

<b>WASTE STREAM</b>	<b>5B303</b>	<b>Dounreay Fast Reactor LLW</b>
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**SITE** Dounreay

**SITE OWNER** Nuclear Decommissioning Authority

**WASTE CUSTODIAN** Dounreay Site Restoration 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.....	153.2 m <sup>3</sup>
	1.4.2023 - 31.3.2024.....	164.5 m <sup>3</sup>
	1.4.2024 - 31.3.2025.....	153.7 m <sup>3</sup>
	1.4.2025 - 31.3.2026.....	153.2 m <sup>3</sup>
	1.4.2026 - 31.3.2027.....	153.2 m <sup>3</sup>
	1.4.2027 - 31.3.2028.....	153.2 m <sup>3</sup>
	1.4.2028 - 31.3.2029.....	96.9 m <sup>3</sup>
	1.4.2029 - 31.3.2030.....	68.3 m <sup>3</sup>
	1.4.2030 - 31.3.2031.....	68.3 m <sup>3</sup>
	1.4.2031 - 31.3.2032.....	104.6 m <sup>3</sup>
	1.4.2032 - 31.3.2033.....	498.0 m <sup>3</sup>
	1.4.2033 - 31.3.2034.....	1291.7 m <sup>3</sup>
	1.4.2034 - 31.3.2035.....	3.8 m <sup>3</sup>
	1.4.2035 - 31.3.2036.....	3.8 m <sup>3</sup>
	1.4.2036 - 31.3.2037.....	2.6 m <sup>3</sup>
Total future arisings:		3069.0 m <sup>3</sup>
Total waste volume:		3069.0 m <sup>3</sup>

Comment on volumes: Waste arisings have been updated in line with Predictive Waste Inventory. Stocks will be captured in waste streams 5B15 and 5B16. It should be noted that arisings are based on programme data from a provisional DSRL site programme.

Uncertainty factors on volumes: Stock (upper): x Arisings (upper) x 1.2  
 Stock (lower): x Arisings (lower) x 0.8

**WASTE SOURCE** Reactor decommissioning.

**PHYSICAL CHARACTERISTICS**

General description: Plant, equipment, pipework, ducting and structures from a demonstration fast reactor. Items will be size reduced where practicable during decommissioning.

Physical components (%vol): Aluminium (0.03%), Asbestos (6.13%), Asphalt (1.73%), Cementitious material (e.g. concrete) (33.82%), Copper (1.09%), Fibreglass (4.76%), Glass (0.29%), Graphite (0.03%), Gypsum Plasterboard/ Fibreboard (0.08%), Lead (0.68%), Mild Steel (13.46%), MMF Insulation Materials (nonHaz) (0.21%), Other (10.74%), Paper (8.13%), Plastic (12.80%), Rubber (1.79%), Stainless steel (2.93%), WEEE not containing hazardous components (0.03%), Wood/ Wood composite (1.08%), Paper / Cardboard (0.20%),

Sealed sources: Not yet determined.

Bulk density (t/m<sup>3</sup>): 0.56

Comment on density: The bulk density is based off consignor's records; D3100 Disposed Inventory Report 2020.

**CHEMICAL COMPOSITION**

General description and components (%wt): Aluminium (0.02%), Asbestos (5.14%), Asphalt (1.32%), Cementitious material (e.g. concrete) (27.77%), Copper (3.35%), Fibreglass (4.26%), Glass (0.24%), Graphite (0.02%), Gypsum Plasterboard/ Fibreboard (0.02%), Lead (2.62%), Mild Steel (36.18%), Other (3.67%), Paper (2.23%), Plastic (4.03%), Rubber (0.93%), Stainless steel (7.88%), WEEE not containing hazardous components (0.05%), Wood/ Wood composite (0.26%),

<b>WASTE STREAM</b>	<b>5B303</b>	<b>Dounreay Fast Reactor LLW</b>
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Chemical state: Neutral

Chemical form of radionuclides: Cl-36: Not known to be present.  
I-129: Not known to be present.  
U: Possibly present as contamination.  
Np: Possibly present at extremely low levels.  
Pu: Possibly present at extremely low levels.

Metals and alloys (%wt): Both bulk and sheet metals are likely to be present, proportions not specified.

