

WASTE STREAM**2D24****Magnox Cladding and Miscellaneous Solid Waste**

SITE Sellafield

SITE OWNER Nuclear Decommissioning Authority

WASTE CUSTODIAN Sellafield Limited

WASTE TYPE ILW

WASTE VOLUMES

Stocks: At 1.4.2013..... ~1370.0 m³

Total future arisings: 0 m³

Total waste volume: 1370.0 m³

Comment on volumes: There are no future arisings. Solids composition is changing by water corrosion.

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

WASTE SOURCE Wastes associated with Magnox fuel decanning and their subsequent underwater storage.

PHYSICAL CHARACTERISTICS

General description: The waste is debris from the process of decanning Magnox reactor fuel elements plus some Magnox waste contained in mild steel drums and tins from Chapelcross. Both have been stored under water since processing. The waste includes pieces of Magnox cans, fins and all other fuel element components, including fuel. Magnox components are corroded by the storage water, and partially converted to magnesium hydroxide as a fixed surface layer and a loose sludge. Fuel is similarly corroded to oxides of uranium. Mild steel cans may be partially corroded. Swarf from Magnox decanning has reacted with storage cover water to form magnesium hydroxide.

Physical components (%wt): Magnox debris (25.3 wt%), magnesium hydroxide (17.3 wt%), fuel (12.6 wt%), non-Magnox fuel furniture (0.7 wt%), water (44.1 wt%).

Bulk density (t/m³): ~1.3

Comment on density: The density of the materials stored has a very wide range. That given includes water associated in the waste (i.e. not the cover water).

CHEMICAL COMPOSITION

General description and components (%wt): Magnox (25.3%), magnesium hydroxide (17.3%), water (44.1%), non-Magnox fuel furniture (0.7%), uranium/uranium oxide (12.6%). The water is that associated with the waste.

Chemical state: The waste is neither a strong oxidising nor a strong reducing agent. The waste is weakly alkaline.

Chemical form of radionuclides: H-3: Present in elemental and reacted forms.
C-14: Present in elemental and reacted forms.
Se-79: Present in elemental and reacted forms.
Tc-99: Present in elemental and reacted forms.
Ra: Ra isotopes are present in less than trace amounts in fuel.
U: Present in metallic and reacted forms (oxides and possibly hydride).
Pu: Present in metallic and mixed oxide forms.

Metals and alloys (%wt): No significant quantities of sheet metal, although small quantities of fabricated items are present, e.g. paint tins, HEPA filters. Total quantities << 1%. Small pieces of fin Magnox metal present.

Stainless steel.....	~0.10	Bronze.....	TR
Other ferrous metals.....	0	Inconel.....	TR
Aluminium.....	~0.15	Nimonic.....	TR
Copper.....	TR	Stellite.....	0
Lead.....	TR	Boral.....	0
Zinc.....	TR	Dural.....	0
Magnox/Magnesium.....	~25.3	Monel.....	0
Zircaloy.....	~0.05	Uranium.....	~7.9
Brass.....	TR	Beryllium.....	
		Other metals (below).....	P

Other metals: Predominantly uranium metal (~7.9%). Other metals include Be, Cd, Ca, Ce, Mn, Nd, Ni and Ag.

Inorganic anions (%wt): Actual inorganic anion content is low but not quantified. Hydroxide also present.

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Fluoride.....	TR	Nitrate.....	TR
Chloride.....	TR	Nitrite.....	TR
Iodide.....	TR	Phosphate.....	TR
Cyanide.....	NE	Sulphate.....	TR
Carbonate.....	P	Sulphide.....	TR

Listed substances: Not present.

Hazardous and problematic materials (%wt): Combustible metals are magnesium and uranium. Uranium hydride may be present but not quantified. Paper filter media are present as putrescible waste.

