

WASTE STREAM	2F03/C	Encapsulated AGR Cladding
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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

		Conditioned	Packaged
Stocks:	At 1.4.2022.....	1999.5 m ³	2247.5 m ³
Total future arisings:		0 m ³	0 m ³
Total waste volume:		1999.5 m ³	2247.5 m ³
Number of waste packages in stock:	At 1.4.2022.....	3936 package(s)	

Comment on volumes: No additional information available, rates processed are dependant solely on donor plant throughput. The uncertainty on the volumes is expected to be +/- a factor of 1.1. Shearing of hulls ceased Nov 2018.

Uncertainty factors on volumes:

Stock (upper):	x 1.1	Arisings (upper)	x
Stock (lower):	x 0.9	Arisings (lower)	x

WASTE SOURCE Leached stainless steel hulls from the reprocessing of AGR fuel.

PHYSICAL CHARACTERISTICS

General description: The waste is AGR cladding, chopped and leached fuel pins and debris from the slotted can which holds the pins during shearing. This is then encapsulated in a grout matrix. No items require special handling. This waste does not go through any physical or chemical process prior to conditioning.

Physical components (%wt): Fuel cladding approx. 23%, concrete approx. 77% (by weight).

Sealed sources: The waste does not contain sealed sources.

Bulk density (t/m³): ~2.3

Comment on density: Density of conditioned waste. Raw waste density ~0.5 t/m³.

CHEMICAL COMPOSITION

General description and components (%wt): Stainless steel (22%), sintox (0.9%), UO₂ (<0.1%), grout (77%).

Chemical state: -

Chemical form of radionuclides:

- H-3: Within stainless steel.
- 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: Fuel fines UO₂.
- Np: Not estimated.
- Pu: Fuel fines PuO₂.

Metals and alloys (%wt): Mostly rings approx 1cm diameter by 5 cm long. Some can material ~2mm thick.

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	(%wt)	Type(s) / Grade(s) with proportions	% of total C14 activity
Stainless steel.....	~21.9	Type 20/25 Nb.	100.0
Other ferrous metals.....	0		
Iron.....			
Aluminium.....			
Beryllium.....	TR		
Cobalt.....	0		
Copper.....			
Lead.....	0		
Magnox/Magnesium.....	0		
Nickel.....			
Titanium.....	NE		
Uranium.....	<0.10	Insoluble fission product residue and fines.	
Zinc.....	0		
Zircaloy/Zirconium.....	0		
Other metals.....	0		

Organics (%wt): There are no organic materials present except for nylon and polyurethane or hydrogenated nitrile rubber (from grout pigs) in very small amounts in drums of encapsulated product. Hydrogenated nitrile rubber and/or polyurethane.

	(%wt)	Type(s) and comment	% of total C14 activity
Total cellulosics.....	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): Sintox (0.9%)

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	(%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.....	~77.0	No sand is present in encapsulation grout.	
Sand.....	0		
Glass/Ceramics.....	1.0		
Graphite.....	0		
Desiccants/Catalysts.....	0		
Asbestos.....	0	No asbestos present in this	
Non/low friable.....			
Moderately friable.....			
Highly friable.....			
Free aqueous liquids.....	0		
Free non-aqueous liquids.....	0		
Powder/Ash.....	0		

Inorganic anions (%wt): No inorganic anions are present, except for minor traces of nitrate.

	(%wt)	Type(s) and comment
Fluoride.....	0	
Chloride.....	0	
Iodide.....	0	
Cyanide.....	0	
Carbonate.....	0	
Nitrate.....	TR	
Nitrite.....	TR	
Phosphate.....	0	
Sulphate.....	0	
Sulphide.....	0	

Materials of interest for waste acceptance criteria: No fire hazards or non-radioactive hazards are present.

	(%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	

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Corrosive materials.....	P	Alkaline encapsulation grout.
Pyrophoric materials.....	0	
Generating toxic gases.....	0	
Reacting with water.....	0	
Higher activity particles.....	NE	Small fraction bound by encapsulation grout.
Soluble solids as bulk chemical compounds.....	P	Some sodium and calcium 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	Small amount is encapsulation grout OPC.
Molybdenum.....	0	
Thallium.....		
Tin.....	P	Trace amount in encapsulation grout OPC.
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.....		

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Complexing agents (%wt): No

(%wt) Type(s) and comment

EDTA.....
DPTA.....
NTA.....
Polycarboxylic acids.....
Other organic complexants.....
Total complexing agents..... 0

Potential for the waste to contain discrete items: No.

PACKAGING AND CONDITIONING

Container type:	Container	Waste packaged (%vol)	Waste loading (m ³)	Payload (m ³)	Number of packages
	500 l drum	100.0	0.508	0.508	3936

Container type comment: Packaging factor 1.12.

Range in container waste volume: -

Other information on containers: Stainless steel drums nominally filled to 508 litres capacity of conditioned waste.

Conditioned density (t/m³): 2.3

Conditioned density comment: -

Other information on conditioning: The waste is already conditioned.

RADIOACTIVITY

Source: Fission product carry-over and activation products will be present in the chopped and leached fuel pin debris. Cobalt-60 will be dominant.

Uncertainty: -

Definition of total alpha and total beta/gamma: Where totals are shown on the table of radionuclide activities they are the sums of the listed alpha or beta/gamma emitting radionuclides plus 'other alpha' or 'other beta/gamma'.

