

<b>WASTE STREAM</b>	<b>2D39</b>	<b>Miscellaneous Beta/Gamma Waste Store</b>
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**SITE** Sellafield  
**SITE OWNER** Nuclear Decommissioning Authority  
**WASTE CUSTODIAN** Sellafield Limited  
**WASTE TYPE** ILW

Is the waste subject to Scottish Policy: No

**WASTE VOLUMES**

		Reported
Stocks:	At 1.4.2022.....	3507.0 m <sup>3</sup>
Future arisings -	1.4.2022 - 31.3.2023.....	311.5 m <sup>3</sup>
	1.4.2023 - 31.3.2024.....	248.5 m <sup>3</sup>
	1.4.2024 - 31.3.2025.....	339.5 m <sup>3</sup>
	1.4.2025 - 31.3.2026.....	294.0 m <sup>3</sup>
	1.4.2026 - 31.3.2027.....	308.0 m <sup>3</sup>
	1.4.2027 - 31.3.2028.....	409.5 m <sup>3</sup>
	1.4.2028 - 31.3.2029.....	231.0 m <sup>3</sup>
	1.4.2029 - 31.3.2030.....	224.0 m <sup>3</sup>
	1.4.2030 - 31.3.2031.....	66.5 m <sup>3</sup>
	1.4.2031 - 31.3.2032.....	52.5 m <sup>3</sup>
	1.4.2032 - 31.3.2033.....	24.5 m <sup>3</sup>
	1.4.2033 - 31.3.2034.....	24.5 m <sup>3</sup>
	1.4.2034 - 31.3.2035.....	24.5 m <sup>3</sup>
	1.4.2035 - 31.3.2036.....	17.5 m <sup>3</sup>
	1.4.2036 - 31.3.2037.....	17.5 m <sup>3</sup>
	1.4.2037 - 31.3.2038.....	17.5 m <sup>3</sup>
	1.4.2038 - 31.3.2039.....	17.5 m <sup>3</sup>
	1.4.2039 - 31.3.2040.....	17.5 m <sup>3</sup>
	1.4.2040 - 31.3.2041.....	17.5 m <sup>3</sup>
	1.4.2041 - 31.3.2042.....	10.5 m <sup>3</sup>
	1.4.2042 - 31.3.2043.....	10.5 m <sup>3</sup>
	1.4.2043 - 31.3.2044.....	10.5 m <sup>3</sup>
	1.4.2044 - 31.3.2045.....	10.5 m <sup>3</sup>
Total future arisings:		2705.5 m <sup>3</sup>
Total waste volume:		6212.5 m <sup>3</sup>

Comment on volumes: The generation of waste from site operations is not constant hence the arisings in the annual period are not constant and may vary from predicted arisings stated. Stocks and arisings volumes include miscellaneous beta/gamma waste from current decommissioning projects. Total arisings are correct for known future wastes, however the throughput from the MPS is probably excessively ambitious. There is potentially a larger uncertainty in this submission for arisings given that the data has been collected from the different consignors and their predictions. Volumes are based on waste internal volume of 3.5m<sup>3</sup>, displacement of box is taken as 4.7m<sup>3</sup>. Stock volumes are considered to be accurate as number of boxes and internal volume is known. Forecast volumes are expected to be within a factor of +/- 0.2.

Uncertainty factors on volumes: Stock (upper): x 1.0 Arisings (upper) x 1.2  
 Stock (lower): x 1.0 Arisings (lower) x 0.8

**WASTE SOURCE** The waste arises from general site operations. Small quantities are from other sites (Chapelcross, UKAEA) and possibly from other sources in the UK, e.g. MOD, hospitals, research establishments, universities.

**PHYSICAL CHARACTERISTICS**

General description: The waste is miscellaneous beta/gamma contaminated items. Laboratory chemicals will normally be immobilised in concrete and oils and liquids will be fully absorbed or otherwise immobilised, if they cannot be eliminated at source. MBGWS Conditions for Acceptance state waste is to be dry. MBGWS Conditions for Acceptance dictates/limits size of large items - this is determined by box envelope. No waste compaction or dilution is carried out to waste consigned to MBGWS, however, size reduction can be performed at source to

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produce a better packing fraction of containers consigned by donor plants.

