

WASTE STREAM	2D34	Sludge from Sand Filters and Transfers
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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.....	956.0 m ³
Future arisings -	1.4.2022 - 31.3.2023.....	0.6 m ³
	1.4.2023 - 31.3.2024.....	0.6 m ³
	1.4.2024 - 31.3.2025.....	0.6 m ³
	1.4.2025 - 31.3.2026.....	0.6 m ³
	1.4.2026 - 31.3.2027.....	0.6 m ³
	1.4.2027 - 31.3.2028.....	0.6 m ³
	1.4.2028 - 31.3.2029.....	0.6 m ³
	1.4.2029 - 31.3.2030.....	0.6 m ³
	1.4.2030 - 31.3.2031.....	0.6 m ³
	1.4.2031 - 31.3.2032.....	0.6 m ³
	1.4.2032 - 31.3.2033.....	0.6 m ³
	1.4.2033 - 31.3.2034.....	0.6 m ³
	1.4.2034 - 31.3.2035.....	0.6 m ³
	1.4.2035 - 31.3.2036.....	35.6 m ³
	1.4.2036 - 31.3.2037.....	0.6 m ³
	1.4.2037 - 31.3.2038.....	0.6 m ³
	1.4.2038 - 31.3.2039.....	0.6 m ³
	1.4.2039 - 31.3.2040.....	0.6 m ³
	1.4.2040 - 31.3.2041.....	0.6 m ³
	1.4.2041 - 31.3.2042.....	0.6 m ³
	1.4.2042 - 31.3.2043.....	0.6 m ³
	1.4.2043 - 31.3.2044.....	0.6 m ³
	1.4.2044 - 31.3.2045.....	0.6 m ³
	1.4.2045 - 31.3.2046.....	0.6 m ³
	1.4.2046 - 31.3.2047.....	0.6 m ³
	1.4.2047 - 31.3.2048.....	0.6 m ³
	1.4.2048 - 31.3.2049.....	0.6 m ³
	1.4.2049 - 31.3.2050.....	0.6 m ³
	1.4.2050 - 31.3.2051.....	0.6 m ³
	1.4.2051 - 31.3.2052.....	0.6 m ³
	1.4.2052 - 31.3.2053.....	0.6 m ³
	1.4.2053 - 31.3.2054.....	0.6 m ³
	1.4.2054 - 31.3.2055.....	0.6 m ³
	1.4.2055 - 31.3.2056.....	0.6 m ³
	1.4.2056 - 31.3.2057.....	0.6 m ³
	1.4.2057 - 31.3.2058.....	0.6 m ³
	1.4.2058 - 31.3.2059.....	0.6 m ³
	1.4.2059 - 31.3.2060.....	0.6 m ³
Total future arisings:		57.0 m ³
Total waste volume:		1013.0 m ³

Comment on volumes: Sludge arisings rate based on assumptions. The BST sludge volume was measured at 956 m³ by SONAR in Aug 2021. Subsequent arisings based on estimated arisings since that date from sand bed backwashing (0.58 m³/yr) and planned bulk sludge transfers from EDT and FHP (35 m³) in 2035. Future sludge arising rates and volumes are dependent on SIXEP donor plant operations and schedules, which may be subject to change. Hence, year-by-year sludge arisings have not been given. SWM will carry out sludge retrievals and waste treatment at some point between 2030 and 2060.

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Uncertainty factors on volumes:

Stock (upper): x 1.01
Stock (lower): x 0.99Arisings (upper) x 1.05
Arisings (lower) x 0.95**WASTE SOURCE**

Magnox storage pond sludges and fuel handling sludges formed via the corrosion of Magnox fuel and its cladding in pond storage.

PHYSICAL CHARACTERISTICS

General description:

The waste is Magnox sludge: a slurry containing varying sizes of particles. No items require special handling. The waste will have settled and consolidated over time. Stored sludge could potentially undergo chemical/physical changes over time as a result of storage conditions. In addition, sludge properties would vary depending on the origin of the sludge. Sludge properties can also be changed by the material handling process used to transfer them.

Physical components (%wt):

Magnox sludge (100%)

Sealed sources:

The waste does not contain sealed sources.

Bulk density (t/m³):

~1.5

Comment on density:

Density is of wet sludge. Settling and consolidation of the material takes place over time.

CHEMICAL COMPOSITION

General description and components (%wt):

Magnox sludge (magnesium hydroxide), with uranium present (metal and oxides).

