

<b>WASTE STREAM</b>	<b>2A313</b>	<b>Final Dismantling &amp; Site Clearance : Miscellaneous Metal (Reactor) ILW</b>
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**SITE** Calder Hall  
**SITE OWNER** Nuclear Decommissioning Authority

**WASTE CUSTODIAN** Sellafield Limited

**WASTE TYPE** ILW

Is the waste subject to Scottish Policy: No

**WASTE VOLUMES**

		Reported
Stocks:	At 1.4.2022.....	0 m <sup>3</sup>
Future arisings -	1.4.2022 - 31.3.2023.....	0 m <sup>3</sup>
	1.4.2023 - 31.3.2024.....	0 m <sup>3</sup>
	1.4.2024 - 31.3.2025.....	0 m <sup>3</sup>
	1.4.2025 - 31.3.2107.....	0 m <sup>3</sup>
	1.4.2107 - 31.3.2111.....	~21.2 m <sup>3</sup>
Total future arisings:		21.2 m <sup>3</sup>
Total waste volume:		21.2 m <sup>3</sup>

Comment on volumes: For inventory purposes the arisings are assumed to arise at a uniform rate over four years. Final Dismantling & Site Clearance is assumed to commence in 2104, with reactor dismantling commencing in 2107, and lasting for ten years. Volumes and radioactivity have been calculated for 100 years after reactor shutdown, i.e. 2103, but the volume in this stream would not change for decommissioning in 2107.

Uncertainty factors on volumes: Stock (upper): x Arisings (upper) x 2.0  
 Stock (lower): x Arisings (lower) x 0.5

**WASTE SOURCE** A variety of miscellaneous metallic wastes resulting from reactor dismantling.

**PHYSICAL CHARACTERISTICS**

General description: Reactor components including control rods, zirconium thimble tubes, CGO thermocouples, core thermocouples and thermocouple ducts. Calder reactors have no channel sleeves or tie rods.

Physical components (%wt): Boron Steel control rods (~95%wt), zirconium thimble tubes (~5% wt). Calder reactors have no channel sleeves or tie rods.

Sealed sources: The waste does not contain sealed sources.

Bulk density (t/m<sup>3</sup>): 1

Comment on density: The density is of the waste as prepared for packaging.

**CHEMICAL COMPOSITION**

General description and components (%wt): Boron steel (~95%wt), zirconium (~5%wt), alumel (<1% wt) and chromel (<1%wt).

Chemical state: Neutral

Chemical form of radionuclides: H-3: The tritium content is insignificant.  
 C-14: The chemical form of carbon 14 has not been assessed but may be graphite.  
 Cl-36: The chlorine content is insignificant  
 Se-79: The selenium content is insignificant.  
 Tc-99: The chemical form of technetium has not been determined.  
 I-129: The iodine content is insignificant  
 Ra: The radium content is insignificant.  
 Th: The thorium content is insignificant.  
 U: The uranium content is insignificant.  
 Np: The neptunium content is insignificant.  
 Pu: The plutonium content is insignificant.

Metals and alloys (%wt): -

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	(%wt)	Type(s) / Grade(s) with proportions	% of total C14 activity
Stainless steel.....	0		
Other ferrous metals.....	~95.0	Boron steel.	100.0
Iron.....			
Aluminium.....			
Beryllium.....	0		
Cobalt.....	0		
Copper.....			
Lead.....	0		
Magnox/Magnesium.....	0		
Nickel.....	<1.0	Chromel and alumeI are both present at 0.45% w/w.	
Titanium.....			
Uranium.....	0		
Zinc.....	0		
Zircaloy/Zirconium.....	~5.0		
Other metals.....	0		

Organics (%wt): No organic wastes are expected.

	(%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): Some graphite dust may be associated with reactor materials.

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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.....	0		
Sand.....			
Glass/Ceramics.....	0		
Graphite.....	TR		
Desiccants/Catalysts.....			
Asbestos.....	0		
Non/low friable.....			
Moderately friable.....			
Highly friable.....			
Free aqueous liquids.....	0		
Free non-aqueous liquids.....	0		
Powder/Ash.....	0		

Inorganic anions (%wt):      Trace quantities of chloride may be present.

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

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.....		

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Corrosive materials.....	0
Pyrophoric materials.....	0
Generating toxic gases.....	0
Reacting with water.....	0
Higher activity particles.....	
Soluble solids as bulk chemical compounds.....	

Hazardous substances / non hazardous pollutants: -

	(%wt)	Type(s) and comment
Acrylamide.....		
Benzene.....		
Chlorinated solvents.....		
Formaldehyde.....		
Organometallics.....		
Phenol.....		
Styrene.....		
Tri-butyl phosphate.....		
Other organophosphates.....		
Vinyl chloride.....		
Arsenic.....		
Barium.....		
Boron.....	<4.0	
Boron (in Boral).....		
Boron (non-Boral).....	<4.0	
Cadmium.....		
Caesium.....		
Selenium.....		
Chromium.....		
Molybdenum.....		
Thallium.....		
Tin.....		
Vanadium.....		
Mercury compounds.....		
Others.....		
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): Not yet determined

(%wt) Type(s) and comment

EDTA.....