Measurement of radioactivities: The activities are calculated, based on characteristics of AGR fuel reprocessed to date for stocks and that still to be reprocessed for arisings.

Other information: -

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Encapsulated AGR Cladding

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	1.02E-02	BB 2			Gd 153	4.84E-10	BB 2		
Be 10	1.65E-08	BB 2			Ho 163	3.62E-12	BB 2		
C 14	1.60E-02	BB 2			Ho 166m	1.50E-07	BB 2		
Na 22		8			Tm 170	1.13E-17	BB 2		
Al 26		8			Tm 171	1.13E-07	BB 2		
Cl 36	1.81E-05	BB 2			Lu 174		8		
Ar 39	3.19E-04	BB 2			Lu 176		8		
Ar 42		8			Hf 178n		8		
K 40	1.37E-09	BB 2			Hf 182	1.24E-16	BB 2		
Ca 41	2.36E-05	BB 2			Pt 193		8		
Mn 53	1.65E-15	BB 2			Tl 204		8		
Mn 54	1.39E-03	BB 1			Pb 205		5		
Fe 55	2.72E+01	BB 2			Pb 210	4.93E-11	BB 2		
Co 60	2.06E+00	BB 1			Bi 208		8		
Ni 59	1.10E+00	BB 2			Bi 210m		5		
Ni 63	1.10E+02	BB 2			Po 210	4.68E-11	BB 2		
Zn 65	3.89E-04	BB 1			Ra 223	1.28E-09	BB 2		
Se 79	4.37E-06	BB 2			Ra 225	1.05E-11	BB 2		
Kr 81	7.99E-12	BB 2			Ra 226	2.07E-10	BB 2		
Kr 85	2.04E-01	BB 2			Ra 228	2.84E-14	BB 2		
Rb 87	1.63E-09	BB 2			Ac 227	1.29E-09	BB 2		
Sr 90	3.52E+00	BB 2			Th 227	1.27E-09	BB 2		
Zr 93	1.39E-04	BB 2			Th 228	7.60E-07	BB 2		
Nb 91	9.46E-18	BB 2			Th 229	1.05E-11	BB 2		
Nb 92	4.08E-16	BB 2			Th 230	3.53E-08	BB 2		
Nb 93m	8.45E-05	BB 2			Th 232	4.14E-14	BB 2		
Nb 94	6.37E-02	BB 2			Th 234	4.54E-05	BB 2		
Mo 93		8			Pa 231	3.12E-09	BB 2		
Tc 97	1.19E-14	BB 2			Pa 233	1.53E-05	BB 2		
Tc 99	1.07E-03	BB 2			U 232	7.46E-07	BB 1		
Ru 106	6.53E-02	BB 1			U 233	2.23E-09	BB 1		
Pd 107	6.38E-06	BB 2			U 234	1.49E-04	BB 1		
Ag 108m	4.39E-01	BB 1			U 235	2.39E-06	BB 1		
Ag 110m	1.72E-05	BB 1			U 236	3.39E-05	BB 1		
Cd 109	6.87E-12	BB 2			U 238	4.54E-05	BB 1		
Cd 113m	6.65E-04	BB 2			Np 237	1.53E-05	BB 2		
Sn 119m	4.97E-09	BB 2			Pu 236	1.93E-07	BB 2		
Sn 121m	1.38E-03	BB 2			Pu 238	8.69E-02	BB 1		
Sn 123	8.05E-13	BB 2			Pu 239	2.13E-02	BB 1		
Sn 126	2.20E-05	BB 2			Pu 240	4.54E-02	BB 1		
Sb 125	6.47E-01	BB 1			Pu 241	2.09E+00	BB 1		
Sb 126	3.07E-06	BB 2			Pu 242	7.82E-05	BB 1		
Te 125m	1.62E-01	BB 2			Am 241	1.34E-01	BB 2		
Te 127m	7.62E-14	8			Am 242m	2.85E-04	BB 2		
I 129	2.23E-06	BB 2			Am 243	4.48E-04	BB 2		
Cs 134	8.76E-03	BB 1			Cm 242	2.35E-04	BB 2		
Cs 135	3.94E-05	BB 2			Cm 243	2.97E-04	BB 2		
Cs 137	3.41E+00	BB 1			Cm 244	1.05E-02	BB 1		
Ba 133	1.33E-10	BB 2			Cm 245	1.71E-06	BB 2		
La 137	2.01E-10	BB 2			Cm 246	2.57E-07	BB 2		
La 138	1.09E-14	BB 2			Cm 248	5.87E-13	BB 2		
Ce 144	2.98E-04	BB 1			Cf 249	2.85E-12	BB 2		
Pm 145	1.92E-11	BB 2			Cf 250	7.24E-12	BB 2		
Pm 147	1.60E-01	BB 2			Cf 251	7.33E-14	BB 2		
Sm 147	6.09E-10	BB 2			Cf 252	2.21E-13	BB 2		
Sm 151	1.95E-02	BB 2			Other a	7.30E-05	BB 2		
Eu 152	6.88E-03	BB 1			Other b/g	2.29E-02	BB 2		
Eu 154	3.43E-02	BB 1			Total a	3.00E-01	BB 2	0	
Eu 155	9.72E-03	BB 2			Total b/g	1.52E+02	BB 2	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 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