

WASTE STREAM	2S09	Waste from P.I.E. Operations
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SITE Windscale

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.....	3.8 m ³
Future arisings - 1.4.2022 - 31.3.2023.....	~0 m ³
1.4.2023 - 31.3.2024.....	~0 m ³
1.4.2024 - 31.3.2025.....	~0 m ³
1.4.2025 - 31.3.2032.....	~0 m ³
1.4.2032 - 31.3.2044.....	~21.0 m ³
Total future arisings:	21.0 m ³
Total waste volume:	24.8 m ³

Comment on volumes: The figures have been aligned with the volumes recorded in the Hazard Inventory and the dates to coincide with the strategic plan. Most operational arisings are expected to be LLW. Small volumes may result from POCO, but cannot be quantified until extent/methodology determined. This waste includes waste from WAGR and Waste from PIE and supporting operations in Windscale Active Handling Facility. The graphite from this waste stream has been packaged as LLW and consigned to the LLWR.

Uncertainty factors on volumes:

Stock (upper):	x 1.25	Arisings (upper)	x 1.25
Stock (lower):	x 0.75	Arisings (lower)	x 0.75

WASTE SOURCE Disassembly of WAGR stringers, and the PIE of WAGR fuels. Stream also contains WAGR operational wastes (mostly steel stringer components) that were in store ex-reactor at shut-down. The waste stream also includes waste from WAGR and waste from PIE and supporting operations in the Windscale Active Handling Facility. This also includes two neutron sources.

PHYSICAL CHARACTERISTICS

General description: Irradiated stainless steel, Zircaloy, Magnox, PE16 alloy, graphite (i.e. general fuel element furniture) and items of equipment contaminated with fission products and activation products (i.e. soft waste, gaiters, gloves and materials used for decontamination), waste associated with PIE operations. WAGR Wastes: WAGR hard wastes (~15vol%) have been size reduced and tubes squashed to fit in 65-litre m/s disposal cans. WAGR soft wastes (~5vol%) have been compacted in paint-cans and placed in similar disposal cans. Remaining 80%- any thin metal items (eg bottles) are compacted into blocks approximately 18" x 18" x 1" thick. Graphite waste has been consigned as LLW to the LLWR. Windscale Active Handling Facility Wastes: Approx 50% of this waste has been packaged into ILW storage boxes.

Physical components (%vol): WAGR Wastes: 28% predominantly steel wastes in 65-litre disposal cans. Balance: irradiated steels (18%), contaminated metals (18%), general soft waste (18%), filters (18%). The graphite has been removed and consigned to the LLWR. Windscale Active Handling Facility Wastes: Waste from PIE operations (100%).

Sealed sources: The waste contains sealed sources.

Bulk density (t/m³): ~2

Comment on density: Waste mass known accurately for substream representing ~10% of WAGR waste. Remainder deduced by analogy. No density data is currently available for the Windscale Active Handling Facility wastes.

CHEMICAL COMPOSITION

General description and components (%wt): WAGR Wastes: Stainless steel ~47%, mild steel incl. disposal cans ~24%, aluminium (<4%), other non-ferrous metal (<6%), paper (<6%), plastics (<8%), rubber (<3%), Magnox (<1%), Zircaloy (<1%). Contamination from U and UO₂ fuel. The graphite has been removed and consigned to the LLWR. Windscale Active Handling Facility Wastes: Wastes from PIE operations (100%).

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Chemical state: -

Chemical form of radionuclides: U: Metal and oxide.
Pu: Unknown.

Metals and alloys (%wt): No sheet metal is consigned in this waste stream. No large items are present in the waste stream.

	(%wt)	Type(s) / Grade(s) with proportions	% of total C14 activity
Stainless steel.....	~47.0	20/25 Nb or 18/8.	
Other ferrous metals.....	~24.0		
Iron.....			
Aluminium.....	<4.0		
Beryllium.....	P		
Cobalt.....	0		
Copper.....	P		
Lead.....	P		
Magnox/Magnesium.....	<1.0		
Nickel.....	P	Tie rods are Nimonic PE16 alloy.	
Titanium.....			
Uranium.....	P		
Zinc.....	P		
Zircaloy/Zirconium.....	<1.0		
Other metals.....	<6.0		

Organics (%wt): PVC may be present as bags and sheet.

