with water.....	0	
Higher activity particles.....	P	Small fraction bound by encapsulation grout.
Soluble solids as bulk chemical compounds.....	P	Some soluble calcium 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 amount in encapsulation grout.
Molybdenum.....	0	
Thallium.....		
Tin.....	P	Trace amount in encapsulation grout.
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.....		

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Complexing agents (%wt): No

	(%wt)	Type(s) and comment
EDTA.....		
DPTA.....		
NTA.....		
Polycarboxylic acids…….	0	
Other organic complexants.....	0	No organic or inorganic complexing agents are present.
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	0.472	0.472	1529

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 an in-drum mixing paddle. Drum is fitted with a lid that has a filter fitted.

Conditioned density (t/m^3): 1.8

Conditioned density comment: -

Other information on conditioning: Waste is already conditioned.

RADIOACTIVITY

Source: The waste will contain insoluble fission products, insoluble plutonium and fuel in solution.

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: -

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Nuclide	Mean radioactivity, TBq/m³				Nuclide	Mean radioactivity, TBq/m³			
	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	3.74E-03	B B 1	6.71E-03	B B 1	Gd 153	1.30E-09	B B 2	3.46E-08	B B 2
Be 10	4.78E-09	B B 2	5.27E-09	B B 2	Ho 163	1.19E-12	B B 2	1.31E-12	B B 2
C 14	9.10E-06	B B 2	8.99E-06	B B 2	Ho 166m	7.37E-08	B B 2	9.23E-08	B B 2
Na 22					Tm 170	1.93E-16	B B 2	2.21E-14	B B 2
Al 26					Tm 171	6.61E-08	B B 2	4.45E-07	B B 2
Cl 36	1.02E-03	B B 2	1.02E-03	B B 2	Lu 174		8		8
Ar 39	1.55E-09	B B 2	1.40E-09	B B 2	Lu 176	1.45E-18	B B 2	1.00E-18	B B 2
Ar 42		8		8	Hf 178n		8		8
K 40	2.72E-12	B B 2	2.39E-12	B B 2	Hf 182	4.71E-17	B B 2	5.30E-17	B B 2
Ca 41	4.12E-08	B B 2	3.57E-08	B B 2	Pt 193		8		8
Mn 53	1.55E-15	B B 2	1.37E-15	B B 2	Tl 204		8		8
Mn 54	1.31E-07	B B 2	2.26E-06	B B 2	Pb 205		5		5
Fe 55	1.95E-01	B B 1	9.72E-01	B B 1	Pb 210	7.83E-08	B B 2	2.93E-12	B B 2
Co 60	2.23E-01	B B 1	6.61E-01	B B 1	Bi 208		8		8
Ni 59	8.52E-06	B B 2	1.19E-05	B B 2	Bi 210m		5		5
Ni 63	1.80E-01	B B 1	2.15E-01	B B 1	Po 210	7.39E-08	B B 2	2.80E-12	B B 2
Zn 65	3.57E-10	B B 2	9.25E-09	B B 2	Ra 223	4.17E-10	B B 2	2.29E-10	B B 2
Se 79	1.32E-06	B B 2	1.46E-06	B B 2	Ra 225	3.45E-09	B B 2	4.06E-12	B B 2
Kr 81	2.91E-12	B B 2	3.32E-12	B B 2	Ra 226	3.47E-07	B B 2	1.86E-11	B B 2
Kr 85	6.02E-02	B B 2	1.25E-01	B B 2	Ra 228	3.04E-10	B B 2	3.01E-15	B B 2
Rb 87	4.94E-10	B B 2	5.44E-10	B B 2	Ac 227	4.20E-10	B B 2	2.28E-10	B B 2
Sr 90	2.38E+00	B B 1	2.86E+00	B B 1	Th 227	4.12E-10	B B 2	2.26E-10	B B 2
Zr 93	4.20E-05	B B 2	4.63E-05	B B 2	Th 228	1.06E-03	B B 2	4.30E-07	B B 2
