

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

SITE OWNER Nuclear Decommissioning Authority

WASTE CUSTODIAN Sellafield Ltd

WASTE TYPE ILW

WASTE VOLUMES

	Reported (m ³)	OR	Conditioned (m ³)	Packaged (m ³)
Stocks:	At 1.4.2025	= 1561.0		
Future arisings:	1.4.2025 - 31.3.2026	= 40.0		
	1.4.2026 - 31.3.2027	= 40.0		
	1.4.2027 - 31.3.2028	= 40.0		
	1.4.2028 - 31.3.2029	= 40.0		
	1.4.2029 - 31.3.2030	= 40.0		
	1.4.2030 - 31.3.2031	= 40.0		
	1.4.2031 - 31.3.2032	= 40.0		
	1.4.2032 - 31.3.2033	= 40.0		
	1.4.2033 - 31.3.2034	= 40.0		
	1.4.2034 - 31.3.2035	= 40.0		
	1.4.2035 - 31.3.2036	= 40.0		
	1.4.2036 - 31.3.2037	= 40.0		
	1.4.2037 - 31.3.2038	= 40.0		
	1.4.2038 - 31.3.2039	= 40.0		
	1.4.2039 - 31.3.2040	= 40.0		
	1.4.2040 - 31.3.2041	= 40.0		
	1.4.2041 - 31.3.2042	= 40.0		
	1.4.2042 - 31.3.2043	= 40.0		
	1.4.2043 - 31.3.2044	= 40.0		
	1.4.2044 - 31.3.2045	= 40.0		
	1.4.2045 - 31.3.2046	= 40.0		
	1.4.2046 - 31.3.2047	= 40.0		
	1.4.2047 - 31.3.2048	= 40.0		
	1.4.2048 - 31.3.2049	= 40.0		
	1.4.2049 - 31.3.2050	= 40.0		
	1.4.2050 - 31.3.2051	= 40.0		
	1.4.2051 - 31.3.2052	= 40.0		
	1.4.2052 - 31.3.2053	= 40.0		
	1.4.2053 - 31.3.2054	= 40.0		
	1.4.2054 - 31.3.2055	= 40.0		
	1.4.2055 - 31.3.2056	= 40.0		
	1.4.2056 - 31.3.2057	= 40.0		
	1.4.2057 - 31.3.2058	= 40.0		
	1.4.2058 - 31.3.2059	= 40.0		
	1.4.2059 - 31.3.2060	= 40.0		
Total future arisings:		1400.0		
Total waste volume:		2961.0		

Number of waste packages in stock: At 1.4.2025..... - packages

Comment on arising rates: 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 August 2021 and SIXOP3 record of BST 14 and MASWEP A waste volumes.

Additional information on quantities: 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 1.20 Arisings (upper): x 1.43
Stock (lower): x 0.80 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.

Changes since waste generated: The waste will have settled and consolidated over time.

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. ion exchange material (60%wt), sand (4%wt) and water (36%wt). 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

Sheet metal proportion / thickness: -

Metals and alloys (%wt):

	(%wt)	Type(s) / Grades(s) with proportions	% of total C14 activity
Stainless steel.....	= 0	-	Very small quantities of Magnox metal may be present, but the quantity is unknown. Small quantities of uranium may be present, but the quantity is unknown.
Other ferrous metals.....	= 0	-	
Iron.....	= 0	-	
Aluminium.....	= 0	-	
Beryllium.....	NE	-	
Cobalt.....	= 0	-	
Copper.....	-	-	
Lead.....	= 0	-	
Magnox/Magnesium.....	TR	-	
Nickel.....	= 0	-	
Titanium.....	= 0	-	
Uranium.....	TR	-	
Zinc.....	= 0	-	
Zircaloy/Zirconium.....	= 0	-	
Other metals.....	= 0	-	

Organics (%wt):

	(%wt)	Type(s) and comment	% of total C14 activity
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.....	= 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.....	~ 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	-	

COMPONENTS OF MATERIALS, WASTE PROPERTIES, MATERIALS NOT CONTRIBUTING TO MASS

Inorganic anions (%wt):

	(%wt)	Type(s) and comment
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:

	(%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.....	= 0	-
Putrescible wastes.....	= 0	-
Non-putrescible wastes.....	= 0	-
Corrosive materials.....	= 0	-
Pyrophoric materials.....	= 0	-
Generating toxic gases.....	= 0	-
Reacting with water.....	= 0	-
Higher activity 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:

