

<b>WASTE STREAM</b>	<b>2D96.5</b>	<b>FGMSP Fuel Bearing Materials</b>
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**SITE** Sellafield

**SITE OWNER** Nuclear Decommissioning Authority

**WASTE CUSTODIAN** Sellafield Limited

**WASTE TYPE** ILW

**WASTE VOLUMES**

		Reported
Stocks:	At 1.4.2019.....	37.0 m <sup>3</sup>
Total future arisings:		0 m <sup>3</sup>
Total waste volume:		37.0 m <sup>3</sup>

Comment on volumes: No further waste is expected to arise. This waste stream consists of a number of different items (cemented bit bins, uncemented TMEC bins, cemented TMEC bins, paint tins) all of which will have varying volume uncertainty. 25% has been deemed to be a conservative estimate.

Uncertainty factors on volumes:	Stock (upper):	x 1.25	Arisings (upper)	x
	Stock (lower):	x 0.75	Arisings (lower)	x

**WASTE SOURCE** Legacy fuel cutting operations (bit bins) and general waste from decanning facilities (paint tins).

**PHYSICAL CHARACTERISTICS**

General description: Uranium pieces in cement (cemented bit bins), uranium/zirconium pieces (uncemented TMEC bins), uranium/zirconium pieces in cemented (cemented TMEC bins), miscellaneous waste e.g. floor sweepings (paint tins).

Physical components (%vol): Exact breakdown unknown and will vary according to whether the item in question is a cemented bit bin or uncemented TMEC bin or cemented TMEC bin or paint tin.

Sealed sources: The waste does not contain sealed sources.

Bulk density (t/m<sup>3</sup>): >2

Comment on density: Based on the density of SDF exports (approx. 2 tonnes of fuel in an approx. 1m<sup>3</sup> skip).

**CHEMICAL COMPOSITION**

General description and components (%wt): Cemented bit bins - irradiated uranium (will include daughter isotopes) in a cement matrix. TMECs - irradiated uranium (could include daughter isotopes) attached to a zirconium plug, sometimes in a cement matrix. Paint tins - miscellaneous waste e.g. floor sweepings.

Chemical state: -

Chemical form of radionuclides:

- H-3: Probably trace amounts in fuel
- C-14: Probably trace amounts in fuel
- Cl-36: Probably trace amounts in fuel
- Se-79: Probably trace amounts in fuel
- Tc-99: Probably trace amounts in fuel
- I-129: Probably trace amounts in fuel
- Ra: Probably trace amounts in fuel
- Th: Probably trace amounts in fuel
- U: As fuel
- Np: Probably trace amounts in fuel
- Pu: Probably trace amounts in fuel

Metals and alloys (%wt): Uranium and zirconium are metals. The bit bins and paint tins themselves are made of mild steel. The cement is Ordinary Portland Cement.

Stainless steel.....	
Other ferrous metals.....	P
Iron.....	TR
Aluminium.....	TR
Beryllium.....	TR
Cobalt.....	TR

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Copper.....	TR
Lead.....	TR
Magnox/Magnesium.....	TR
Nickel.....	TR
Titanium.....	TR
Uranium.....	P
Zinc.....	TR
Zircaloy/Zirconium.....	P
Other metals.....	TR

Organics (%wt):

Organic materials are unlikely to be present.

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):

-	
Inorganic ion exchange materials.	0
Inorganic sludges and flocs.....	0
Soil.....	0
Brick/Stone/Rubble.....	0
Cementitious material.....	P
Sand.....	0
Glass/Ceramics.....	0
Graphite.....	0
Desiccants/Catalysts.....	0
Asbestos.....	0
Non/low friable.....	
Moderately friable.....	
Highly friable.....	