Physical components (%vol): HEPA filters, maintenance scrap, laboratory wastes, thermocouples, scrap equipment. The waste is sorted into general scrap, including non-combustible and combustible, (90%) and filters (10%).

Sealed sources: The waste contains sealed sources. 1000s of sources across ~100 consignments from around 5-6 consignors.

Bulk density (t/m<sup>3</sup>): ~1.4

Comment on density: Calculated using boxed volume = 3.5 m<sup>3</sup> and average weight of full box = 4.8 t. Therefore density = 1.371 t/m<sup>3</sup>, ie. approx 1.4 t/m<sup>3</sup>.

**CHEMICAL COMPOSITION**

General description and components (%wt): Various steels (70%), other metals including copper, aluminium, lead, brass (15%), paper (2%), plastics and rubber (3%), concrete (8%), fibreglass and asbestos (1%), others including laboratory chemicals, oils, liquids (1%).

Chemical state: Neutral

Chemical form of radionuclides: H-3: Not estimated.  
C-14: Not estimated.  
Cl-36: Present as trace amounts of clathrate compounds of metallic salts readily lost to aqueous solution.  
Se-79: Not estimated.  
Tc-99: Not estimated.  
I-129: Present as trace amounts of clathrate compounds of metallic salts readily lost to aqueous solution.  
Ra: Not estimated.  
Th: Not estimated.  
U: Not estimated.  
Np: Not estimated.  
Pu: Not estimated.

Metals and alloys (%wt): Both sheet and bulk metals likely to be present, proportions may vary dependant on consignment.

	(%wt)	Type(s) / Grade(s) with proportions	% of total C14 activity
Stainless steel.....	59.9	Grades 316L, 304 ratio unknown.	
Other ferrous metals.....	10.0	Mild steel, carbon steel ratio unknown.	
Iron.....			
Aluminium.....	5.0	Unknown grade(s).	
Beryllium.....	TR		
Cobalt.....	NE		
Copper.....	5.0	Unknown grade(s).	
Lead.....	~4.0	Unknown grade(s).	
Magnox/Magnesium.....	<0.01		
Nickel.....	NE		
Titanium.....	P	Unknown grade(s).	
Uranium.....	0.02		
Zinc.....	1.0		
Zircaloy/Zirconium.....	<0.01		
Other metals.....	NE		

Organics (%wt): The total organic content of the waste is 5 wt%. This includes cellulose, halogenated and non-halogenated plastics, rubbers (including hypalon) and laboratory chemicals and oil. Halogenated plastics or rubbers may be present in small quantities, materials not specified.

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	(%wt)	Type(s) and comment	% of total C14 activity
Total celluloseics.....	2.0		
Paper, cotton.....	P		
Wood.....	P		
Halogenated plastics .....	2.0		
Total non-halogenated plastics.....	0.50		
Condensation polymers.....	0.25		
Others.....	0.25		
Organic ion exchange materials....	0		
Total rubber.....	0.50		
Halogenated rubber .....	0.25		
Non-halogenated rubber.....	0.25		
Hydrocarbons.....	<<0.10		
Oil or grease .....	<<0.10		
Fuel.....	0		
Asphalt/Tarmac (cont.coal tar)...	0		
Asphalt/Tarmac (no coal tar)....	0		
Bitumen.....	0		
Others.....	0		
Other organics.....	TR		

Other materials (%wt): -

	(%wt)	Type(s) and comment	% of total C14 activity
Inorganic ion exchange materials..	NE		
Inorganic sludges and flocs.....	NE		
Soil.....	NE		
Brick/Stone/Rubble.....	NE		
Cementitious material.....	8.0		
Sand.....	P		
Glass/Ceramics.....	<1.0		
Graphite.....	NE		
Desiccants/Catalysts.....			
Asbestos.....	<1.0		
Non/low friable.....	<<1.0		
Moderately friable.....	<<1.0		
Highly friable.....	<<1.0		
Free aqueous liquids.....	0		
Free non-aqueous liquids.....	0		
Powder/Ash.....	NE		

Inorganic anions (%wt): Anions are mostly nitrates, but other forms will be present in varying amounts.

