

WASTE STREAM	5B315	MTR Reprocessing Plant 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.....	63.9 m ³
	1.4.2023 - 31.3.2024.....	63.9 m ³
	1.4.2024 - 31.3.2025.....	64.1 m ³
	1.4.2025 - 31.3.2026.....	63.9 m ³
	1.4.2026 - 31.3.2027.....	63.9 m ³
	1.4.2027 - 31.3.2028.....	63.9 m ³
	1.4.2028 - 31.3.2029.....	64.1 m ³
	1.4.2029 - 31.3.2030.....	63.9 m ³
	1.4.2030 - 31.3.2031.....	67.7 m ³
	1.4.2031 - 31.3.2032.....	73.1 m ³
	1.4.2032 - 31.3.2033.....	73.3 m ³
	1.4.2033 - 31.3.2034.....	73.1 m ³
	1.4.2034 - 31.3.2035.....	16.2 m ³
Total future arisings:		815.0 m ³
Total waste volume:		815.0 m ³

Comment on volumes: Arisings have been revised in line with plant waste inventory walk round exercise. Stocks are captured under waste streams 5B15 and 5B16. It should be noted that DSRL uses a provisional LifeTime Plan and future arisings dates are subject to change. Large increase in routine & soft wastes due to increased program length.

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

WASTE SOURCE LLW contaminated fuel reprocessing plant hardware, concrete shielding.

PHYSICAL CHARACTERISTICS

General description: Fuel reprocessing plant hardware, e.g. vessels, ducting and pipework and concrete shielding. Steel vessels will be cut to an economic size and concrete shielding will be size reduced.

Physical components (%vol): Aluminium (1.37%), Asbestos (0.26%), Asphalt (0.80%), Brick/Rubble (1.70%), Cementitious material (e.g. concrete) (4.72%), Copper (0.01%), Fabric (0.01%), Glass (0.05%), Gypsum Plasterboard/ Fibreboard (0.10%), Lead (2.34%), Mild Steel (21.38%), Oil (0.02%), Other (1.04%), Paper (11.43%), Plastic (40.51%), Rubber (7.52%), Sand (0.12%), Stainless steel (1.06%), Titanium (0.02%), WEEE containing hazardous components (0.02%), WEEE not containing hazardous components (0.06%), Wood/ Wood composite (5.44%),

Sealed sources: Not yet determined.

Bulk density (t/m³): 0.35

Comment on density: The bulk density is based on consignor's records (D3100 disposed Inventory Report 2020).

CHEMICAL COMPOSITION

General description and components (%wt): Aluminium (1.24%), Asbestos (0.22%), Asphalt (0.62%), Brick/Rubble (1.18%), Cementitious material (e.g. concrete) (3.94%), Copper (0.05%), Glass (0.04%), Gypsum Plasterboard/ Fibreboard (0.02%), Lead (9.21%), Mild Steel (58.47%), Other (0.36%), Paper (3.18%), Plastic (12.97%), Rubber (3.98%), Sand (0.07%), Stainless steel (2.89%), Titanium (0.04%), WEEE containing hazardous components (0.04%), WEEE not containing hazardous components (0.11%), Wood/ Wood composite (1.34%),

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Chemical state: Neutral

Chemical form of radionuclides: Cl-36: Not likely to be present
I-129: Not likely to be present
U: Likely to be present as oxide and/or nitrate as very low level contamination.
Pu: Likely to be present as oxide and/or nitrate as very low level contamination.

Metals and alloys (%wt): Mild steel drums, other ferrous items, such as chequer plate and small pieces of supporting steelwork.

	(%wt)	Type(s) / Grade(s) with proportions	% of total C14 activity
Stainless steel.....	2.9		
Other ferrous metals.....	58.5	mild steel	
Iron.....			
Aluminium.....	1.2		
Beryllium.....			
Cobalt.....			
Copper.....	0.05		
Lead.....	9.2		
Magnox/Magnesium.....			
Nickel.....			
Titanium.....	0.04		
Uranium.....			
Zinc.....	TR		
Zircaloy/Zirconium.....			
Other metals.....	0.54	misc materials from routine waste, WEEE, corrected to 100%	

Organics (%wt):	(%wt)	Type(s) and comment	% of total C14 activity
Total cellulose.....	4.5		
Paper, cotton.....	3.2		
Wood.....	1.3		
Halogenated plastics	6.5	Assume 50% split as no further breakdown can be provided	
Total non-halogenated plastics.....	6.5	Assume 50% split as no further breakdown can be provided	
Condensation polymers.....			
Others.....	6.5		
Organic ion exchange materials....	0		
Total rubber.....	4.0	No further information is available on the type of rubber at this time	
Halogenated rubber	P		
Non-halogenated rubber.....	P		
Hydrocarbons.....	0.62		
Oil or grease			
Fuel.....			
Asphalt/Tarmac (cont.coal tar)...	~0.31		
Asphalt/Tarmac (no coal tar)....	~0.31		
Bitumen.....			

