

WASTE STREAM	5B301	Prototype Fast Reactor LLW
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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 ³
Future arisings -	1.4.2022 - 31.3.2023.....	367.6 m ³
	1.4.2023 - 31.3.2024.....	148.9 m ³
	1.4.2024 - 31.3.2025.....	149.3 m ³
	1.4.2025 - 31.3.2026.....	148.9 m ³
	1.4.2026 - 31.3.2027.....	148.9 m ³
	1.4.2027 - 31.3.2028.....	164.2 m ³
	1.4.2028 - 31.3.2029.....	208.9 m ³
	1.4.2029 - 31.3.2030.....	190.9 m ³
	1.4.2030 - 31.3.2031.....	190.1 m ³
	1.4.2031 - 31.3.2032.....	341.6 m ³
	1.4.2032 - 31.3.2033.....	508.5 m ³
	1.4.2033 - 31.3.2034.....	370.9 m ³
	1.4.2034 - 31.3.2035.....	345.0 m ³
	1.4.2035 - 31.3.2036.....	176.1 m ³
	1.4.2036 - 31.3.2037.....	88.7 m ³
	1.4.2037 - 31.3.2038.....	44.1 m ³
Total future arisings:		3592.6 m ³
Total waste volume:		3592.6 m ³
Comment on volumes:	Programme data is based on a DSRL provisional programme and therefore future arisings dates are subject to change. DSRL are undertaking further sampling to improve understanding of tritium content of reactor items to confirm if they are LLW or ILW	
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: Building materials from decommissioning, and redundant equipment; reactor components; reaction products from treatment of alkali metals

Physical components (%vol): Alkali Metal (0.16%), Aluminium (0.04%), Brass (0.01%), Cementitious material (e.g. concrete) (21.78%), Copper (0.17%), Fibreglass (0.14%), Glass (0.02%), Graphite (0.07%), Iron (0.21%), Lead (2.88%), Mild Steel (38.75%), MMF Insulation Materials (nonHaz) (0.01%), Other (3.76%), Paper (5.99%), Plastic (13.15%), Rubber (2.27%), Sodium (0.47%), Stainless steel (5.77%), WEEE not containing hazardous components (1.63%), Wood/ Wood composite (1.59%), Paper / Cardboard (0.75%), Other Resins (0.39%),

Sealed sources: Not yet determined.

Bulk density (t/m³): 0.38

Comment on density: The density quoted is based on consignor's data.

CHEMICAL COMPOSITION

General description and components (%wt): Alkali Metal (0.03%), Aluminium (0.02%), Brass (0.02%), Cementitious material (e.g. concrete) (11.06%), Copper (0.31%), Fibreglass (0.08%), Glass (0.01%), Graphite (0.03%), Iron (0.35%), Lead (6.88%), Mild Steel (64.43%), Other (0.80%), Paper (1.01%), Plastic (2.56%), Rubber (0.73%), Sodium (0.10%), Stainless steel (9.60%), Uranium (0.01%), WEEE not containing hazardous components (1.72%), Wood/ Wood composite (0.24%),

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Chemical state: Neutral

Chemical form of radionuclides: H-3: Tritiated steel will be present.
 C-14: Possibly present at low concentrations.
 Cl-36: Likely to be present at low levels.
 I-129: Likely to be present at low levels.
 Ra: Not known to be present.
 Th: Not known to be present.
 U: Likely to be present at low levels.
 Np: Likely to be present at low levels.
 Pu: Likely to be present at low levels.

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

	(%wt)	Type(s) / Grade(s) with proportions	% of total C14 activity
Stainless steel.....	9.6		
Other ferrous metals.....	64.4		
Iron.....	0.35		
Aluminium.....	0.02		
Beryllium.....			
Cobalt.....	NE		
Copper.....	0.31		
Lead.....	6.9		
Magnox/Magnesium.....	NE		
Nickel.....	NE		
Titanium.....			
Uranium.....	0.01		
Zinc.....			
Zircaloy/Zirconium.....	NE		
Other metals.....	0.93	Others (0.03%) are alloys of unknown type and mercury and barium.	

Organics (%wt): The waste contains halogenated and non-halogenated plastics and rubber. Wood may be present as a construction material but only in very small amounts. PVC is likely to be the major constituent of halogenated plastics.