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

Materials of interest for waste acceptance criteria: All hazardous materials will be made safe prior to acceptance at MBGWS.

	(%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.....	NE	
Putrescible wastes.....	0	
Non-putrescible wastes.....	NE	
Corrosive materials.....	0	
Pyrophoric materials.....	0	
Generating toxic gases.....	0	
Reacting with water.....	0	
Higher activity particles.....	NE	
Soluble solids as bulk chemical compounds.....	NE	

Hazardous substances / non hazardous pollutants: Lead (4%) is present. The waste contains asbestos (<1%), which may qualify as special waste, but may contain other listed substances.

	(%wt)	Type(s) and comment
Acrylamide.....	NE	
Benzene.....	NE	
Chlorinated solvents.....	NE	
Formaldehyde.....	NE	
Organometallics.....	NE	
Phenol.....	NE	
Styrene.....	NE	
Tri-butyl phosphate.....	NE	
Other organophosphates.....	NE	

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Vinyl chloride.....	NE
Arsenic.....	NE
Barium.....	NE
Boron.....	NE
Boron (in Boral).....	NE
Boron (non-Boral).....	NE
Cadmium.....	NE
Caesium.....	NE
Selenium.....	NE
Chromium.....	NE
Molybdenum.....	NE
Thallium.....	NE
Tin.....	NE
Vanadium.....	NE
Mercury compounds.....	NE
Others.....	NE

## Electronic Electrical Equipment (EEE)

EEE Type 1.....
EEE Type 2.....
EEE Type 3.....
EEE Type 4.....
EEE Type 5.....

Complexing agents (%wt):      Yes

	(%wt)	Type(s) and comment
EDTA.....	0	
DPTA.....	0	
NTA.....	0	
Polycarboxylic acids.....	NE	
Other organic complexants.....	NE	Trace amounts of organic complexing agents may be present in the waste.
Total complexing agents.....	TR	

Potential for the waste to contain discrete items:      Yes. By definition, yes but it is not relevant as waste will not be transferred to LLWR.

**PACKAGING AND CONDITIONING**

Conditioning method:	Proposed that current storage box is flood grouted and if suitable, the product will form final conditioned package.
Plant Name:	Not yet established
Location:	Sellafield
Plant startup date:	Not yet established
Total capacity (m <sup>3</sup> /y incoming waste):	NE
Target start date for packaging this stream:	-

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Other information: -

Likely container type:

Container	Waste packaged (%vol)	Waste loading (m <sup>3</sup> )	Payload (m <sup>3</sup> )	Number of packages
MBGWS box	100.0	3.5	3.5	1775

Likely container type comment:

Average packing fraction over lifetime of plant is 57%. Therefore it is assumed that 43% of payload is grout.

Range in container waste volume:

There is a 65% packing fraction target applied to boxes however this has not always been the case. There is opportunity for boxes with lower packing fractions to be repacked in the future to conform with the target but not all boxes will be available for this.

Other information on containers:

Mild steel box with gunite (concrete) lining for older style boxes. Stainless steel box without gunite lining for newer style boxes.

Likely conditioning matrix:

Blast furnace slag/Ordinary Portland cement mixture

Other information:

-

Conditioned density (t/m<sup>3</sup>):

~1.55

Conditioned density comment:

Average weight of full box = 4.8Te and Average weight of grout (assumed to be 43% of payload) = 2.5Te. Average weight of conditioned box = 7.3Te Container displacement = 4.7m<sup>3</sup>.

Other information on conditioning:

-

Opportunities for alternative disposal routing:

No

Baseline Management Route	Opportunity Management Route	Stream volume (%)	Estimated Date that Opportunity will be realised	Opportunity Confidence	Comment
-	-	-	-	-	-

**RADIOACTIVITY**

Source:

Miscellaneous Beta/Gamma waste containing variety of contamination including fission products, activated materials (e.g. steel), Uranium (enriched, natural and depleted) along with a variety of sources.