	(%wt)	Type(s) and comment	% of total C14 activity
Total cellulose.....	<6.0		
Paper, cotton.....	<6.0		
Wood.....	TR		
Halogenated plastics	NE		
Total non-halogenated plastics.....	<8.0		
Condensation polymers.....	NE		
Others.....	NE		
Organic ion exchange materials....	0		
Total rubber.....	<3.0		
Halogenated rubber	0		
Non-halogenated rubber.....	P		
Hydrocarbons.....			
Oil or grease			
Fuel.....			
Asphalt/Tarmac (cont.coal tar)...			
Asphalt/Tarmac (no coal tar)....			
Bitumen.....			
Others.....			
Other organics.....	0		

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.....	0		
Brick/Stone/Rubble.....	0		
Cementitious material.....	0		
Sand.....			
Glass/Ceramics.....	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.....	TR		

Inorganic anions (%wt): Traces arising from decontaminants and etches etc.

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

Materials of interest for waste acceptance criteria: Powders will be present as contamination and dust from size reduction operations.

	(%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: The waste contains bulk lead and a small amount of mercury.

	(%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): Yes

	(%wt)	Type(s) and comment
EDTA.....		
DPTA.....		
NTA.....		
Polycarboxylic acids.....		
Other organic complexants.....	TR	The waste contains traces of decontamination materials (<<1%).
Total complexing agents.....	TR	

Potential for the waste to contain discrete items: Yes. Sealed waste cans are included in this waste stream.

PACKAGING AND CONDITIONING

Conditioning method: Conditioning plans for the bulk of the waste stream have not yet been decided. The graphite has been consigned to the LLWR. Historic canned waste to be consigned to MBGWS for interim storage

Plant Name: Not yet determined.

Location: Windscale.

Plant startup date: -

Total capacity (m³/y incoming waste): -

Target start date for packaging this stream: 2042

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

Other information: -

Likely container type:	Container	Waste packaged (%vol)	Waste loading (m ³)	Payload (m ³)	Number of packages
	MBGWS box	~13.6	~0.2	~2.8	17
	Sellafield 3m ³ box	~86.4	~0.85	2.1	26

Likely container type comment: Actual container type in unknown so Sellafield 3 m³ boxes are assumed for calculation purposes for future arisings. Stocks are to be consigned to MBGWS

Range in container waste volume: Waste to MBGWS may be used as infill rather than generating new boxes of waste

Other information on containers: -

Likely conditioning matrix: Not specified

Other information: -

Conditioned density (t/m³): -

Conditioned density comment: -

Other information on conditioning: -

Opportunities for alternative disposal routing: Not yet determined

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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 products of steel, PE16, Magnox, Zircaloy and contamination from U and UO2 fuel.
Uncertainty:	Average activity of some waste known with far greater accuracy. This radionuclide data is not applicable to the waste that originates from the Windscale Active Handling Facility.
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:	Activity of 10% of waste assessed by FISPACT modelling, other 10% by sampling and analysis of contamination. No detail on radionuclide content of remaining 80%, so higher of derived data and 1998 inventory (unknown provenance) quoted. These percentage breakdowns are for the WAGR waste only not for the waste from the Windscale Active Handling Facility.
Other information:	-

