

<b>WASTE STREAM</b>	<b>2S303</b>	<b>Windscale Pile 2 LLW</b>
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**SITE** Windscale  
**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 - 31.3.2042.....	0 m <sup>3</sup>
	1.4.2042 - 31.3.2044.....	~2117.0 m <sup>3</sup>
	1.4.2044 - 31.3.2047.....	~876.0 m <sup>3</sup>
	1.4.2047 - 31.3.2052.....	~657.0 m <sup>3</sup>
Total future arisings:		3650.0 m <sup>3</sup>
Total waste volume:		3650.0 m <sup>3</sup>

Comment on volumes: Arisings have been amended from previous declarations and this declaration is congruent with the Hazard Inventory for the plant. The figures have been amended proportionally to the total arisings. LLW produced as a result of decommissioning activities including operational and secondary waste. Compactable secondary wastes - soft organics, rubber/plastics, PVC, etc. 13 x 205l mild steel drums water duct debris & redundant machinery from Pile 2. Mild steel. Concrete and graphite will be present but not yet determined. Concrete blocks, scabblings, cores, etc. Percentage breakdowns are by weight and based on same rebar to concrete ratio as that in GLEEP and as detailed in PRWI. Activity is that measured in sampling in 2008.

Uncertainty factors on volumes: Stock (upper): x Arisings (upper) x 1.5  
Stock (lower): x Arisings (lower) x 0.5

**WASTE SOURCE** Decommissioning of Windscale Pile 2, an air-cooled graphite-moderated reactor.

**PHYSICAL CHARACTERISTICS**

General description: Wastes from decommissioning comprising bioshield concrete, thermal shield steel work, insulation and duct work. Plastics and rubber wastes will be produced due to operations ongoing as part of decommissioning. No large items of waste will be generated. All reactor components will be size reduced during decommissioning. Some size reduction may be necessary.

Physical components (%wt): Soil/ Rubble/ Concrete (69%), Metal (<10%), Wood (3%), Fibreglass (<1%), Soft Organics (7%), Plastic/ Rubber (12%).

Sealed sources: The waste does not contain sealed sources.

Bulk density (t/m<sup>3</sup>): 2.4

Comment on density: The density is for the raw waste and varies considerably across the stream. This may change upon characterisation.

**CHEMICAL COMPOSITION**

General description and components (%wt): Soil/ Rubble/ Concrete (69%), Carbon Steel (8%), Stainless Steel (<1%), Aluminium (<1%), Wood (3%), Fibreglass (<1%), Soft Organics (7%), Plastic/ Rubber (12%).

Chemical state: The waste believed to be alkaline due to the concrete content.

Chemical form of radionuclides: H-3: Tritium is present as activation within graphite and concrete.  
C-14: C-14 is present as activation within steel and concrete.  
Se-79: Possibly present as a result of contamination.  
Tc-99: Possibly present as a result of contamination.  
U: Originally present as metal, but oxidation likely.  
Np: Possibly present as a result of contamination.  
Pu: Possibly present as a result of contamination.

Metals and alloys (%wt): No metal is present as sheet form. The steel is mainly present as plate or girders. This will

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be clarified upon characterisation.

	(%wt)	Type(s) / Grade(s) with proportions	% of total C14 activity
Stainless steel.....	<1.0		
Other ferrous metals.....	<8.0		
Iron.....			
Aluminium.....	<1.0		
Beryllium.....			
Cobalt.....	0		
Copper.....	0		
Lead.....	TR		
Magnox/Magnesium.....	0		
Nickel.....	0		
Titanium.....			
Uranium.....	P		
Zinc.....	0		
Zircaloy/Zirconium.....	0		
Other metals.....	0		

Organics (%wt): The other organics present are fibreglass (<1%) and soft organics (7%). The halogenated plastics which are present in the waste are PVC and the non-halogenated are polythene. The rubbers present are Neoprene and Nitrile. Non-halogenated plastics and rubbers are present in the waste arising from decommissioning operations.

	(%wt)	Type(s) and comment	% of total C14 activity
Total cellulosics.....	~3.0		
Paper, cotton.....	P		
Wood.....	~3.0		
Halogenated plastics .....	P		
Total non-halogenated plastics.....	P		
Condensation polymers.....	0		
Others.....	P		
Organic ion exchange materials....	0		
Total rubber.....	~~12.0		
Halogenated rubber .....	P		
Non-halogenated rubber.....	P		
Hydrocarbons.....			
Oil or grease .....			
Fuel.....			
Asphalt/Tarmac (cont.coal tar)...			
Asphalt/Tarmac (no coal tar)....			
Bitumen.....			
Others.....			
Other organics.....	~7.0	Soft organics.	

Other materials (%wt): -

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	(%wt)	Type(s) and comment	% of total C14 activity
Inorganic ion exchange materials..	0		
Inorganic sludges and flocs.....	0		
Soil.....	~~4.0		
Brick/Stone/Rubble.....	~~9.0		
Cementitious material.....	~~56.0	Contains an undeterminable amount of 'REBAR'.	
Sand.....			
Glass/Ceramics.....	<1.0		
Graphite.....	0		
Desiccants/Catalysts.....			
Asbestos.....	P		
Non/low friable.....			
Moderately friable.....			
Highly friable.....			
Free aqueous liquids.....	0		
Free non-aqueous liquids.....	0		
Powder/Ash.....	0		

Inorganic anions (%wt):            Carbonates will be present in concrete.

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

Materials of interest for waste acceptance criteria:            Trace levels of asbestos may be present. Trace levels of lead may be present. Characterisation will give clarification.