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:

No direct measurements were taken for the specific activity values, they were derived from an amalgamation of fingerprints taking into account the key consignors.

Other information:

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Nuclide	Mean radioactivity, TBq/m <sup>3</sup>				Nuclide	Mean radioactivity, TBq/m <sup>3</sup>			
	Waste at 1.4.2022	Bands and Code	Future arisings	Bands and Code		Waste at 1.4.2022	Bands and Code	Future arisings	Bands and Code
H 3					Gd 153				
Be 10					Ho 163				
C 14					Ho 166m				
Na 22					Tm 170				
Al 26					Tm 171				
Cl 36					Lu 174				
Ar 39					Lu 176				
Ar 42					Hf 178n				
K 40					Hf 182				
Ca 41					Pt 193				
Mn 53					Tl 204				
Mn 54					Pb 205				
Fe 55					Pb 210				
Co 60					Bi 208				
Ni 59					Bi 210m				
Ni 63					Po 210				
Zn 65					Ra 223				
Se 79					Ra 225				
Kr 81					Ra 226				
Kr 85					Ra 228				
Rb 87					Ac 227				
Sr 90	7.08E-01	CC 2	9.09E-01	CC 2	Th 227				
Zr 93					Th 228				
Nb 91					Th 229				
Nb 92					Th 230				
Nb 93m					Th 232				
Nb 94					Th 234	4.17E-07	CC 2		
Mo 93					Pa 231				
Tc 97					Pa 233	3.17E-07	CC 2		
Tc 99					U 232				
Ru 106	2.82E-03	CC 2	3.98E-02	CC 2	U 233				
Pd 107					U 234	8.49E-07	CC 2	7.93E-07	CC 2
Ag 108m					U 235	1.08E-08	CC 2	1.08E-08	CC 2
Ag 110m					U 236	1.83E-07	CC 2	1.83E-07	CC 2
Cd 109					U 238	4.19E-07	CC 2	4.19E-07	CC 2
Cd 113m					Np 237	3.19E-07	CC 2	2.58E-07	CC 2
Sn 119m					Pu 236				
Sn 121m					Pu 238	1.76E-03	CC 2	1.92E-03	CC 2
Sn 123					Pu 239	2.48E-04	CC 2	2.48E-04	CC 2
Sn 126					Pu 240	4.24E-04	CC 2	3.96E-04	CC 2
Sb 125	8.04E-05	CC 2	4.19E-04	CC 2	Pu 241	3.83E-02	CC 2	6.18E-02	CC 2
Sb 126					Pu 242	1.42E-06	CC 2	1.42E-06	CC 2
Te 125m	1.91E-05	CC 2			Am 241	1.72E-02	CC 2	1.67E-02	CC 2
Te 127m					Am 242m				
I 129					Am 243				
Cs 134	8.09E-03	CC 2	5.51E-02	CC 2	Cm 242	1.02E-05	CC 2	3.49E-04	CC 2
Cs 135					Cm 243				
Cs 137	9.80E-01	CC 2	1.25E+00	CC 2	Cm 244	2.31E-02	CC 2	3.41E-02	CC 2
Ba 133					Cm 245	8.42E-07	CC 2	8.43E-07	CC 2
La 137					Cm 246				
La 138					Cm 248				
Ce 144	7.59E-03	CC 2	1.41E-01	CC 2	Cf 249				
Pm 145					Cf 250				
Pm 147	6.97E-02	CC 2	3.80E-01	CC 2	Cf 251				
Sm 147	2.57E-12	CC 2			Cf 252				
Sm 151					Other a				
Eu 152					Other b/g	1.05E-04	CC 2	1.05E-04	CC 2
Eu 154	1.44E-02	CC 2	3.05E-02	CC 2	<b>Total a</b>	<b>4.27E-02</b>	<b>CC 2</b>	<b>5.37E-02</b>	<b>CC 2</b>
Eu 155	9.58E-05	CC 2	3.04E-04	CC 2	<b>Total b/g</b>	<b>1.83E+00</b>	<b>CC 2</b>	<b>2.87E+00</b>	<b>CC 2</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