

<b>WASTE STREAM</b>	<b>2A910</b>	<b>Care and Maintenance Preparation (Reactor LLW)</b>
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**SITE** Calder Hall

**SITE OWNER** Nuclear Decommissioning Authority

**WASTE CUSTODIAN** Sellafield Limited

**WASTE TYPE** LLW

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 - 31.3.2027.....	0 m <sup>3</sup>
	1.4.2027 - 31.3.2028.....	~218.9 m <sup>3</sup>
	1.4.2028 - 31.3.2029.....	~218.9 m <sup>3</sup>
	1.4.2029 - 31.3.2030.....	~282.4 m <sup>3</sup>
	1.4.2030 - 31.3.2031.....	~282.4 m <sup>3</sup>
	1.4.2031 - 31.3.2032.....	~282.4 m <sup>3</sup>
	1.4.2032 - 31.3.2033.....	~409.4 m <sup>3</sup>
	1.4.2033 - 31.3.2034.....	~409.4 m <sup>3</sup>
	1.4.2034 - 31.3.2035.....	~370.7 m <sup>3</sup>
	1.4.2035 - 31.3.2036.....	~370.7 m <sup>3</sup>
	1.4.2036 - 31.3.2037.....	~377.3 m <sup>3</sup>
	1.4.2037 - 31.3.2038.....	~377.3 m <sup>3</sup>
	1.4.2038 - 31.3.2039.....	~246.3 m <sup>3</sup>
	1.4.2039 - 31.3.2040.....	~246.3 m <sup>3</sup>
	1.4.2040 - 31.3.2041.....	~28.7 m <sup>3</sup>
	1.4.2041 - 31.3.2042.....	~1.4 m <sup>3</sup>
	1.4.2042 - 31.3.2043.....	~0.3 m <sup>3</sup>
1.4.2043 - 31.3.2044.....	~0.3 m <sup>3</sup>	
1.4.2044 - 31.3.2045.....	< 0.1 m <sup>3</sup>	
1.4.2045 - 31.3.2046.....	~0 m <sup>3</sup>	
Total future arisings:		4122.8 m <sup>3</sup>
Total waste volume:		4122.8 m <sup>3</sup>

Comment on volumes: Early similar arisings are being consigned under the 2X22 waste stream. Although the overall volume of waste arising between the two streams should remain the same, the amount arising in any given year may vary due to programme changes.

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

**WASTE SOURCE** Waste from Calder Hall Reactor Areas including turbine halls and LLW from Non-active support buildings e.g. workshops.

**PHYSICAL CHARACTERISTICS**

General description: Hard trash and redundant equipment. Steelwork from overhead crane structure & hoist mechanism, watertanks / storage cylinder, switchboards, pipework, flask transporter trailer, iodine void filter, cooling tower, precipitator unit, humidrier, charge chute, etc. Other materials such as timber from scaffolding, copper cabling, aluminium, brass, glass, lead, asbestos cement are also present. Includes some secondary waste.

Physical components (%vol): Steelwork (~90%) timber, copper, aluminium, brass, glass, lead (~10%).

Sealed sources: Not yet determined.

Bulk density (t/m<sup>3</sup>): ~0.7

Comment on density: Density of 0.7 t/m<sup>3</sup> is an initial estimate subject to confirmation.

**CHEMICAL COMPOSITION**

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General description and components (%wt): Metal (~95%), other inorganics (~2%), organics (~3%).

Chemical state: Neutral

Chemical form of radionuclides: H-3: The chemical form of tritium has not been determined.  
 C-14: The chemical form of carbon-14 has not been determined.  
 Cl-36: The chemical form of chlorine has not been determined.  
 Se-79: The chemical form of selenium has not been determined.  
 Tc-99: The chemical form of technetium has not been determined.  
 I-129: The chemical form of iodine has not been determined.  
 Ra: Radium isotope content is expected to be insignificant.  
 Th: Thorium isotope content is expected to be insignificant.  
 U: Uranium isotope content is expected to be insignificant.  
 Np: Neptunium isotope content is expected to be insignificant.  
 Pu: Chemical form of plutonium isotopes has not been determined but may be plutonium oxides.

