WASTE STREAM 2D26 Ion Exchange Material (Clinoptilolite) and Sand

SITE Sellafield

SITE OWNER Nuclear Decommissioning Authority

WASTE CUSTODIAN Sellafield Limited

WASTE TYPE ILW

WASTE VOLUMES

		Reported
Stocks:	At 1.4.2019.....	~1335.0 m³
Future arisings -	1.4.2019 - 31.3.2020.....	40.0 m³
	1.4.2020 - 31.3.2021.....	40.0 m³
	1.4.2021 - 31.3.2022.....	40.0 m³
	1.4.2022 - 31.3.2023.....	40.0 m³
	1.4.2023 - 31.3.2024.....	40.0 m³
	1.4.2024 - 31.3.2025.....	40.0 m³
	1.4.2025 - 31.3.2026.....	40.0 m³
	1.4.2026 - 31.3.2027.....	40.0 m³
	1.4.2027 - 31.3.2028.....	40.0 m³
	1.4.2028 - 31.3.2029.....	40.0 m³
	1.4.2029 - 31.3.2030.....	40.0 m³
	1.4.2030 - 31.3.2031.....	40.0 m³
	1.4.2031 - 31.3.2060.....	1160.0 m³
Total future arisings:		1640.0 m³
Total waste volume:		2975.0 m³

Comment on volumes: SIXEP to continue generating spent sand and ion exchange material at an assumed rate of 40 m3/yr (5 IX bed changes). Current storage volume based upon SONAR scan of BST 13 in April 2019 and SIXOP3 record of BST 14 and MASWEP A waste volumes. Uncertainty in arisings is linked to the forecast frequency of sand bed or ion exchange resin changes and the duration of plant operations in SIXEP.

Uncertainty factors on volumes:

Stock (upper):	x 1.2	Arisings (upper)	x 1.43
Stock (lower):	x 0.8	Arisings (lower)	x 0.88

WASTE SOURCE Waste arises from operation of SIXEP.

PHYSICAL CHARACTERISTICS

General description: Waste is a granular material - spent ion exchanger (clinoptilolite) and sand, stored under water. There are no large items requiring special handling. The waste will have settled and consolidated over time.

Physical components (%wt): Current stocks are approx. 60% wt. ion exchange material, 4% wt. sand and 36% wt. water. The stock by 31/12/2060 is estimated to be of generally similar composition.

Sealed sources: The waste does not contain sealed sources.

Bulk density (t/m³): ~1.5

Comment on density: The density (about 1.5 t/m³) is based on the densities of the two constituents (clinoptilolite and sand). Settling and consolidation of the material takes place over time.

CHEMICAL COMPOSITION

General description and components (%wt): Current stocks are approx. 60% wt. clinoptilolite, 4% wt. sand and 36% wt. water. The stock by 31/12/2060 is estimated to be of generally similar composition. Spent pre-treated clinoptilolite would probably have a different composition of adsorbed cations compared to natural clinoptilolite.

Chemical state: Neutral

Chemical form of radionuclides:
Cl-36: Unknown.
I-129: Unknown.
U: Present as metal and oxides.
Np: Unknown.
Pu: Present as metal and oxides.

Metals and alloys (%wt): -

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	Stainless steel	0	
	Other ferrous metals	0	
	Iron		
	Aluminium		
	Beryllium	NE	
	Cobalt	0	
	Copper		
	Lead	0	
	Magnox/Magnesium	TR	Very small quantities of Magnox metal may be present, but the quantity is unknown.
	Nickel		
	Titanium		
	Uranium	TR	Small quantities of uranium may be present, but the quantity is unknown.
	Zinc	0	
	Zircaloy/Zirconium	0	
	Other metals		
Organics (%wt):	There are no organics present. Only inorganic ion exchange material is present.		
	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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Inorganic ion exchange materials.	~60.0
Inorganic sludges and flocs.....	0
Soil.....	0
Brick/Stone/Rubble.....	0
Cementitious material.....	0
Sand.....	~4.0
Glass/Ceramics.....	0
Graphite.....	0
Desiccants/Catalysts.....	0
Asbestos.....	0
Non/low friable.....	
Moderately friable.....	
Highly friable.....	
Free aqueous liquids.....	~36.0
Free non-aqueous liquids.....	0
Powder/Ash.....	0

Inorganic anions (%wt): The waste contains silicates and trace amounts of carbonates. 1996 sample data indicated high levels of chloride which may be erroneous. Other anions given below are unlikely to be present except in trace quantities.

Fluoride.....	TR	
Chloride.....	~1.3	Based on 1996 sample results - 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: -

Combustible metals.....	0
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.....	0
Corrosive materials.....	0
Pyrophoric materials.....	0
Generating toxic gases.....	0

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	Reacting with water.....	0	
	Active particles.....	P	Sand (4% wt.) and clinoptilolite (60% wt.) particles have activity associated with them.
	Soluble solids as bulk chemical compounds.....	0	
Hazardous substances / non hazardous pollutants:	None		
	Acrylamide.....		
	Benzene.....	0	
	Chlorinated solvents.....		
	Formaldehyde.....		
	Organometallics.....		
	Phenol.....	0	
	Styrene.....		
	Tri-butyl phosphate.....	0	
	Other organophosphates.....		
	Vinyl chloride.....	0	
	Arsenic.....	0	
	Barium.....		
	Boron.....	0	
	Cadmium.....	0	
	Caesium.....		
	Selenium.....	0	
	Chromium.....	0	
	Molybdenum.....	0	
	Thallium.....		
	Tin.....	0	
	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.....		
Complexing agents (%wt):	No		
	EDTA.....		
	DPTA.....		
	NTA.....		
	Polycarboxylic acids……		
	Other organic complexants.....	0	There are no organic complexing agents present.

Total complexing agents..... 0

PACKAGING AND CONDITIONING

Conditioning method: To be confirmed.

Plant Name: To be confirmed.

Location: Sellafield.

Plant startup date: To be confirmed.

Total capacity (m^3/y incoming waste): -

Target start date for packaging this stream: -

Throughput for this stream (m^3/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
Not specified	100.0	NE	NE	NE

Likely container type comment: -

Range in container waste volume: -

Other information on containers: -

Likely conditioning matrix:

Other information: -

Conditioned density (t/m^3): -

Conditioned density comment: -

Other information on conditioning: -

Opportunities for alternative disposal routing: Not yet determined

Treatment	Stream volume (%)	Comment
-	-	-

RADIOACTIVITY

Source: The main activity sources are Cs-134, Cs-137, Sr-90 and various alpha species, which are associated with the clinoptilolite and sand. These species would also be present in the water associated with these waste materials.

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 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/m³				Nuclide	Mean radioactivity, TBq/m³			
	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					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