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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	1.20E-01	BA 2		6	Gd 153				
Be 10	9.30E-07	BA 2		6	Ho 163	4.69E-07	BA 2		6
C 14	4.19E-02	BA 2		6	Ho 166m	5.25E-05	BA 2		6
Na 22					Tm 170				
Al 26					Tm 171	1.96E-09	BA 2		6
Cl 36	6.00E-06	BA 2		6	Lu 174	1.14E-09	BA 2		6
Ar 39	3.75E-03	BA 2		6	Lu 176	2.90E-10	BA 2		6
Ar 42	1.31E-08	BA 2		6	Hf 178n	2.22E-04	BA 2		6
K 40	1.90E-08	BA 2		6	Hf 182	1.60E-10	BA 2		6
Ca 41	2.40E-04	BA 2		6	Pt 193	5.29E-04	BA 2		6
Mn 53	5.20E-08	BA 2		6	Tl 204	3.72E-05	BA 2		6
Mn 54	1.79E-14	BB 2		6	Pb 205	2.20E-09	BA 2		6
Fe 55	1.82E-03	BB 2	1.38E-05	BB 1	Pb 210	1.11E-09	BA 2		6
Co 60	1.39E-01	BB 2	1.57E-04	BB 1	Bi 208	5.70E-09	BA 2		6
Ni 59	2.00E-01	BA 2		6	Bi 210m	1.90E-09	BA 2		6
Ni 63	1.71E+01	BA 2		6	Po 210	1.05E-09	BA 2		6
Zn 65	6.39E-19	BA 2		6	Ra 223	7.41E-05			
Se 79	1.16E-07	BB 2	1.90E-07	BB 1	Ra 225	4.80E-08			
Kr 81	4.70E-07	BA 2		6	Ra 226	4.82E-09	BA 2		6
Kr 85	4.55E-05	BA 2		6	Ra 228	8.88E-08	BA 2		6
Rb 87	3.90E-08	BA 2		6	Ac 227	7.45E-05	BA 2		6
Sr 90	8.38E-04	BB 2	1.55E-03	BB 1	Th 227	7.32E-05			
Zr 93	9.30E-03	BA 2	3.90E-02	BB 1	Th 228	3.97E-06	BB 2		6
Nb 91	1.48E-05	BA 2		6	Th 229	4.80E-08	BB 2		6
Nb 92	2.70E-09	BA 2		6	Th 230	6.20E-07	BB 2	2.60E-06	BB 1
Nb 93m	5.15E-02	BA 2		6	Th 232	8.90E-08	BA 2		6
Nb 94	6.60E-03	BB 2	2.10E-06	BB 1	Th 234	7.10E-06			
Mo 93	9.77E-04	BA 2		6	Pa 231	1.70E-04	AC 2	7.10E-04	AC 1
Tc 97	1.50E-10	BA 2		6	Pa 233	3.96E-08			
Tc 99	1.30E-04	BB 2	1.10E-06	BB 1	U 232	3.79E-06	AC 2	1.16E-06	AC 1
Ru 106	2.19E-16	BA 2		6	U 233	7.10E-06	AC 2		6
Pd 107	3.40E-09	BA 2		6	U 234	1.90E-06	AC 2	6.81E-06	AC 1
Ag 108m	7.12E-05	BA 2		6	U 235	1.70E-07	AC 2	6.90E-07	AC 1
Ag 110m	3.26E-20	BB 2		6	U 236	1.21E-09	AC 2		6
Cd 109	1.02E-13	BA 2		6	U 238	7.10E-06	AC 2	2.90E-05	AC 1
Cd 113m	7.08E-05	BB 2	8.86E-05	BB 1	Np 237	3.96E-08	AC 2	1.62E-07	AC 1
Sn 119m	1.72E-18	BA 2		6	Pu 236				
Sn 121m	3.78E-05	BA 2		6	Pu 238	4.31E-05	AC 2	4.34E-05	AC 1
Sn 123					Pu 239	4.90E-05	AC 2	3.60E-05	AC 1
Sn 126	4.10E-09	BA 2		6	Pu 240	3.10E-05	AC 2	3.09E-05	AC 1
Sb 125	1.50E-07	BB 2	3.20E-06	BB 1	Pu 241	7.77E-04	AC 2	1.52E-03	AC 1
Sb 126	5.74E-10				Pu 242	4.20E-07	AC 2	1.50E-06	AC 1
Te 125m	3.75E-08				Am 241	1.44E-04	AC 2	2.67E-04	AC 1
Te 127m					Am 242m	1.02E-04	AC 2	6.69E-06	AC 1
I 129	4.30E-10	BA 2		6	Am 243	1.40E-06	AC 2	3.59E-06	AC 1
Cs 134	2.60E-08	BB 2	1.17E-09	BB 1	Cm 242	8.43E-05	AC 2	5.52E-06	AC 1
Cs 135	2.70E-08	BA 2		6	Cm 243	5.66E-07	AC 2	1.65E-06	AC 1
Cs 137	1.56E-03	BB 2	3.47E-03	BB 1	Cm 244	1.18E-05	AC 2	7.02E-06	AC 1
Ba 133	4.11E-04	BA 2		6	Cm 245	4.03E-08	AC 2	1.49E-07	AC 1
La 137	8.00E-06	BA 2		6	Cm 246	6.42E-08	AC 2	2.92E-07	AC 1
La 138	2.20E-12	BA 2		6	Cm 248				
Ce 144	1.58E-12	BB 2	3.79E-16	BB 1	Cf 249	1.07E-06	AC 2	4.37E-06	AC 1
Pm 145	9.45E-07	BA 2		6	Cf 250	8.13E-06	AC 2	1.87E-05	AC 1
Pm 147	2.66E-07	BB 2	6.11E-08	BB 1	Cf 251				
Sm 147	7.60E-11	BA 2		6	Cf 252				
Sm 151	3.47E-04	BB 2	4.34E-04	BB 1	Other a				
Eu 152	3.55E-03	BB 2	7.39E-04	BB 1	Other b/g				
Eu 154	2.80E-04	BB 2	1.84E-06	BB 1	Total a	7.19E-04	CD 2	1.17E-03	CD 2
Eu 155	1.91E-06	BB 2	1.07E-07	BB 1	Total b/g	1.77E+01	CD 2	4.70E-02	CD 2

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