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	Free aqueous liquids.....	P	Water within bit bins
	Free non-aqueous liquids.....	0	
	Powder/Ash.....	0	
Inorganic anions (%wt):	-		
	Fluoride.....		
	Chloride.....		
	Iodide.....		
	Cyanide.....		
	Carbonate.....		
	Nitrate.....		
	Nitrite.....		
	Phosphate.....		
	Sulphate.....		
	Sulphide.....		
Materials of interest for waste acceptance criteria:	N/A		
	Combustible metals.....	0	
	Low flash point liquids.....	0	
	Explosive materials.....	0	
	Phosphorus.....	0	
	Hydrides.....		
	Biological etc. materials.....	0	
	Biodegradable materials.....	0	
	Putrescible wastes.....	0	
	Non-putrescible wastes.....	0	
	Corrosive materials.....	0	
	Pyrophoric materials.....	0	
	Generating toxic gases.....	0	
	Reacting with water.....	0	
	Active particles.....	NE	
	Soluble solids as bulk chemical compounds.....	NE	
Hazardous substances / non hazardous pollutants:	-		
	Acrylamide.....		
	Benzene.....		
	Chlorinated solvents.....		
	Formaldehyde.....		
	Organometallics.....		
	Phenol.....		
	Styrene.....		
	Tri-butyl phosphate.....		
	Other organophosphates.....		

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- Vinyl chloride.....
- Arsenic.....
- Barium.....
- Boron.....
- Cadmium.....
- Caesium.....
- Selenium.....
- Chromium.....
- Molybdenum.....
- Thallium.....
- Tin.....
- Vanadium.....
- Mercury compounds.....
- Others.....
- Electronic Electrical Equipment (EEE)
  - EEE Type 1.....
  - EEE Type 2.....
  - EEE Type 3.....
  - EEE Type 4.....
  - EEE Type 5.....

Complexing agents (%wt):

- EDTA.....
- DPTA.....
- NTA.....
- Polycarboxylic acids.....
- Other organic complexants.....
- Total complexing agents.....

**PACKAGING AND CONDITIONING**

- Conditioning method:            Not yet defined
- Plant Name:                        Not yet defined
- Location:                            Not yet defined
- Plant startup date:                Not yet defined
- Total capacity  
(m<sup>3</sup>/y incoming waste):            -
- Target start date for  
packaging this stream:            -
- Throughput for this stream  
(m<sup>3</sup>/y incoming waste):            -
- Other information:                -

Likely container type:	Container	Waste packaged (%vol)	Waste loading (m <sup>3</sup> )	Payload (m <sup>3</sup> )	Number of packages
	Not specified	100.0	NE	NE	NE

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Likely container type comment: -

Range in container waste volume: -

Other information on containers: -

Likely conditioning matrix:

Other information: 5:1 GGBS:CEM I grout with a water/solids ratio of 0.55 (see p. 243 of Nature and Quantity Assessment of Box Encapsulation Plant Wastes and Waste Packages”, RP/BEP-B873/TECH/00394/B, P. Swift, June 22nd 2017)

Conditioned density (t/m³): -

Conditioned density comment: -

Other information on conditioning: -

Opportunities for alternative disposal routing:

Treatment	Stream volume (%)	Comment
-	-	-

**RADIOACTIVITY**

Source: Spent uranium fuel pieces ("u-bits"), TMECs.

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 activity values have been taken from the "Maximum Package Radionuclide Content" tables for UBBs on pp. 251 – 255 of the BEP report ("Nature and Quantity Assessment of Box Encapsulation Plant Wastes and Waste Packages", RP/BEP-B873/TECH/00394/B, P. Swift, June 22nd 2017), because this is the most challenging of the relevant inventories and therefore its use is conservative.

