

WASTE STREAM	5B301	Prototype Fast Reactor LLW
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SITE Dounreay

SITE OWNER Nuclear Decommissioning Authority

WASTE CUSTODIAN Nuclear Restoration Services Ltd (NRS)

WASTE TYPE LLW

WASTE VOLUMES

Stocks:
Future arisings:

	Reported (m ³)
At 1.4.2025	0
1.4.2025 - 31.3.2026	= 71.7
1.4.2026 - 31.3.2027	= 70.4
1.4.2027 - 31.3.2028	= 77.1
1.4.2028 - 31.3.2029	= 90.8
1.4.2029 - 31.3.2030	= 138.5
1.4.2030 - 31.3.2031	= 188.2
1.4.2031 - 31.3.2032	= 156.7
1.4.2032 - 31.3.2033	= 117.0
1.4.2033 - 31.3.2034	= 107.5
1.4.2034 - 31.3.2035	= 110.4
1.4.2035 - 31.3.2036	= 122.8
1.4.2036 - 31.3.2037	= 122.2
1.4.2037 - 31.3.2038	= 121.8
1.4.2038 - 31.3.2039	= 102.9
1.4.2039 - 31.3.2040	= 102.9
1.4.2040 - 31.3.2041	= 103.2
1.4.2041 - 31.3.2042	= 102.9
1.4.2042 - 31.3.2043	= 102.9
1.4.2043 - 31.3.2044	= 102.9
1.4.2044 - 31.3.2045	= 103.2
1.4.2045 - 31.3.2046	= 100.4
1.4.2046 - 31.3.2047	= 161.9
1.4.2047 - 31.3.2048	= 251.7
1.4.2048 - 31.3.2049	= 221.5
1.4.2049 - 31.3.2050	= 236.2
1.4.2050 - 31.3.2051	= 212.5
1.4.2051 - 31.3.2052	= 65.9
1.4.2052 - 31.3.2053	= 227.7
1.4.2053 - 31.3.2054	= 210.7

OR

Conditioned (m ³)	Packaged (m ³)

Total future arisings: **3904.3**
Total waste volume: **3904.3**

Number of waste packages in stock: At 1.4.2025..... - packages

Comment on arising rates: Programme data is based on Life Time Plan 2024 dataset generated in December 2023.

Additional information on quantities: NRS Dounreay 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 1.20
Stock (lower): x - Arisings (lower): x 0.80

WASTE SOURCE Reactor decommissioning.

PHYSICAL CHARACTERISTICS

General description: Building materials from decommissioning, and redundant equipment; reactor components; reaction products from treatment of alkali metals.

Changes since waste generated: -

Bulk density (t/m³): = 0.73

Comment on density: Based on actuals data from Dounreay's waste consignment system. Data considered acceptable for 2025 submission.

CHEMICAL COMPOSITION

General description and components (%wt): Alkali Metal (0.11%), Aluminium (0.03%), Brass (0.01%), Cementitious material (e.g. concrete) (21.61%), Copper (0.16%), Fibreglass (0.13%), Glass (0.02%), Graphite (0.28%), Iron (0.20%), Lead (1.19%), Mild Steel (26.96%), MMF Insulation Materials (nonHaz) (0.01%), Other (4.26%), Paper (11.30%), Plastic (22.03%), Rubber (3.95%), Sodium (0.43%), Sources (TR), Stainless steel (5.26%), Uranium (TR), WEEE containing hazardous components (0.02%), WEEE not containing hazardous components (0.06%), Wood/ Wood composite (1.98%), Halogenated Plastic (TR).

Chemical state: Neutral

Sheet metal proportion / thickness: 7.72% by wt of all metals will be sheet from ventilation and ducting. Assumed sheet metal thickness is of a range between 1.6-2.5mm.
8.13% by wt of all metals will be bulk from tanks and gloveboxes.