	(%wt)	Type(s) and comment	% of total C14 activity
Total cellulose.....	1.3		
Paper, cotton.....	1.0		
Wood.....	0.24		
Halogenated plastics	1.3	PVC	
Total non-halogenated plastics.....	1.3		
Condensation polymers.....	NE		
Others.....			
Organic ion exchange materials....	0		
Total rubber.....	0.73		
Halogenated rubber	0.51		
Non-halogenated rubber.....	0.23		
Hydrocarbons.....			
Oil or grease			
Fuel.....			

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Asphalt/Tarmac (cont.coal tar)...
 Asphalt/Tarmac (no coal tar)....
 Bitumen.....
 Others.....
 Other organics..... 1.8

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.....	P		
Cementitious material.....	11.1		
Sand.....			
Glass/Ceramics.....	0.08	Fiberglass	
Graphite.....	0.03		
Desiccants/Catalysts.....	NE		
Asbestos.....	P		
Non/low friable.....			
Moderately friable.....			
Highly friable.....			
Free aqueous liquids.....	0		
Free non-aqueous liquids.....	0		
Powder/Ash.....	0		

Inorganic anions (%wt): Inorganic anions (about 3%) are probably present.

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

Materials of interest for waste acceptance criteria: Asbestos is present. Trace quantities of sodium may also be present.

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	(%wt)	Type(s) and comment
Combustible metals.....		
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.....	NE	
Soluble solids as bulk chemical compounds.....	NE	

Hazardous substances / non hazardous pollutants: Lead and mercury are present. Barium is present in Barytes concrete. Asbestos is also 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	

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Mercury compounds..... P
 Others..... NE
 Electronic Electrical Equipment (EEE)
 EEE Type 1.....
 EEE Type 2..... ~1.6 Electrical panels, cooling system; vacuums
 EEE Type 3.....
 EEE Type 4.....
 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 durable engineered items and/or contaminated hand tools.

TREATMENT, PACKAGING AND DISPOSAL

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

Treatment	On-site / Off site	Stream volume %
Low force compaction	On-site	31.6
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 is investigating the feasibility of alternative waste treatment routes in particular Metal Treatment for Tritiated steel but no decision has been made on their use yet.

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):

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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	27.0	-	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	32.0		High	Trial is currently underway to open the Metal Treatment Route

Waste Packaging for Disposal:

Container	Stream volume %	Waste loading m ³	Number of packages
1/3 Height IP-1 ISO	100.0	10.160	354
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 for arisings.
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:	From modelling results and waste consignor's declarations.
Other information:	Specific Activity uses 2019 UKRWI data decayed to 2022.

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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			1.43E-04	CC 2	Gd 153				
Be 10					Ho 163				
C 14					Ho 166m				
Na 22			1.06E-07	CC 2	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			7.88E-12	CC 2	Pb 205				
Fe 55					Pb 210				
Co 60			2.06E-05	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			2.25E-06	CC 2	Th 227				
Zr 93					Th 228				
Nb 91					Th 229				
Nb 92					Th 230				
Nb 93m					Th 232				
Nb 94					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		5.61E-13	CC 2	
Ag 110m					U 236				
Cd 109			4.74E-12	CC 2	U 238		4.82E-12	CC 2	
Cd 113m					Np 237				
Sn 119m					Pu 236				
Sn 121m					Pu 238		1.11E-07	CC 2	
Sn 123					Pu 239		8.08E-08	CC 2	
Sn 126					Pu 240		1.20E-07	CC 2	
Sb 125					Pu 241		5.43E-06	CC 2	
Sb 126					Pu 242				
Te 125m					Am 241		1.25E-07	CC 2	
Te 127m					Am 242m				
I 129					Am 243				
Cs 134			5.9E-12	CC 2	Cm 242		1.28E-10	CC 2	
Cs 135					Cm 243				
Cs 137			1.21E-04	CC 2	Cm 244		3.44E-09	CC 2	
Ba 133			6.78E-10	CC 2	Cm 245				
La 137					Cm 246				
La 138					Cm 248				
Ce 144					Cf 249				
Pm 145					Cf 250				
Pm 147					Cf 251				
Sm 147					Cf 252				
Sm 151					Other a				
Eu 152					Other b/g				
Eu 154					Total a		4.41E-07	CC 2	
Eu 155			3.78E-10	CC 2	Total b/g		2.92E-04	CC 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