

WASTE STREAM	2D76/C	Encapsulated Retrieved Pond Sludge
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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		= 0.5	0.6
Future arisings:				0.0
				0.0
Total future arisings:			0.0	0.0
Total waste volume:			0.5	0.6

Number of waste packages in stock: At 1.4.2025..... 1 packages

Comment on arising rates: Future arisings are not reported to avoid double counting with stream 2D95.1 FGMSP pond and bay sludge (stocks only) and 2D95.5 SPP1 buffer store (stocks only). 2D76/C is the treatment stream with arisings from 2022. Projected arisings of 2D76/C are estimated to be 472m³ per year (1,000 drums per year) over period 2022/23 - 2033/34 (total 5,664m³).

Additional information on quantities: Single trial drum for encapsulation of pond sludges produced to date.

Uncertainty factors on volumes: Stock (upper): x 1.00 Arisings (upper): x -
Stock (lower): x 1.00 Arisings (lower): x -

WASTE SOURCE The degradation of Magnox fuel during pond storage results in the generation of magnesium hydroxide sludge in the pond. Sludge retrieved from the pond for encapsulation.

PHYSICAL CHARACTERISTICS

General description: The waste is a sludge comprising magnesium hydroxide contaminated with irradiated fuel, which has been encapsulated in a cement matrix.

Changes since waste generated: This waste has been encapsulated in cement in a 500 litre drum. It will be stored in an interim engineered store prior to final disposal to a repository.

Bulk density (t/m³): NE

Comment on density: This was processed in the same manner using the same ratio of powder mixing as current slurry drums, weight when drum weighed before sentencing to store is consistent with other slurry waste streams.

CHEMICAL COMPOSITION

General description and components (%wt): Magnesium hydroxide ~5%; Uranium ~0.13%; Water ~25%; Cement ~70%.

Chemical state: Alkali

Sheet metal proportion / thickness: No sheet metal present.

Metals and alloys (%wt):

	(%wt)	Type(s) / Grades(s) with proportions	% of total C14 activity
Stainless steel.....	= 0	-	
Other ferrous metals.....	TR	-	
Iron.....		-	
Aluminium.....		-	
Beryllium.....	< 0.01	-	
Cobalt.....	= 0	-	
Copper.....		-	
Lead.....	= 0	-	
Magnox/Magnesium.....	= 0	-	
Nickel.....		-	
Titanium.....	NE	-	
Uranium.....	0.13	-	
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.....		-	
Oil or grease.....		-	
Fuel.....		-	
Asphalt/Tarmac (cont.coal tar).....		-	
Asphalt/Tarmac (no coal tar).....		-	
Bitumen.....		-	
Others.....		-	
Other organics.....	= 0	-	

Other materials (%wt):

	(%wt)	Type(s) and comment	% of total C14 activity
Inorganic ion exchange materials.....	= 0	-	
Inorganic sludges and flocs.....	= 5.0	-	
Soil.....	= 0	-	
Brick/Stone/Rubble.....	= 0	-	
Cementitious material.....	= 94.9	-	
Sand.....	= 0	Sand not present in encapsulation grout.	
Glass/Ceramics.....	= 0	-	
Graphite.....	= 0	-	
Desiccants/Catalysts.....	= 0	-	
Asbestos.....	= 0	None present in this waste.	
Non/low friable.....		-	
Moderately friable.....		-	
Highly friable.....		-	
Free aqueous liquids.....	= 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.....	NE	-
Chloride.....	NE	-
Iodide.....	NE	-
Cyanide.....	NE	-
Carbonate.....	NE	-
Nitrate.....	NE	-
Nitrite.....	NE	-
Phosphate.....	NE	-
Sulphate.....	NE	-
Sulphide.....	NE	-

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.....		-
Corrosive materials.....	P	Encapsulation grout is strongly alkaline.
Pyrophoric materials.....	= 0	-
Generating toxic gases.....	= 0	-
Reacting with water.....	= 0	-
Higher activity particles.....	= 0	All loose material bound in encapsulation grout.
Soluble solids as bulk chemical compounds.....	P	Some sodium and magnesium compounds.