Combustible metals.....	33.2	Strong oxidising agents.....	0
Low flash point liquids.....	0	Pyrophoric materials.....	P
Explosive materials.....	0	Generating toxic gases.....	0
Phosphorus.....	0	Reacting with water.....	33.2
Hydrides.....	P	Asbestos.....	0
Putrescible wastes.....	TR	Free aqueous liquids.....	44.1
Biological etc. materials.....	0	Free non-aqueous liquids.....	0
Powder.....	0		

Asbestos types and proportions: -

Complexing agents (%wt): Not present.

Complexing agents..... 0

Organics (%wt): Organics may be present in small quantities (<0.4% by volume). There may be small amounts of halogenated plastics, non-halogenated plastics, rubber and nylon present.

Total cellulosics.....	TR
Paper, cotton.....	
Wood.....	
Halogenated plastics	<0.10
Total non-halogenated plastics....	<0.10
Condensation polymers.....	TR
Others.....	TR
Organic ion exchange materials...	0
Total rubber.....	TR
Halogenated rubber	TR
Non-halogenated rubber.....	TR
Other organics.....	TR

Halogenated plastics and rubber (%wt): PVC from hoses/cables.

Other materials (%wt): -

Inorganic ion exchange materials..	0
Inorganic sludges and flocs.....	~23.0
Soil.....	0
Rubble.....	0
Concrete, cement and sand.....	0
Glass.....	0
Ceramics.....	~0.50
Graphite.....	TR

PACKAGING AND CONDITIONINGConditioning method: The waste will be transferred to SDP, and directly encapsulated in 3m³ boxes.

Plant Name: Silos Direct Encapsulation Plant (SDP)

Location: Sellafeld

Plant startup date: -

Total capacity (m³/y incoming waste): ~700.0

Target start date for packaging this stream: 2011

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Throughput for this stream
(m³/y incoming waste): -

Other information: The waste will be split into 2 streams, very large items will be sent to oversize, the rest to undersize where it will be mixed with grout prior to addition to a box. The oversize waste will be placed in a box and grout added.

Likely container type:	Container	Waste packaged (%vol)	Waste loading (m ³)	Payload (m ³)	Container displacement volume (m ³)
	Sellafield enhanced 3m ³ box	100.0	~0.8968	2.15	3.3

Likely container type comment: 1 skip in = 1 undersize box out.

Range in container waste volume: There will be considerable variability in unconditioned waste volume per package due to variations in skip loading and oversize content.

Other information on containers: Stainless Steel.

Likely conditioning matrix: BFS/OPC;PFA/OPC

Other information: .

Conditioned density (t/m³): ~2.0

Conditioned density comment: Density of conditioned waste will be fairly uniform.

Other information on conditioning: Direct encapsulation plant for Magnox Wet Silo waste. Screen to split gross oversize from undersize. Oversize into box, grouted, capped, lidded and exported. Undersize into mixing vessel, intimately mixed with matrix grout poured into box, capped, lidded and exported.

RADIOACTIVITY

Source: The main sources of activity are mixed fission products, reactor fuel carry over and tritium contaminated Magnox cladding. The activity mainly arises from: Co-60, Ni-63, Kr-85, Sr-90, Cs-137, Pm-147, Pu-283, Pu-239, Pu-240, Pu-241 and Am-241.

Accuracy: Compartment data are generally derived activities (best estimate) to + / - 50% (Band A).

Definition of total alpha and total beta/gamma: Totals shown on table of radionuclide activities are the sums of the listed alpha or beta/gamma emitting radionuclides plus 'other alpha' or 'other beta/gamma.'

Measurement of specific activities: All activities are calculated using FISPIN based on fuel burnup, uranium carryover, and aged to the stated date as necessary.

Other information: Short-lived daughters are included in the "other" beta/gamma activity.