Nb 91	4.58E-18	B B 2	6.00E-18	B B 2	Th 229	3.47E-09	B B 2	4.06E-12	B B 2
Nb 92	1.33E-16	B B 2	1.46E-16	B B 2	Th 230	5.13E-05	B B 1	1.84E-05	B B 1
Nb 93m	2.62E-05	B B 2	1.93E-05	B B 2	Th 232	3.43E-10	B B 1	5.89E-15	B B 2
Nb 94	1.11E-02	B B 1	7.23E-07	B B 2	Th 234	2.69E-05	B B 2	1.05E-05	B B 2
Mo 93	3.98E-08	B B 2	3.04E-08	B B 2	Pa 231	1.12E-09	B B 2	8.18E-10	B B 2
Tc 97	3.88E-15	B B 2	4.25E-15	B B 2	Pa 233	1.00E-01	B B 2	5.38E-06	B B 2
Tc 99	1.97E-01	B B 1	2.09E-01	B B 1	U 232	1.29E-03	B B 2	4.52E-07	B B 2
Ru 106	2.63E-01	B B 1	3.58E+00	B B 1	U 233	4.75E-06	B B 2	6.35E-10	B B 2
Pd 107	2.11E-06	B B 2	2.33E-06	B B 2	U 234	8.16E-04	B B 1	1.27E-03	B B 1
Ag 108m	2.99E-10	B B 2	3.35E-10	B B 2	U 235	1.66E-06	B B 1	1.45E-06	B B 1
Ag 110m	2.01E-07	B B 2	4.99E-06	B B 2	U 236	1.50E-05	B B 1	1.32E-05	B B 1
Cd 109	6.82E-12	B B 2	6.98E-11	B B 2	U 238	2.69E-05	B B 1	2.24E-05	B B 1
Cd 113m	2.13E-04	B B 2	3.96E-04	B B 2	Np 237	1.00E-01	B B 1	1.07E-01	B B 1
Sn 119m	8.89E-09	B B 2	1.69E-07	B B 2	Pu 236	1.09E-02	B B 1	5.23E-02	B B 1
Sn 121m	4.26E-04	B B 2	5.45E-04	B B 2	Pu 238	1.65E-01	B B 1	1.95E-01	B B 1
Sn 123	1.35E-11	B B 2	1.53E-09	B B 2	Pu 239	3.15E-02	B B 1	3.11E-02	B B 1
Sn 126	7.03E-06	B B 2	7.78E-06	B B 2	Pu 240	5.08E-02	B B 1	5.19E-02	B B 1
Sb 125	6.90E-01	B B 2	3.47E+00	B B 2	Pu 241	2.94E+00	B B 1	4.83E+00	B B 1
Sb 126	9.85E-07	B B 2	2.51E-06	B B 2	Pu 242	1.88E-04	B B 1	2.17E-04	B B 1
Te 125m	1.72E-01	B B 2	5.41E-03	B B 2	Am 241	3.14E-01	B B 1	3.41E-01	B B 1
Te 127m	2.58E-12	B B 2	4.92E-10	B B 2	Am 242m	9.80E-05	B B 2	1.21E-04	B B 2
I 129	6.95E-07	B B 2	7.64E-07	B B 2	Am 243	2.06E-04	B B 2	2.50E-04	B B 2
Cs 134	4.16E-02	B B 1	2.63E-01	B B 1	Cm 242	8.08E-05	B B 1	1.01E-04	B B 2
Cs 135	1.11E-05	B B 2	1.29E-05	B B 2	Cm 243	1.25E-04	B B 1	1.60E-04	B B 1
Cs 137	5.28E+00	B B 1	7.06E+00	B B 1	Cm 244	8.11E-03	B B 1	1.24E-02	B B 1
Ba 133	4.16E-11	B B 2	8.70E-11	B B 2	Cm 245	1.71E-06	B B 2	2.25E-06	B B 2
La 137	6.54E-11	B B 2	7.17E-11	B B 2	Cm 246	2.69E-07	B B 2	3.75E-07	B B 2
La 138	5.51E-15	B B 2	5.97E-15	B B 2	Cm 248	1.54E-12	B B 2	2.33E-12	B B 2
Ce 144	1.47E-03	B B 2	2.92E-02	B B 2	Cf 249	1.41E-11	B B 2	2.22E-11	B B 2
Pm 145	7.89E-12	B B 2	1.38E-11	B B 2	Cf 250	3.33E-11	B B 2	7.53E-11	B B 2
Pm 147	6.92E-02	B B 2	3.61E-01	B B 2	Cf 251	5.20E-13	B B 2	8.32E-13	B B 2
Sm 147	1.70E-10	B B 2	1.78E-10	B B 2	Cf 252	9.51E-13	B B 2	4.95E-12	B B 2
Sm 151	5.86E-03	B B 2	6.77E-03	B B 2	Other a	2.97E-05	B B 2	3.72E-05	B B 2
Eu 152	4.32E-05	B B 2	8.29E-05	B B 2	Other b/g	8.29E-03	B B 2	7.92E-03	B B 2
Eu 154	5.68E-02	B B 1	1.28E-01	B B 1	**Total a**	**6.84E-01**	**B B 2**	**7.93E-01**	**B B 2**
Eu 155	3.94E-03	B B 2	1.31E-02	B B 2	**Total b/g**	**1.29E+01**	**B B 2**	**2.48E+01**	**B B 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