DPTA.....

NTA.....

Polycarboxylic acids.....

Other organic complexants.....

Total complexing agents..... NE

Potential for the waste to contain discrete items: Yes. "Large" fabricated steel items.

**PACKAGING AND CONDITIONING**

Conditioning method: The exact method of waste conditioning has not yet been established.

Plant Name: Not yet established.

Location: -

Plant startup date: -

Total capacity (m³/y incoming waste): -

Target start date for packaging this stream: 2107

Throughput for this stream (m³/y incoming waste): -

Other information: -

Likely container type:	Container	Waste packaged (%vol)	Waste loading (m³)	Payload (m³)	Number of packages
	Sellafield 3m³ box	100.0	1.33	2.8	16

Likely container type comment: -

Range in container waste volume: Waste loading estimated based on the total volume of Calder Hall FSC wastes (2A310, 2A311, 2A312 & 2A313) being packaged into 3,300 Sellafield 3m³ boxes.

Other information on containers: The packaged waste will be in a form suitable for disposal at a GDF.

Likely conditioning matrix: -

Other information: -

Conditioned density (t/m³): -

Conditioned density comment: -

Other information on conditioning: -

Opportunities for alternative disposal routing: Not yet determined

Baseline Management Route	Opportunity Management Route	Stream volume (%)	Estimated Date that Opportunity will be realised	Opportunity Confidence	Comment
-	-	-	-	-	-

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**RADIOACTIVITY**

Source:	Activation of the materials and impurities. There may be some contamination.
Uncertainty:	The values quoted were derived by calculation from available material specification and are indicative of the activities that are expected. The major source of uncertainty is the impurity levels.
Definition of total alpha and total beta/gamma:	All alpha emitters activities are insignificant and the total is therefore given as $<1\text{E-}9$ TBq/m <sup>3</sup> . An estimate of total beta/gamma activity is provided, individual nuclide activities have not been quantified.
Measurement of radioactivities:	The specific activities have been estimated using a neutron activation calculation using available material specifications. The major source of uncertainty is the impurity levels.
Other information:	There may be some contamination by Cs137. The activities quoted are those at 100 years after reactor shutdown, i.e. in 2103.

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Nuclide	Mean radioactivity, TBq/m <sup>3</sup>				Nuclide	Mean radioactivity, TBq/m <sup>3</sup>			
	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				8	Gd 153				8
Be 10				8	Ho 163				8
C 14			3.00E-03	CC 2	Ho 166m				8
Na 22				8	Tm 170				8
Al 26			4.00E-07	CC 2	Tm 171				8
Cl 36				8	Lu 174				8
Ar 39				8	Lu 176				8
Ar 42				8	Hf 178n				8
K 40				8	Hf 182				8
Ca 41				8	Pt 193				8
Mn 53				8	Tl 204				8
Mn 54				8	Pb 205				8
Fe 55				8	Pb 210				8
Co 60			2.00E-04	CC 2	Bi 208				8
Ni 59			1.00E-01	CC 2	Bi 210m				8
Ni 63			6.00E+00	CC 2	Po 210				8
Zn 65				8	Ra 223				8
Se 79				8	Ra 225				8
Kr 81				8	Ra 226				8
Kr 85				8	Ra 228				8
Rb 87				8	Ac 227				8
Sr 90				8	Th 227				8
Zr 93				8	Th 228				8
Nb 91				8	Th 229				8
Nb 92				8	Th 230				8
Nb 93m				8	Th 232				8
Nb 94			2.00E-03	CC 2	Th 234				8
Mo 93			1.00E-03	CC 2	Pa 231				8
Tc 97				8	Pa 233				8
Tc 99			1.00E-05	CC 2	U 232				8
Ru 106				8	U 233				8
Pd 107				8	U 234				8
Ag 108m			1.00E-04	CC 2	U 235				8
Ag 110m				8	U 236				8
Cd 109				8	U 238				8
Cd 113m				8	Np 237				8
Sn 119m				8	Pu 236				8
Sn 121m				8	Pu 238				8
Sn 123				8	Pu 239				8
Sn 126				8	Pu 240				8
Sb 125				8	Pu 241				8
Sb 126				8	Pu 242				8
Te 125m				8	Am 241				8
Te 127m				8	Am 242m				8
I 129				8	Am 243				8
Cs 134				8	Cm 242				8
Cs 135				8	Cm 243				8
Cs 137				6	Cm 244				8
Ba 133				8	Cm 245				8
La 137				8	Cm 246				8
La 138				8	Cm 248				8
Ce 144				8	Cf 249				8
Pm 145				8	Cf 250				8
Pm 147				8	Cf 251				8
Sm 147				8	Cf 252				8
Sm 151				8	Other a				8
Eu 152				8	Other b/g				8
Eu 154				8	<b>Total a</b>	<b>0</b>	<b>&lt;1.00E-09</b>	<b>C 3</b>	
Eu 155				8	<b>Total b/g</b>	<b>0</b>	<b>6.00E+00</b>	<b>CC 2</b>	

**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