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Others.....			
Other organics.....		TR	
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.....	1.2	includes plasterboard	
Cementitious material.....	3.9		
Sand.....	0.07		
Glass/Ceramics.....	0.04		
Graphite.....	0		
Desiccants/Catalysts.....	0		
Asbestos.....	0.22	Asbestos may be present however Friability not known at this time	
Non/low friable.....			
Moderately friable.....			
Highly friable.....			
Free aqueous liquids.....	0		
Free non-aqueous liquids.....	0		
Powder/Ash.....	TR		

Inorganic anions (%wt): Trace quantities of inorganic anions may be present dependent on operations undertaken.

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

Materials of interest for waste acceptance criteria: Asbestos may be present. Possible trace contamination of material from potential unforeseen spillage of Nitric or Hydrofluoric Acid or potentially picked up on filters.

	(%wt)	Type(s) and comment
Combustible metals.....	0	
Low flash point liquids.....	0	
Explosive materials.....	0	
Phosphorus.....	0	
Hydrides.....	0	

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Biological etc. materials.....	0
Biodegradable materials.....	0
Putrescible wastes.....	0
Non-putrescible wastes.....	0
Corrosive materials.....	
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: Mercury may be present in trace quantities. Lead is present at 9.21% mostly in the form of contaminated bricks used for shielding. Asbestos may be present in trace quantities. WEEE %wt as whole unit, not component.

	(%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.....	P	
Vanadium.....	NE	
Mercury compounds.....		
Others.....	NE	
Electronic Electrical Equipment (EEE)		
EEE Type 1.....		
EEE Type 2.....	~1.0	Control Panels, Pond infrastructure, HIAB lifting arm

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EEE Type 3..... ~1.0 Envirovacs, diamond wire cutting unit
 EEE Type 4.....
 EEE Type 5.....

Complexing agents (%wt): Yes

	(%wt)	Type(s) and comment
EDTA.....		
DPTA.....		
NTA.....		
Polycarboxylic acids.....		
Other organic complexants.....	TR	Trace contamination may only be possible from potential spills of decontamination agents e.g. DECON90, GRAMOS.
Total complexing agents.....	TR	

Potential for the waste to contain discrete items: Yes. The waste has the potential to contain contaminated hand tools plus engineered durable steel structures such as ducting.

TREATMENT, PACKAGING AND DISPOSAL

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

Treatment	On-site / Off site	Stream volume %
Low force compaction	On-site	72.0
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):

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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	72.0	-	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	9.0	2022	High	Trial is 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	18.1	46
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 be loaded into an alternative non-IP2 rated LLW Disposal HHISO for transfer to the DSRL LLW Disposal Facility. Each HHISO may have LLW items from other waste streams in the final HHISO. The high loading volume is due to large volume of compactable waste in the waste stream.

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 source of radioactivity is from MTR fuel reprocessing work previously carried out in the facility (and also from other research reactors).
Uncertainty:	Within a factor of three.
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:	The fingerprint for the waste will be consistent with the composition of Uranyl Nitrate product liquor which typically contained U235, U234 and U238 as the predominant radionuclides by mass. To confirm the relative compositions of these species a swab of the Product Cabinet floor and a sample of contaminated concrete were taken for analysis.
Other information:	Specific Activities used are from UKRWI 2019 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					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					Hf 182				
Ca 41					Pt 193				
Mn 53					Tl 204				
Mn 54					Pb 205				
Fe 55					Pb 210				
Co 60			1.65E-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			3.71E-05	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		1.05E-08	CC 2	
Ru 106					U 233				
Pd 107					U 234		1.10E-06	CC 2	
Ag 108m					U 235		2.93E-08	CC 2	
Ag 110m					U 236		1.40E-07	CC 2	
Cd 109			9.81E-08	CC 2	U 238		3.04E-09	CC 2	
Cd 113m					Np 237				
Sn 119m					Pu 236				
Sn 121m					Pu 238		1.11E-06	CC 2	
Sn 123					Pu 239		3.95E-08	CC 2	
Sn 126					Pu 240		4.13E-08	CC 2	
Sb 125					Pu 241		1.95E-06	CC 2	
Sb 126					Pu 242				
Te 125m					Am 241		3.05E-07	CC 2	
Te 127m					Am 242m				
I 129					Am 243		1.02E-12	CC 2	
Cs 134			9.68E-10	CC 2	Cm 242				
Cs 135					Cm 243				
Cs 137			4.57E-05	CC 2	Cm 244		9.98E-09	CC 2	
Ba 133					Cm 245				
La 137					Cm 246				
La 138					Cm 248				
Ce 144					Cf 249				
Pm 145					Cf 250				
Pm 147			4.75E-08	CC 2	Cf 251				
Sm 147			7.96E-19	CC 2	Cf 252				
Sm 151			1.73E-07	CC 2	Other a				
Eu 152					Other b/g				
Eu 154			2.50E-07	CC 2	Total a	0	2.79E-06	CC 2	
Eu 155			1.65E-08	CC 2	Total b/g	0	8.53E-05	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