Chemical state:

Alkali

Chemical form of radionuclides:

Cl-36: Unknown.
I-129: Unknown.
U: U234, U235, U236, U238. Present as metal and oxides.
Np: Np237 present as metal and oxide.
Pu: Pu238, Pu239, Pu240, Pu241, Pu242. Present as metal and oxide.

Metals and alloys (%wt):

-

	(%wt)	Type(s) / Grade(s) with proportions	% of total C14 activity
Stainless steel.....	0		
Other ferrous metals.....	0		
Iron.....	0		
Aluminium.....	0		
Beryllium.....	NE		
Cobalt.....	0		
Copper.....	0		
Lead.....	0		
Magnox/Magnesium.....	NE	Some Magnox metal might be present, but the quantity is unknown.	
Nickel.....	0		
Titanium.....	0		
Uranium.....	~~10.0	Based on 1996 sample results. Uranium will certainly be present but the exact quantity is not known.	
Zinc.....	0		
Zircaloy/Zirconium.....	0		
Other metals.....	0		

Organics (%wt):

Organics are unlikely to be present.

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	(%wt)	Type(s) and comment	% of total C14 activity
Total celluloseics.....	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.....	0		
Oil or grease	0		
Fuel.....	0		
Asphalt/Tarmac (cont.coal tar)...	0		
Asphalt/Tarmac (no coal tar)....	0		
Bitumen.....	0		
Others.....	0		
Other organics.....	0		

Other materials (%wt): -

	(%wt)	Type(s) and comment	% of total C14 activity
Inorganic ion exchange materials..	0		
Inorganic sludges and flocs.....	~90.0		
Soil.....	0		
Brick/Stone/Rubble.....	0		
Cementitious material.....	0		
Sand.....	0		
Glass/Ceramics.....	0		
Graphite.....	0		
Desiccants/Catalysts.....	0		
Asbestos.....	0		
Non/low friable.....	0		
Moderately friable.....	0		
Highly friable.....	0		
Free aqueous liquids.....	0		
Free non-aqueous liquids.....	0		
Powder/Ash.....	0		

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

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	(%wt)	Type(s) and comment
Fluoride.....	TR	
Chloride.....	~1.0	Based on 1996 sample results. Value may be erroneous.
Iodide.....	TR	
Cyanide.....	0	
Carbonate.....	TR	
Nitrate.....	TR	
Nitrite.....	TR	
Phosphate.....	TR	
Sulphate.....	TR	
Sulphide.....	TR	

Materials of interest for waste acceptance criteria: Magnox metal could be present but is stored in wet conditions (limited oxygen available for combustion). Hence, combustion of the metal is unlikely.

	(%wt)	Type(s) and comment
Combustible metals.....	P	Magnox metal is combustible, but the quantity is unknown.
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.....	0	
Pyrophoric materials.....	0	
Generating toxic gases.....	0	
Reacting with water.....	P	Corrosion of Magnox and uranium metal present in the sludge is likely to take place.
Higher activity particles.....	P	Sludge particles are radioactive due to the radioisotopes associated with them.
Soluble solids as bulk chemical compounds.....	0	

Hazardous substances / non hazardous pollutants: -

	(%wt)	Type(s) and comment
Acrylamide.....	0	
Benzene.....	0	
Chlorinated solvents.....	0	
Formaldehyde.....	0	
Organometallics.....	0	
Phenol.....	0	
Styrene.....	0	

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Tri-butyl phosphate.....	0
Other organophosphates.....	
Vinyl chloride.....	0
Arsenic.....	0
Barium.....	0
Boron.....	P
Boron (in Boral).....	0
Boron (non-Boral).....	P
Cadmium.....	0
Caesium.....	0
Selenium.....	0
Chromium.....	0
Molybdenum.....	0
Thallium.....	0
Tin.....	0
Vanadium.....	0
Mercury compounds.....	0
Others.....	0
Electronic Electrical Equipment (EEE)	
EEE Type 1.....	0
EEE Type 2.....	0
EEE Type 3.....	0
EEE Type 4.....	0
EEE Type 5.....	0

Small quantities of boron may be fed to the storage tanks in process effluent. The quantity of boron present is unknown.

Chemical form of any boron is not likely to be boral.

Complexing agents (%wt): No

	(%wt)	Type(s) and comment
EDTA.....	0	
DPTA.....	0	
NTA.....	0	
Polycarboxylic acids.....	0	
Other organic complexants.....	0	
Total complexing agents.....	0	

Potential for the waste to contain discrete items:

No. Waste itself not considered as a Discrete Item. This may require revisiting once waste is conditioned.

