

WASTE STREAM	2F04/C	Encapsulated LWR Cladding
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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		1825.8	2052.2
Future arisings:				0.0
				0.0
Total future arisings:			0.0	0.0
Total waste volume:			1825.8	2052.2

Number of waste packages in stock: At 1.4.2025..... 3594 packages

Comment on arising rates: -

Additional information on quantities: Known volume in store, no more future arisings other than what's currently in WEP cave awaiting export.

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

WASTE SOURCE Leached hulls and ends from the reprocessing of PWR and BWR fuel.

PHYSICAL CHARACTERISTICS

General description: The waste arises as leached hulls and ends from the reprocessing of PWR and BWR fuel. It includes chopped and leached fuel pins and associated fuel assembly debris (end appendages, spacer grids etc.). This is then encapsulated in concrete. No items require special handling.

Changes since waste generated: This waste stream does not undergo any physical or chemical processes prior to conditioning.

Bulk density (t/m³): ~ 2.5

Comment on density: Density of conditioned waste. Raw waste density ~0.9 t/m³.

CHEMICAL COMPOSITION

General description and components (%wt): Zircaloy (26.9%), Inconel (0.6%), stainless steel (4.5%), concrete (68%), UO₂ (TR).

Chemical state: Alkali

Sheet metal proportion / thickness: Mostly Zircaloy hulls - rings ~ 50mm length, 10 mm diameter. Significant proportion is bulky stainless steel end appendages varying in size from 100 x 100 x 100mm to 300 x 300 x 300mm, up to 5mm thick.

Metals and alloys (%wt):

	(%wt)	Type(s) / Grades(s) with proportions	% of total C14 activity
Stainless steel.....	= 4.5	-	100.0
Other ferrous metals.....	TR	-	
Iron.....		-	
Aluminium.....	= 0	-	
Beryllium.....	TR	-	
Cobalt.....	= 0	-	
Copper.....	= 0	-	
Lead.....	= 0	-	
Magnox/Magnesium.....	= 0	-	
Nickel.....	= 0.60	Inconel is type X750 or 718.	
Titanium.....	= 0	-	
Uranium.....	= 0.04	-	
Zinc.....	= 0	-	
Zircaloy/Zirconium.....	= 26.9	-	
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.....	TR	-	
Condensation polymers.....	TR	-	
Others.....	TR	-	
Organic ion exchange materials.....	= 0	-	
Total rubber.....	TR	-	
Halogenated rubber.....	= 0	-	
Non-halogenated rubber.....	TR	-	
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.....	= 0	-	
Soil.....	= 0	-	
Brick/Stone/Rubble.....	= 0	-	
Cementitious material.....	= 68.0	-	
Sand.....	= 0	No sand present in encapsulation grout.	
Glass/Ceramics.....	= 0	-	
Graphite.....	= 0	-	
Desiccants/Catalysts.....	= 0	-	
Asbestos.....	= 0	No asbestos present.	
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.....	= 0	-
Chloride.....	= 0	-
Iodide.....	= 0	-
Cyanide.....	= 0	-
Carbonate.....	= 0	-
Nitrate.....	TR	-
Nitrite.....	= 0	-
Phosphate.....	= 0	-
Sulphate.....	= 0	-
Sulphide.....	= 0	-

Materials of interest for waste acceptance criteria:

	(%wt)	Type(s) and comment
Combustible metals.....	P	0.269 (1% allowance for Zirconium fines).
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	Small fraction may be present.
Soluble solids as bulk chemical compounds.....	P	Some calcium and sodium 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.....	P	Trace present in OPC in encapsulation grout.
Molybdenum.....	= 0	-
Thallium.....		-
Tin.....	P	Trace present in OPC in encapsulation grout.
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.....	= 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	-

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:

Encapsulation

Conditioning method:

Encapsulation in Waste 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 3:1 to 5.67:1 (4.5:1) @ 0.33:1 – 0.37:1 (0.35:1) w/s.

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	0.51	0.51	3594	-

Range in container waste loading: Volume is dependant on cutting length i.e. a better packing fraction can be achieved if hulls lengths are shorter but calculations are based on average cutting length.

Other information on packaging and conditioning: Waste is already conditioned.

Conditioned density (t/m³): = 2.5
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 main sources of activity will be fission product carry-over and activation products.

Uncertainty: -

Measurement of radioactivities: The activities are calculated, based on characteristics of LWR fuel reprocessed to date for stocks.

Chemical form of radionuclides: H-3: Within cladding materials.
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: UO2.
Np: Not estimated.
Pu: PuO2.