Metals and alloys (%wt): This waste stream will contain waste of various sizes and thicknesses.

	(%wt)	Type(s) / Grade(s) with proportions	% of total C14 activity
Stainless steel.....	~6.0		
Other ferrous metals.....	~86.0		
Iron.....			
Aluminium.....	~1.0		
Beryllium.....	0		
Cobalt.....	0		
Copper.....	~2.0		
Lead.....	TR		
Magnox/Magnesium.....	0		
Nickel.....	0		
Titanium.....			
Uranium.....	0		
Zinc.....	0		
Zircaloy/Zirconium.....	0		
Other metals.....	0		

Organics (%wt): -

	(%wt)	Type(s) and comment	% of total C14 activity
Total cellulose.....	~2.0		
Paper, cotton.....	0		
Wood.....	~2.0		
Halogenated plastics .....	0		
Total non-halogenated plastics.....	~0.30		
Condensation polymers.....	0		
Others.....	~0.30		
Organic ion exchange materials....	0		
Total rubber.....	0		
Halogenated rubber .....	0		
Non-halogenated rubber.....	0		
Hydrocarbons.....			
Oil or grease .....			

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Fuel.....  
 Asphalt/Tarmac (cont.coal tar)...  
 Asphalt/Tarmac (no coal tar)....  
 Bitumen.....  
 Others.....  
 Other organics..... 0.70

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.....	~1.0		
Cementitious material.....	<0.50		
Sand.....			
Glass/Ceramics.....	TR		
Graphite.....	0		
Desiccants/Catalysts.....			
Asbestos.....	<0.50	Brown, white and blue asbestos may be present. The proportions of each type have not been determined.	
Non/low friable.....			
Moderately friable.....			
Highly friable.....			
Free aqueous liquids.....	0		
Free non-aqueous liquids.....	0		
Powder/Ash.....	0		

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: -

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	(%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.....	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.....		
Boron (in Boral).....		
Boron (non-Boral).....		
Cadmium.....		
Caesium.....		
Selenium.....		
Chromium.....		
Molybdenum.....		
Thallium.....		
Tin.....		
Vanadium.....		

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Mercury compounds.....  
 Others.....  
 Electronic Electrical Equipment (EEE)  
   EEE Type 1.....  
   EEE Type 2.....  
   EEE Type 3.....  
   EEE Type 4.....  
   EEE Type 5.....

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. Tools and fabricated items will be included in this stream.

**TREATMENT, PACKAGING AND DISPOSAL**

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

Treatment	On-site / Off site	Stream volume %
Low force compaction	Off-site	~5.0
Supercompaction (HFC)		
Incineration		
Solidification	Off-site	~90.0
Decontamination		
Metal treatment		
Size reduction		
Decay storage		
Recycling / reuse	~5.0	~5.0
Other / various		
None		

Comment on planned treatments:

Although there are no firm plans in place, based on current experience we have assumed the treatment methods set out in the table for the purposes of the 2022UK Inventory. For Inventory purposes, it is assumed incineration can be extended to this waste stream as it has to 2X22. It has also been assumed that 90% of the metallic waste will be treated by the supply chain and will subsequently be 'out of scope', with the remaining 10% consigned to LLWR for disposal as non-compactable LLW. The other inorganics are assumed to be non-compactable LLW that require no further treatment.