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Nuclide	Average specific activity, TBq/m ³		Future arisings	Bands and Code	Nuclide	Average specific activity, TBq/m ³		Future arisings	Bands and Code
	Waste at 1.4.2013	Bands and Code				Waste at 1.4.2013	Bands and Code		
H 3	7.21E-02	AA 2			Ho 163				
Be 10	1.03E-07	AA 2			Ho 166m				
C 14	8.08E-03	AA 2			Tm 170				
Cl 36	2.49E-05	AA 2			Tm 171				
Ar 39					Lu 174				
Ar 42					Lu 176				
K 40					Hf 178n				
Ca 41	1.83E-04	AA 2			Hf 182				
Mn 53					Pt 193				
Mn 54	3.35E-11	AA 2			Tl 204				
Fe 55	3.41E-03	AA 2			Pb 205				
Co 60	2.12E-01	AA 2			Pb 210	3.64E-10	AA 2		
Ni 59	6.78E-03	AA 2			Bi 208				
Ni 63	6.59E-01	AA 2			Bi 210m				
Zn 65	4.19E-13	AA 2			Po 210	3.34E-10	AA 2		
Se 79	3.95E-05	AA 2			Ra 223				
Kr 81					Ra 225				
Kr 85	1.07E+00	AA 2			Ra 226	2.19E-09	AA 2		
Rb 87					Ra 228				
Sr 90	2.84E+01	AA 2			Ac 227				
Zr 93	1.44E-03	AA 2			Th 227				
Nb 91					Th 228	1.84E-06	AA 2		
Nb 92					Th 229	1.61E-11	AA 2		
Nb 93m	5.38E-04	AA 2			Th 230	5.06E-07	AA 2		
Nb 94	9.02E-07	AA 2			Th 232	1.30E-13	AA 2		
Mo 93	4.23E-06	AA 2			Th 234				
Tc 97					Pa 231	4.58E-08	AA 2		
Tc 99	1.16E-02	AA 2			Pa 233				
Ru 106	1.44E-06	AA 2			U 232	1.79E-06	AA 2		
Pd 107	6.99E-05	AA 2			U 233	1.47E-08	AA 2		
Ag 108m	1.37E-09	AA 2			U 234	1.64E-03	AA 2		
Ag 110m	3.83E-13	AA 2			U 235	4.54E-05	AA 2		
Cd 109					U 236	1.96E-04	AA 2		
Cd 113m	6.46E-13	AA 2			U 238	1.83E-03	AA 2		
Sn 119m					Np 237	8.38E-05	AA 2		
Sn 121m	1.21E-05	AA 2			Pu 236				
Sn 123					Pu 238	2.99E-01	AA 2		
Sn 126	2.63E-04	AA 2			Pu 239	7.14E-01	AA 2		
Sb 125	4.64E-03	AA 2			Pu 240	8.27E-01	AA 2		
Sb 126					Pu 241	1.96E+01	AA 2		
Te 125m	4.92E-03	AA 2			Pu 242	4.48E-04	AA 2		
Te 127m					Am 241	1.93E+00	AA 2		
I 129	2.19E-05	AA 2			Am 242m	3.94E-03	AA 2		
Cs 134	2.14E-03	AA 2			Am 243	9.75E-04	AA 2		
Cs 135	6.28E-04	AA 2			Cm 242	3.25E-03	AA 2		
Cs 137	4.10E+01	AA 2			Cm 243	6.07E-04	AA 2		
Ba 133					Cm 244	7.68E-03	AA 2		
La 137					Cm 245	4.07E-07	AA 2		
La 138					Cm 246	3.19E-08	AA 2		
Ce 144	1.10E-08	AA 2			Cm 248				
Pm 145					Cf 249				
Pm 147	1.05E-01	AA 2			Cf 250				
Sm 147					Cf 251				
Sm 151	2.18E-01	AA 2			Cf 252				
Eu 152	4.71E-03	AA 2			Other a	4.04E-06	AA 2		
Eu 154	1.84E-01	AA 2			Other b/g	8.77E+01	AA 2		
Eu 155	6.27E-02	AA 2			Total a	3.79E+00	AA 2	0	
Gd 153					Total b/g	1.79E+02	AA 2	0	

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 average specific activity.

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