WASTE STREAM			2F04/C		Encapsulated LWR Cladding				
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	2.01E+00	B B 2			Gd 153	8.21E-15	B B 2		
Be 10	7.65E-09	B B 2			Ho 163	1.59E-12	B B 2		
C 14	1.61E-02	B B 2			Ho 166m	9.08E-08	B B 2		
Na 22					Tm 170				
Al 26					Tm 171	5.41E-10	B B 2		
Cl 36	4.57E-05	B B 2			Lu 174				
Ar 39	8.67E-07	B B 2			Lu 176	1.22E-12	B B 2		
Ar 42					Hf 178n				
K 40	6.87E-12	B B 2			Hf 182	6.64E-17	B B 2		
Ca 41	2.15E-05	B B 2			Pt 193				
Mn 53	3.84E-15	B B 2			Tl 204				
Mn 54	4.87E-05	B B 1			Pb 205				
Fe 55	6.61E-02	B B 2			Pb 210	8.70E-11	B B 2		
Co 60	2.25E+00	B B 1			Bi 208				
Ni 59	8.04E-02	B B 2			Bi 210m				
Ni 63	7.32E+00	B B 2			Po 210	8.38E-11	B B 2		
Zn 65	7.00E-06	B B 1			Ra 223	1.38E-09	B B 2		
Se 79	2.11E-06	B B 2			Ra 225	7.08E-12	B B 2		
Kr 81	3.83E-12	B B 2			Ra 226	2.84E-10	B B 2		
Kr 85	4.15E-02	B B 2			Ra 228	1.44E-14	B B 2		
Rb 87	8.10E-10	B B 2			Ac 227	1.38E-09	B B 2		
Sr 90	1.27E+00	B B 2			Th 227	1.36E-09	B B 2		
Zr 93	8.72E-03	B B 2			Th 228	4.02E-07	B B 2		
Nb 91	6.08E-18	B B 2			Th 229	7.09E-12	B B 2		
Nb 92	1.81E-16	B B 2			Th 230	3.37E-08	B B 2		
Nb 93m	6.92E-03	B B 2			Th 232	1.84E-14	B B 2		
Nb 94	8.56E-03	B B 2			Th 234	2.39E-05	B B 2		
Mo 93	3.91E-04	B B 2			Pa 231	2.81E-09	B B 2		
Tc 97	5.27E-15	B B 2			Pa 233	7.51E-06	B B 2		
Tc 99	5.26E-04	B B 2			U 232	3.91E-07	B B 1		
Ru 106	3.26E-03	B B 1			U 233	1.74E-09	B B 1		
Pd 107	2.95E-06	B B 2			U 234	9.30E-05	B B 1		
Ag 108m	7.18E-01	B B 1			U 235	2.42E-06	B B 1		
Ag 110m	6.93E-07	B B 1			U 236	9.58E-06	B B 1		
Cd 109	8.04E-11	B B 2			U 238	2.39E-05	B B 1		
Cd 113m	4.69E-04	B B 2			Np 237	7.52E-06	B B 2		
Sn 119m	1.07E-08	B B 2			Pu 236	7.53E-09	B B 2		
Sn 121m	2.92E-02	B B 2			Pu 238	8.06E-02	B B 1		
Sn 123					Pu 239	4.12E-02	B B 1		
Sn 126	1.03E-05	B B 2			Pu 240	4.22E-02	B B 1		
Sb 125	1.57E-01	B B 1			Pu 241	1.58E+00	B B 1		
Sb 126	1.44E-06	B B 2			Pu 242	8.55E-05	B B 1		
Te 125m	3.93E-02	B B 2			Am 241	1.38E-01	B B 2		
Te 127m					Am 242m	1.21E-04	B B 2		
I 129	1.07E-06	B B 2			Am 243	2.50E-04	B B 2		
Cs 134	8.34E-03	B B 1			Cm 242	9.98E-05	B B 2		
Cs 135	2.08E-05	B B 2			Cm 243	1.12E-04	B B 2		
Cs 137	1.28E+01	B B 1			Cm 244	4.94E-02	B B 1		
Ba 133	2.40E-11	B B 2			Cm 245	2.33E-06	B B 2		
La 137	8.95E-11	B B 2			Cm 246	3.57E-07	B B 2		
La 138	8.66E-15	B B 2			Cm 248	2.12E-12	B B 2		
Ce 144	1.99E-05	B B 1			Cf 249	1.92E-11	B B 2		
Pm 145	7.10E-12	B B 2			Cf 250	2.76E-11	B B 2		
Pm 147	1.82E-03	B B 2			Cf 251	7.09E-13	B B 2		
Sm 147	2.90E-10	B B 2			Cf 252	1.13E-13	B B 2		
Sm 151	1.21E-02	B B 2			Unsp a	4.27E-05	B B 2		
Eu 152	7.58E+00	B B 1			Unsp b/g	1.81E-02	B B 2		
Eu 154	7.46E-02	B B 1			Total a	3.52E-01	*	0	*
Eu 155	9.78E-04	B B 2			Total b/g	3.61E+01	*	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