**Disposal Routes:**

Disposal Route	Stream volume %	Disposal density t/m3
Expected to be consigned to the LLW Repository	5.0	1.2
Expected to be consigned to a Landfill Facility		
Expected to be consigned to an On-Site Disposal Facility		
Expected to be consigned to an Incineration Facility	5.0	0.14
Expected to be consigned to a Metal Treatment Facility	90.0	1.4
Expected to be consigned as Out of Scope		
Expected to be recycled / reused		
Disposal route not known		

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

**Upcoming (2022/23-2024/25) Waste Routing (if expected to change from above):**

Disposal Route	Stream volume %		
	2022/23	2023/24	2024/25
Expected to be consigned to the LLW Repository			
Expected to be consigned to a Landfill Facility			
Expected to be consigned to an On-Site Disposal Facility			
Expected to be consigned to an Incineration Facility			
Expected to be consigned to a Metal Treatment Facility			
Expected to be consigned as Out of Scope			
Expected to be recycled / reused			
Disposal route not known			

**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
-	-	-	-	-	-

**Waste Packaging for Disposal:**

Container	Stream volume %	Waste loading m <sup>3</sup>	Number of packages
1/3 Height IP-1 ISO			
2/3 Height IP-2 ISO			
1/2 Height WAMAC IP-2 ISO			
1/2 Height IP-2 Disposal/Re-usable ISO	~5.0	10	21
2m box (no shielding)			
4m box (no shielding)			
Other			

Other information: -

**Waste Planned for Disposal at the LLW Repository:**

Container voidage: -

Waste Characterisation Form (WCH): It is not yet determined if the waste meets LLWR's Waste Acceptance Criteria (WAC).

Waste consigned for disposal to LLWR in year of generation: Not yet determined.

**Non-Containerised Waste for In-Vault Grouting:** (Not applicable to this waste stream)

Stream volume (%): -

Waste stream variation: -

Bounding cuboidal volume:

Inaccessible voidage: -

Other information: -

**RADIOACTIVITY**

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Source:	Activation and contamination of materials.
Uncertainty:	Activity values are current best estimates. Specific activity is a function of operating history. The values are indicative of the activities that would be expected.
Definition of total alpha and total beta/gamma:	Total beta/gamma is given as the sum of the listed activities of all nuclides other than alpha emitters. All alpha emitter activities are insignificant and the total is therefore given as <1E-9 TBq/m <sup>3</sup> .
Measurement of radioactivities:	Estimates were originally made for the 2004 UK RWI based on the specific activity of stream 2A03 General LLW (LLW from Calder Hall arising as a result of maintenance and operations) in the 2001 UK RWI. These have been modified by considering the current operational LLW waste stream 2X22.
Other information:	-

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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			8.00E-06	DD 2	Gd 153				8
Be 10				8	Ho 163				8
C 14			4.00E-07	DD 2	Ho 166m				8
Na 22					Tm 170				8
Al 26					Tm 171				8
Cl 36			8.00E-09	DD 2	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			1.00E-06	DD 2	Pb 205				8
Fe 55			3.00E-04	DD 2	Pb 210				8
Co 60			3.00E-05	DD 2	Bi 208				8
Ni 59				8	Bi 210m				8
Ni 63			3.00E-06	DD 2	Po 210				8
Zn 65			4.00E-07	DD 2	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				8	Th 234				8
Mo 93				8	Pa 231				8
Tc 97				8	Pa 233				8
Tc 99				8	U 232				8
Ru 106				8	U 233				8
Pd 107				8	U 234				8
Ag 108m				8	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			1.00E-07	DD 2	Pu 241				8
Sb 126				8	Pu 242				8
Te 125m				8	Am 241				8
Te 127m				8	Am 242m				8
I 129			1.00E-07	DD 2	Am 243				8
Cs 134				8	Cm 242				8
Cs 135				8	Cm 243				8
Cs 137			2.00E-08	DD 2	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		9.00E-07	DD 2	
Eu 154				8	<b>Total a</b>	<b>0</b>	<b>&lt;1.00E-09</b>	<b>D 3</b>	
Eu 155				8	<b>Total b/g</b>	<b>0</b>	<b>3.44E-04</b>	<b>DD 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