Hazardous substances / non hazardous pollutants:

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

Complexing agents (%wt):

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

Physical components:

	Number	Type(s) and comment
Sources.....		-
Electronic & Electrical Equipment (EEE)		-
EEE Type 1.....	= 0	-
EEE Type 2.....	= 0	-
EEE Type 3.....	= 0	-
EEE Type 4.....	= 0	-
EEE Type 5.....	= 0	-

TREATMENT, PACKAGING AND DISPOSAL

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

Treatment	On-site / Off-site	Stream volume %
Size reduction	On-site	= 100.0
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		

Comments on planned treatments:

This waste stream currently represents 1 trial drum

Conditioning method:

immobilisation with cementitious powders at Wastes Encapsulation Plant

Conditioning plants:

Plant Name	Location
Wastes Encapsulation Plant (WEP)	Sellafield

Likely conditioning matrix:

Non-standard

Further information on the conditioning matrix:

BFS/OPC 9:1 @ 2.26 kg/l powder to slurry

Waste Packaging:

Likely container type:	Container	Waste packaged (vol%)	Waste loading (m³)	Payload (m³)	Number of packages	Estimated start date for packaging
	500 l drum	100.0	0.47	0.47	1	-

Range in container waste loading:

Other information on packaging and conditioning: -

Conditioned density (t/m³): ~ 2.0

Conditioned density comment: -

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		2077
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: No

Baseline Management Route	Opportunity Management Route	Stream volume (%)	Opportunity Confidence	Comment
-	-	-	-	-

RADIOACTIVITY

Source: The waste is pond sludge from long term storage of irradiated fuel. It is composed of corroded fuel and fuel cladding material.

Uncertainty: The data is based on sample data from pre-consigned waste route fingerprint. Future arisings expected to be significantly different as solids loadings optimised.

Measurement of radioactivities: The supernate and sludge samples were analysed and the derived data combined.

Chemical form of radionuclides:

- H-3: -
- C-14: Carbonate.
- Cl-36: Present as trace amount of clathrate compounds of metallic salts readily lost to aqueous solution.
- Se-79: Not estimated.
- Tc-99: Not estimated.
- I-129: Present as trace amount of clathrate metallic salt compounds readily lost to aqueous solution.
- Ra: None declared in product spec.
- Th: Not estimated.
- U: As metal oxide
- Np: Not estimated.
- Pu: Not estimated.

WASTE STREAM 2D76/C Encapsulated Retrieved Pond Sludge									
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	4.78E-05	B B 2			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					Ti 204				
Mn 54	1.22E-10	B B 2			Pb 205				
Fe 55					Pb 210	4.31E-21			
Co 60	1.19E-05	B B 2			Bi 208				
Ni 59					Bi 210m				
Ni 63					Po 210	2.19E-21			
Zn 65	4.15E-12	B B 2			Ra 223	3.22E-13			
Se 79					Ra 225	1.15E-12			
Kr 81					Ra 226	2.12E-19			
Kr 85					Ra 228	1.40E-17			
Rb 87					Ac 227	3.48E-13			
Sr 90	4.83E-04	B B 2			Th 227	3.27E-13			
Zr 93					Th 228	6.50E-07	B B 2		
Nb 91					Th 229	1.20E-12			
Nb 92					Th 230	5.56E-16			
Nb 93m					Th 232	8.72E-17			
Nb 94					Th 234	5.08E-06			
Mo 93					Pa 231	7.52E-12			
Tc 97					Pa 233	6.94E-04			
Tc 99	4.39E-07	B B 2			U 232				
Ru 106	5.08E-09	B B 2			U 233	8.74E-09			
Pd 107					U 234	4.16E-11			
Ag 108m					U 235	1.18E-07	B B 2		
Ag 110m	5.79E-12	B B 2			U 236	5.90E-07	B B 2		
Cd 109					U 238	5.08E-06	B B 2		
Cd 113m					Np 237	6.94E-04	B B 2		
Sn 119m					Pu 236				
Sn 121m					Pu 238				
Sn 123					Pu 239	2.65E-03	B B 2		
Sn 126					Pu 240	3.57E-03	B B 2		
Sb 125	1.18E-05	B B 2			Pu 241	3.65E-02	B B 2		
Sb 126					Pu 242	3.78E-06	B B 2		
Te 125m	2.96E-06				Am 241	9.17E-03	B B 2		
Te 127m					Am 242m				
I 129	3.31E-04	B B 2			Am 243				
Cs 134	5.23E-07	B B 2			Cm 242				
Cs 135					Cm 243				
Cs 137	5.44E-02	B B 2			Cm 244				
Ba 133					Cm 245				
La 137					Cm 246				
La 138					Cm 248				
Ce 144	9.53E-11	B B 2			Cf 249				
Pm 145					Cf 250				
Pm 147					Cf 251				
Sm 147					Cf 252				
Sm 151					Unsp a				
Eu 152	1.13E-04	B B 2			Unsp b/g				
Eu 154	8.17E-05	B B 2			Total a	1.61E-02	*	0	*
Eu 155	1.66E-06	B B 2			Total b/g	9.26E-02	*	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