	(%wt)	Type(s) / Grade(s) with proportions	% of total C14 activity
Stainless steel.....	7.9		
Other ferrous metals.....	36.2		
Iron.....			
Aluminium.....	0.02		
Beryllium.....			
Cobalt.....	NE		
Copper.....	3.4		
Lead.....	2.6		
Magnox/Magnesium.....	NE		
Nickel.....	NE		
Titanium.....			
Uranium.....			
Zinc.....	NE		
Zircaloy/Zirconium.....	NE		
Other metals.....	3.7	Others (4.2%) are alloys of unknown composition.	

Organics (%wt): The waste contains halogenated and non-halogenated plastics and rubber. Wood may be present but only in small amounts. PVC and neoprene are likely to be present.

	(%wt)	Type(s) and comment	% of total C14 activity
Total cellulose.....	2.5		
Paper, cotton.....	2.2		
Wood.....	0.26		
Halogenated plastics .....	2.0	PVC	
Total non-halogenated plastics.....	2.0		
Condensation polymers.....	TR		
Others.....	2.0		
Organic ion exchange materials....	0		
Total rubber.....	0.93		
Halogenated rubber .....	0.46	Neoprene	
Non-halogenated rubber.....	0.47		
Hydrocarbons.....	1.3		
Oil or grease .....			
Fuel.....			
Asphalt/Tarmac (cont.coal tar)...	0.62		
Asphalt/Tarmac (no coal tar)....	0.70		
Bitumen.....			
Others.....			

<b>WASTE STREAM</b>	<b>5B303</b>	<b>Dounreay Fast Reactor LLW</b>
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Other organics..... 0.07 Includes Plasterboard and WEEE

Other materials (%wt): Fibreglass 4.26%, Plasterboard 0.02%, WEEE 0.05%

	(%wt)	Type(s) and comment	% of total C14 activity
Inorganic ion exchange materials..	0		
Inorganic sludges and flocs.....	0		
Soil.....			
Brick/Stone/Rubble.....			
Cementitious material.....	27.8		
Sand.....			
Glass/Ceramics.....	4.5	includes 4.26% Fiberglass	
Graphite.....	0.02		
Desiccants/Catalysts.....			
Asbestos.....	5.1	Type unknown at present - not accessible	
Non/low friable.....			
Moderately friable.....			
Highly friable.....			
Free aqueous liquids.....	0		
Free non-aqueous liquids.....	0		
Powder/Ash.....	0		

Inorganic anions (%wt): Inorganic anions are present at approximately 3%.

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

Materials of interest for waste acceptance criteria: Asbestos is present. NaK contamination may also be 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	

<b>WASTE STREAM</b>	<b>5B303</b>	<b>Dounreay Fast Reactor LLW</b>
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Biodegradable materials.....	0
Putrescible wastes.....	0
Non-putrescible wastes.....	0
Corrosive materials.....	0
Pyrophoric materials.....	0
Generating toxic gases.....	0
Reacting with water.....	
Higher activity particles.....	NE
Soluble solids as bulk chemical compounds.....	0

Hazardous substances / non hazardous pollutants:      Lead and asbestos are present.

	(%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.....	~0.05	Control panels, lights, junction boxes
EEE Type 2.....		
EEE Type 3.....		
EEE Type 4.....		

**WASTE STREAM 5B303 Dounreay Fast Reactor LLW**

EEE Type 5.....

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. The waste has the potential to contain contaminated hand tools, durable, engineered steel structures and uncompacted 200L drums.

**TREATMENT, PACKAGING AND DISPOSAL**

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

Treatment	On-site / Off site	Stream volume %
Low force compaction	On-site	29.0
Supercompaction (HFC)		
Incineration	On-site	100.0
Solidification		
Decontamination		
Metal treatment		
Size reduction		
Decay storage		
Recycling / reuse		
Other / various		
None		

Comment on planned treatments:

Uncompacted drums will be supercompacted before being placed in HHISOs. The waste will be encapsulated before final disposal. DSRL has begun trialling alternative waste treatment routes in particular, Metal Treatment. These opportunities, however, are not yet fully established waste routes.