	(%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.....	NE	
Putrescible wastes.....	0	
Non-putrescible wastes.....	NE	

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

Hazardous substances / non hazardous pollutants:      It is possible that the waste may be classified as containing hazardous materials once the potential asbestos content is better characterised.

	(%wt)	Type(s) and comment
Acrylamide.....		
Benzene.....	NE	
Chlorinated solvents.....		
Formaldehyde.....		
Organometallics.....		
Phenol.....	NE	
Styrene.....		
Tri-butyl phosphate.....	NE	
Other organophosphates.....		
Vinyl chloride.....	NE	
Arsenic.....	NE	
Barium.....		
Boron.....	NE	
Boron (in Boral).....		
Boron (non-Boral).....		
Cadmium.....	NE	
Caesium.....		
Selenium.....	NE	
Chromium.....	NE	
Molybdenum.....	NE	
Thallium.....		
Tin.....	NE	
Vanadium.....	NE	
Mercury compounds.....		
Others.....	NE	
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:      Yes. Tools, steel fabrications and castings are likely to be present.

**TREATMENT, PACKAGING AND DISPOSAL**

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

Treatment	On-site / Off site	Stream volume %
Low force compaction		
Supercompaction (HFC)		
Incineration	Off-site	~22.0
Solidification		
Decontamination		
Metal treatment	Off-site	~8.0
Size reduction	On-site	<70.0
Decay storage		
Recycling / reuse		
Other / various		
None		<70.0

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 2022 UK Inventory plus some size reduction to allow packing at source into Half Height ISOs for disposal.

**Disposal Routes:**

Disposal Route	Stream volume %	Disposal density t/m3
Expected to be consigned to the LLW Repository	<70.0	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	~22.0	0.14
Expected to be consigned to a Metal Treatment Facility	~8.0	1.4
Expected to be consigned as Out of Scope		
Expected to be recycled / reused		
Disposal route not known		

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			

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**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 2m box (no shielding) 4m box (no shielding) Other	~70.0	10	256

Other information: -

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

Container voidage: Yet to be determined

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

Waste consigned for disposal to LLWR in year of generation: Yes.

**Non-Containerised Waste for In-Vault Grouting:**

Stream volume (%): -

Waste stream variation: -

Bounding cuboidal volume:

Inaccessible voidage: -

Other information: -

**RADIOACTIVITY**

Source: Activity due to activation of concrete and metals and from fuel contamination.

Uncertainty: Total alpha is 2.47E-07 TBq/m<sup>3</sup>.

Definition of total alpha and total beta/gamma: This will be clarified upon characterisation.

Measurement of radioactivities: Samples taken from Pile 1 concrete, soft compactable waste and rubble, and was subject to radiometric analysis in 2003 in order to produce a radiometric fingerprint for both piles.

Other information: Other Beta/ Gamma comprises of Co57, Co58, and Zr95.

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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			1.57E-07	BC 1	Gd 153				
Be 10					Ho 163				
C 14			1.23E-08	BC 1	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					Tl 204				
Mn 54			2.21E-14	BC 1	Pb 205				
Fe 55			2.21E-09	BC 1	Pb 210				
Co 60			2.80E-09	BC 1	Bi 208				
Ni 59					Bi 210m				
Ni 63			1.77E-05	BC 1	Po 210				
Zn 65			1.40E-15	BC 1	Ra 223				
Se 79					Ra 225				
Kr 81					Ra 226				
Kr 85					Ra 228				
Rb 87					Ac 227				
Sr 90			2.49E-05	BC 1	Th 227				
Zr 93					Th 228				
Nb 91					Th 229				
Nb 92					Th 230				
Nb 93m					Th 232				
Nb 94					Th 234		2.48E-08	BC 1	
Mo 93					Pa 231		3.48E-13	BC 1	
Tc 97					Pa 233		6.22E-08	BC 1	
Tc 99			6.01E-08	BC 1	U 232		2.92E-09	BC 1	
Ru 106			4.21E-13	BC 1	U 233				
Pd 107					U 234		3.73E-08	BC 1	
Ag 108m					U 235		1.49E-09	BC 1	
Ag 110m			3.74E-15	BC 1	U 236		2.34E-10	BC 1	
Cd 109					U 238		2.48E-08	BC 1	
Cd 113m					Np 237		6.22E-08	BC 1	
Sn 119m					Pu 236				
Sn 121m					Pu 238		5.49E-09	BC 1	
Sn 123					Pu 239		4.08E-08	BC 1	
Sn 126					Pu 240		5.36E-08	BC 1	
Sb 125			1.06E-10	BC 1	Pu 241		1.24E-07	BC 1	
Sb 126					Pu 242		4.30E-10	BC 1	
Te 125m					Am 241		1.63E-08	BC 1	
Te 127m					Am 242m				
I 129			6.10E-09	BC 1	Am 243				
Cs 134			9.93E-12	BC 1	Cm 242		1.66E-18	BC 1	
Cs 135					Cm 243		7.67E-11	BC 1	
Cs 137			4.10E-04	BC 1	Cm 244		1.68E-09	BC 1	
Ba 133					Cm 245				
La 137					Cm 246				
La 138					Cm 248				
Ce 144			1.64E-14	BC 1	Cf 249				
Pm 145					Cf 250				
Pm 147					Cf 251				
Sm 147					Cf 252				
Sm 151					Other a				
Eu 152			1.46E-09	BC 1	Other b/g				
Eu 154			5.80E-09	BC 1	<b>Total a</b>	<b>0</b>	<b>2.47E-07</b>	<b>BC 1</b>	
Eu 155			4.41E-10	BC 1	<b>Total b/g</b>	<b>0</b>	<b>4.54E-04</b>	<b>BC 1</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