Other information: -

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Nuclide	Mean radioactivity, TBq/m <sup>3</sup>				Nuclide	Mean radioactivity, TBq/m <sup>3</sup>			
	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	6.41E-01	BB 2			Gd 153				
Be 10	5.71E-06	BB 2			Ho 163	1.68E-09	BB 2		
C 14	6.12E-02	BB 2			Ho 166m	2.55E-05	BB 2		
Na 22					Tm 170				
Al 26					Tm 171	1.38E-10	BB 2		
Cl 36	8.24E-06	BB 2			Lu 174				
Ar 39	1.02E-26	BB 2			Lu 176				
Ar 42	9.41E-39	BB 2			Hf 178n				
K 40	1.35E-39	BB 2			Hf 182	4.31E-14	BB 2		
Ca 41	6.29E-05	BB 2			Pt 193				
Mn 53	4.24E-10	BB 2			Tl 204				
Mn 54	8.76E-19	BB 2			Pb 205	1.04E-23	BB 2		
Fe 55	2.35E-05	BB 2			Pb 210	3.85E-08	BB 2		
Co 60	1.79E-02	BB 2			Bi 208				
Ni 59	2.67E-03	BB 2			Bi 210m	9.47E-21	BB 2		
Ni 63	2.15E-01	BB 2			Po 210	3.89E-08	BB 2		
Zn 65		B 2			Ra 223	2.17E-06	BB 2		
Se 79	8.53E-03	BB 2			Ra 225	3.38E-09	BB 2		
Kr 81	2.75E-09	BB 2			Ra 226	2.24E-07	BB 2		
Kr 85	8.71E+00	BB 2			Ra 228	1.24E-11	BB 2		
Rb 87	5.19E-07	BB 2			Ac 227	8.59E-07	BB 2		
Sr 90	5.39E+02	BB 2			Th 227	8.41E-07	BB 2		
Zr 93	4.59E-02	BB 2			Th 228	6.59E-05	BB 2		
Nb 91	2.96E-15	BB 2			Th 229	3.38E-09	BB 2		
Nb 92	1.94E-13	BB 2			Th 230	1.86E-05	BB 2		
Nb 93m	4.10E-02	BB 2			Th 232	1.46E-11	BB 2		
Nb 94	2.86E-06	BB 2			Th 234	4.31E-02	BB 2		
Mo 93	1.44E-06	BB 2			Pa 231	1.39E-06	BB 2		
Tc 97	5.65E-12	BB 2			Pa 233	3.88E-03	BB 2		
Tc 99	3.74E-01	BB 2			U 232	6.47E-05	BB 2		
Ru 106	8.76E-12	BB 2			U 233	8.76E-07	BB 2		
Pd 107	2.80E-03	BB 2			U 234	3.74E-02	BB 2		
Ag 108m	4.11E-07	BB 2			U 235	8.06E-04	BB 2		
Ag 110m					U 236	5.58E-03	BB 2		
Cd 109	2.98E-18	BB 2			U 238	4.31E-02	BB 2		
Cd 113m	5.36E-02	BB 2			Np 237	3.88E-03	BB 2		
Sn 119m	5.19E-20	BB 2			Pu 236	5.29E-09	BB 2		
Sn 121m	3.72E-01	BB 2			Pu 238	1.46E+01	BB 2		
Sn 123					Pu 239	1.78E+01	BB 2		
Sn 126	2.04E-02	BB 2			Pu 240	2.85E+01	BB 2		
Sb 125	8.24E-04	BB 2			Pu 241	2.49E+02	BB 2		
Sb 126	2.84E-03	BB 2			Pu 242	2.61E-02	BB 2		
Te 125m	2.00E-04	BB 2			Am 241	8.65E+01	BB 2		
Te 127m					Am 242m	1.59E-01	BB 2		
I 129	8.24E-04	BB 2			Am 243	8.24E-02	BB 2		
Cs 134	5.01E-05	BB 2			Cm 242	1.31E-01	BB 2		
Cs 135	1.94E-02	BB 2			Cm 243	2.73E-02	BB 2		
Cs 137	8.12E+02	BB 2			Cm 244	4.50E-01	BB 2		
Ba 133	8.12E-09	BB 2			Cm 245	9.24E-05	BB 2		
La 137	9.35E-08	BB 2			Cm 246	9.29E-06	BB 2		
La 138	2.92E-12	BB 2			Cm 248	6.82E-12	BB 2		
Ce 144	6.65E-16	BB 2			Cf 249	1.55E-11	BB 2		
Pm 145	1.32E-09	BB 2			Cf 250	4.81E-12	BB 2		
Pm 147	8.29E-03	BB 2			Cf 251	2.01E-13	BB 2		
Sm 147	2.29E-07	BB 2			Cf 252	4.21E-17	BB 2		
Sm 151	6.47E+00	BB 2			Other a				
Eu 152	2.41E-02	BB 2			Other b/g				
Eu 154	1.65E+00	BB 2			<b>Total a</b>	<b>1.48E+02</b>	<b>BB 2</b>	<b>0</b>	
Eu 155	4.36E-02	BB 2			<b>Total b/g</b>	<b>1.62E+03</b>	<b>BB 2</b>	<b>0</b>	

**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