**Disposal Routes:**

Disposal Route	Stream volume %	Disposal density t/m3
Expected to be consigned to the LLW Repository	100.0	1.8
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		

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):**

**WASTE STREAM 5B303 Dounreay Fast Reactor LLW**

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:** Yes

Baseline Management Route	Opportunity Management Route	Stream volume (%)	Estimated Date that Opportunity will be realised	Opportunity Confidence	Comment
Onsite disposal	Incineration	26.0	-	Low	This opportunity is still at an early stage of development. A small scale trial is expected to take place in FY22/23 The timing is dependent on the non-containerised waste tasks which will generate the wastes.
Onsite disposal	Metal treatment	7.0		High	Trial is currently underway to open the Metal Treatment Route

**Waste Packaging for Disposal:**

Container	Stream volume %	Waste loading m <sup>3</sup>	Number of packages
1/3 Height IP-1 ISO	100.0	10.12	304
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			

Other information: The waste will consist of large uncompactable items and 200 litre drums that have already been compacted. The waste will be loaded into alternative non-IP2 rated LLW Disposal HHISO for transfer to the DSRL LLW Disposal Facility. Each HHISO may have other LLW items in the final HHISO.

**Waste Planned for Disposal at the LLW Repository:** (Not applicable to this waste stream)

Container voidage: -  
Waste Characterisation Form (WCH): -  
Waste consigned for disposal to LLWR in year of generation: -

**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**

Source:	The radioactivity arises from contamination of reactor building construction materials.
Uncertainty:	Within a factor of 10.
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:	Mainly from NDA measurements and consignor's records.
Other information:	Specific activity uses UKRWI 2019 data decayed to 2022

**WASTE STREAM 5B303 Dounreay Fast Reactor LLW**

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			1.33E-09	CC 2	Gd 153				
Be 10					Ho 163				
C 14					Ho 166m				
Na 22					Tm 170				
Al 26					Tm 171				
Cl 36					Lu 174				
Ar 39					Lu 176				
Ar 42					Hf 178n				
K 40			8.59E-15	CC 2	Hf 182				
Ca 41					Pt 193				
Mn 53					Tl 204				
Mn 54					Pb 205				
Fe 55			5.05E-15	CC 2	Pb 210				
Co 60			1.24E-10	CC 2	Bi 208				
Ni 59					Bi 210m				
Ni 63					Po 210				
Zn 65					Ra 223				
Se 79					Ra 225				
Kr 81					Ra 226				
Kr 85					Ra 228				
Rb 87					Ac 227				
Sr 90			5.37E-07	CC 2	Th 227				
Zr 93					Th 228				
Nb 91					Th 229				
Nb 92					Th 230				
Nb 93m					Th 232		9.43E-16	CC 2	
Nb 94			4.78E-10	CC 2	Th 234				
Mo 93					Pa 231				
Tc 97					Pa 233				
Tc 99					U 232				
Ru 106					U 233				
Pd 107					U 234				
Ag 108m					U 235		9.68E-17	CC 2	
Ag 110m					U 236		1.45E-16	CC 2	
Cd 109					U 238		3.51E-14	CC 2	
Cd 113m					Np 237				
Sn 119m					Pu 236				
Sn 121m					Pu 238		4.39E-10	CC 2	
Sn 123					Pu 239		1.67E-09	CC 2	
Sn 126					Pu 240		1.36E-09	CC 2	
Sb 125					Pu 241		1.33E-09	CC 2	
Sb 126					Pu 242		2.99E-12	CC 2	
Te 125m					Am 241		4.01E-10	CC 2	
Te 127m					Am 242m				
I 129					Am 243				
Cs 134					Cm 242				
Cs 135					Cm 243				
Cs 137			2.08E-06	CC 2	Cm 244				
Ba 133			7.24E-14	CC 2	Cm 245				
La 137					Cm 246				
La 138					Cm 248				
Ce 144			9.88E-18	CC 2	Cf 249				
Pm 145					Cf 250				
Pm 147					Cf 251				
Sm 147					Cf 252				
Sm 151					Other a				
Eu 152			2.04E-14	CC 2	Other b/g				
Eu 154					<b>Total a</b>	<b>0</b>	<b>3.87E-09</b>	<b>CC 2</b>	
Eu 155					<b>Total b/g</b>	<b>0</b>	<b>2.62E-06</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