	(%wt)	Type(s) and comment
Acrylamide.....	= 0	-
Benzene.....	= 0	-
Chlorinated solvents.....	= 0	-
Formaldehyde.....	= 0	-
Organometallics.....	= 0	-
Phenol.....	= 0	-
Styrene.....	= 0	-
Tri-butyl phosphate.....	= 0	-
Other organophosphates.....	= 0	-
Vinyl chloride.....	= 0	-
Arsenic.....	= 0	-
Barium.....	= 0	-
Boron.....	= 0	-
Boron (in Boral).....	= 0	-
Boron (non-Boral).....	= 0	-
Cadmium.....	= 0	-
Caesium.....	= 0	-
Selenium.....	= 0	-
Chromium.....	= 0	-
Molybdenum.....	= 0	-
Thallium.....	= 0	-
Tin.....	= 0	-
Vanadium.....	= 0	-
Mercury compounds.....	= 0	-
Others.....	= 0	-

Complexing agents (%wt):

No	(%wt)	Type(s) and comment
EDTA.....	= 0	-
DPTA.....	= 0	-
NTA.....	= 0	-
Polycarboxylic acids.....	= 0	-
Other organic complexants.....	= 0	There are no organic complexing agents present.
Total complexing agents.....	= 0	-

Physical components:

	Number	Type(s) and comment
Sources.....		-
Electronic & Electrical Equipment (EEE)		-
EEE Type 1.....		-
EEE Type 2.....		-
EEE Type 3.....		-
EEE Type 4.....		-
EEE Type 5.....		-

TREATMENT, PACKAGING AND DISPOSAL

Planned on-site / off-site treatment(s):

Treatment	On-site / Off-site	Stream volume %
Size reduction Decay storage Low force compaction Supercompaction (HFC) Incineration Drying/dewatering/liquid separation Tie down/fixatives/strippable coating/painting application Decontamination Metal treatment Recycling / reuse Thermal treatment, including vitrification Encapsulation Polymer encapsulation Other physical treatment Other chemical treatment Containerisation Treatment not yet determined None		= 100.0

Comments on planned treatments:

-

Conditioning method:

To be confirmed. The strategy for retrieval and packaging of waste from the SIXEP Bulk Storage Tanks is currently undergoing review.

Conditioning plants:

Plant Name	Location

Likely conditioning matrix:

-

Further information on the conditioning matrix:

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

Waste Packaging:

Likely container type:

Container	Waste packaged (vol%)	Waste loading (m³)	Payload (m³)	Number of packages	Estimated start date for packaging
3 m³ box (corner lifting)	100.0	1.9	2.8	1543	-

Range in container waste loading:

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 1.31 applies to this waste, yielding 1.92m3. Waste loading will vary based on conditioning requirements.

Other information on packaging and 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%, +40%)

Conditioned density (t/m³):

~ 1.5

Conditioned density comment:

Density above provided on unconditioned waste.

Management Routes:

Disposal Route	Stream volume %	Raw density t/m³	Start date
Expected to be consigned to a Near Site, Near Surface Disposal Facility (Scotland)	= 100.0		
Expected to be Non-NSD HAW managed under Scottish Government's policy			
Expected to be disposed to LLW Vaults NRS Dounreay			
Expected to be consigned to the Geological Disposal Facility			
Expected to be consigned to a Near Surface Disposal Facility			
Expected to be consigned to the LLW Repository			
Expected to be consigned to a Landfill Facility			
Expected to be disposed On-Site			
Expected to be managed by In-Situ Disposal			
Expected to be consigned to an Incineration Facility			
Expected to be consigned to a Metal Treatment Facility			
Expected to be Out of Scope			
Expected to be recycled / reused			
Disposal route not known			

Classification codes for waste expected to be consigned to a landfill facility:

Opportunities for alternative disposal routing: Yes

Baseline Management Route	Opportunity Management Route	Stream volume (%)	Opportunity Confidence	Comment
GDF	GDF	NE	RED	Potential opportunity for Thermal Treatment

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.

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

Chemical form of radionuclides:

- H-3: -
- C-14: -
- Cl-36: Unknown.
- Se-79: -
- Tc-99: -
- I-129: Unknown.
- Ra: -
- Th: -
- U: Present as metal and oxides.
- Np: Unknown.
- Pu: Present as metal and oxides.

WASTE STREAM		2D26		Ion Exchange Material (Clinoptilolite) and Sand					
Nuclide	Mean radioactivity, TBq/m³				Nuclide	Mean radioactivity, TBq/m³			
	Waste at 1.4.2025	Bands and Code	Future Arisings	Bands and Code		Waste at 1.4.2025	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					Unsp a				
Eu 152		6		6	Unsp b/g				
Eu 154		6		6	Total a	0	*	0	*
Eu 155		6		6	Total b/g	0	*	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 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
* Total calculated from the 114 declared radionuclides