PACKAGING AND CONDITIONING

Conditioning method: To be confirmed.
 Plant Name: To be confirmed.
 Location: Sellafield.
 Plant startup date: To be confirmed.
 Total capacity (m³/y incoming waste): -

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Target start date for packaging this stream: -

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

Other information: The strategy for retrieval and packaging of waste from the SIXEP Bulk Storage Tanks is currently undergoing review.

Likely container type:	Container	Waste packaged (%vol)	Waste loading (m ³)	Payload (m ³)	Number of packages
	3m ³ box (square corners)	100.0	2.23	2.8	455

Likely container type comment: 3m³ box considered as a baseline. Waste materials could also be placed into 500 litre drums.

Range in container waste volume: Container waste loading provided on the basis of raw ion-exchange material being loaded into a 3m³ box. Note: maximum waste loading is 2.52m³ but volume reduction factor of 1.13 applies to this waste, yielding 1.92m³. Waste loading will vary based on conditioning requirements.

Other information on containers: -

Likely conditioning matrix: Not Specified

Other information: Material may be thermally treated beforehand which may change encapsulant. Encapsulating raw waste may also be required.

Conditioned density (t/m³): ~1.5

Conditioned density comment: Density above provided on unconditioned waste.

Other information on conditioning: Two potential conditioning options are: thermal treatment to minimise waste volume, or encapsulation to stabilise the waste. This may significantly change the number of waste package numbers required for these wastes (-66%,+80%)

Opportunities for alternative disposal routing: Yes

Baseline Management Route	Opportunity Management Route	Stream volume (%)	Estimated Date that Opportunity will be realised	Opportunity Confidence	Comment
Disposal at a Geological Disposal Facility	Disposal at a Geological Disposal Facility	NE	NE	Low	Potential opportunity for Thermal Treatment

RADIOACTIVITY

Source: The waste is Magnox sludge containing uranium and associated fission products.

Uncertainty: Specific activity data is based on limited sample data collected in 1996. Hence, there is a significant degree of uncertainty regarding the accuracy of the data. The data may also not be representative of current operations.

Definition of total alpha and total beta/gamma: Constituents of total alpha activity not known. Total beta was not measured during the 1996 sampling campaign (Beta 5 was measured), and the activities of all the relevant beta emitters are unknown.

Measurement of radioactivities: Major radionuclides were measured by analysis of samples taken from storage tanks.

Other information: The activity data has not been decayed because fresh arisings have continued to be fed to the storage tanks since 1996. Activity in older material would have decayed since consignment to the tanks, but it is not currently possible to quantify the effect of this. The activity present in future arisings has not been assessed.

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Nuclide	Mean radioactivity, TBq/m ³				Nuclide	Mean radioactivity, TBq/m ³			
	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		6		6	Pb 205				
Fe 55					Pb 210				
Co 60		6		6	Bi 208				
Ni 59					Bi 210m				
Ni 63					Po 210				
Zn 65		6		6	Ra 223				
Se 79					Ra 225				
Kr 81					Ra 226				
Kr 85					Ra 228				
Rb 87					Ac 227				
Sr 90		6		6	Th 227				
Zr 93					Th 228				
Nb 91					Th 229				
Nb 92					Th 230				
Nb 93m					Th 232				
Nb 94					Th 234				
Mo 93					Pa 231				
Tc 97					Pa 233		6		6
Tc 99					U 232				
Ru 106		6		6	U 233				
Pd 107					U 234		6		6
Ag 108m					U 235		6		6
Ag 110m		6		6	U 236		6		6
Cd 109					U 238		6		6
Cd 113m					Np 237				
Sn 119m					Pu 236				
Sn 121m					Pu 238		6		6
Sn 123					Pu 239		6		6
Sn 126					Pu 240		6		6
Sb 125		6		6	Pu 241		6		6
Sb 126					Pu 242		6		6
Te 125m					Am 241				
Te 127m					Am 242m				
I 129					Am 243				
Cs 134		6		6	Cm 242				
Cs 135					Cm 243				
Cs 137		6		6	Cm 244				
Ba 133					Cm 245				
La 137					Cm 246				
La 138					Cm 248				
Ce 144		6		6	Cf 249				
Pm 145					Cf 250				
Pm 147					Cf 251				
Sm 147					Cf 252				
Sm 151					Other a				
Eu 152		6		6	Other b/g				
Eu 154		6		6	Total a	NE	6	NE	6
Eu 155		6		6	Total b/g	NE	6	NE	6

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