Metals and alloys (%wt):

	(%wt)	Type(s) / Grades(s) with proportions	% of total C14 activity
Stainless steel.....	= 5.3	-	
Other ferrous metals.....	= 27.0	-	
Iron.....	= 0.20	-	
Aluminium.....	= 0.03	-	
Beryllium.....	0	-	
Cobalt.....	0	-	
Copper.....	= 0.16	-	
Lead.....	= 1.2	-	
Magnox/Magnesium.....	0	-	
Nickel.....	0	-	
Titanium.....	0	-	
Uranium.....	< 0.01	-	
Zinc.....	0	-	
Zircaloy/Zirconium.....	0	-	
Other metals.....	= 0.62	Alkali Metal 0.11%, Sodium 0.43%, Sources 0.00%, WEEE containing hazardous components 0.02%, WEEE not containing hazardous components 0.06%	

Organics (%wt):

	(%wt)	Type(s) and comment	% of total C14 activity
Total cellulotics.....	= 13.3	-	
Paper, cotton.....	= 11.3	-	
Wood.....	= 2.0	-	
Halogenated plastics.....	= 11.0	PVC	
Total non-halogenated plastics.....	= 11.0	-	
Condensation polymers.....	NE	-	
Others.....	NE	-	
Organic ion exchange materials.....	0	-	
Total rubber.....	= 3.9	-	
Halogenated rubber.....	NE	-	
Non-halogenated rubber.....	NE	-	
Hydrocarbons.....	0	-	
Oil or grease.....	0	-	
Fuel.....	NE	-	
Asphalt/Tarmac (cont.coal tar).....	0	-	
Asphalt/Tarmac (no coal tar).....	0	-	
Bitumen.....	0	-	
Others.....	NE	-	
Other organics.....	= 4.3	Other 4.26%	

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.....	0	Inc plasterboard	
Cementitious material.....	= 21.6	-	
Sand.....	0	-	
Glass/Ceramics.....	= 0.17	Glass 0.02%, Fibreglass 0.13%, MMF Insulation Materials (nonHaz) 0.01%.	
Graphite.....	= 0.28	-	
Desiccants/Catalysts.....	0	-	
Asbestos.....	0	-	
Non/low friable.....	NE	-	
Moderately friable.....	NE	-	
Highly friable.....	NE	-	
Free aqueous liquids.....	0	-	
Free non-aqueous liquids.....	0	-	
Powder/Ash.....	0	-	

COMPONENTS OF MATERIALS, WASTE PROPERTIES, MATERIALS NOT CONTRIBUTING TO MASS

Inorganic anions (%wt):

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

Materials of interest for waste acceptance criteria:

	(%wt)	Type(s) and comment
Combustible metals.....	NE	-
Low flash point liquids.....	NE	-
Explosive materials.....	NE	-
Phosphorus.....	NE	-
Hydrides.....	NE	-
Biological etc. materials.....	NE	-
Biodegradable materials.....	= 0	-
Putrescible wastes.....	NE	-
Non-putrescible wastes.....	NE	-
Corrosive materials.....	NE	-
Pyrophoric materials.....	NE	-
Generating toxic gases.....	NE	-
Reacting with water.....	= 0.43	Sodium
Higher activity particles.....	NE	-
Soluble solids as bulk chemical compounds.....	NE	-

Hazardous substances / non hazardous pollutants:

	(%wt)	Type(s) and comment
Acrylamide.....	NE	-
Benzene.....	= 0	-
Chlorinated solvents.....	NE	-
Formaldehyde.....	NE	-
Organometallics.....	NE	-
Phenol.....	NE	-
Styrene.....	NE	-
Tri-butyl phosphate.....	NE	-
Other organophosphates.....	NE	-
Vinyl chloride.....	NE	-
Arsenic.....	= 0	-
Barium.....	-	-
Boron.....	= 0	-
Boron (in Boral).....	NE	-
Boron (non-Boral).....	NE	-
Cadmium.....	= 0	-
Caesium.....	NE	-
Selenium.....	= 0	-
Chromium.....	= 0	-
Molybdenum.....	= 0	-
Thallium.....	NE	-
Tin.....	= 0	-
Vanadium.....	= 0	-
Mercury compounds.....	= 0	-
Others.....	-	-

Complexing agents (%wt):

No		
	(%wt)	Type(s) and comment
EDTA.....	NE	-
DPTA.....	NE	-
NTA.....	NE	-
Polycarboxylic acids.....	NE	-
Other organic complexants.....	NE	-
Total complexing agents.....	= 0	-

Physical components:

	Number	Type(s) and comment
Sources.....	= 17	Solid LLW Cs137, Mn54, Am241, Cl36, Pu239, Sr90, Tc99.
Electronic & Electrical Equipment (EEE)	-	-
EEE Type 1.....	= 4	Fluorescent Light Fittings.
EEE Type 2.....	= 19	Hand and Foot Monitor, ICAMS, Tritium Sampler, Monitoring Equipment, Transporter Bridge and Trolley.
EEE Type 3.....	-	-
EEE Type 4.....	-	-
EEE Type 5.....	-	-

TREATMENT, PACKAGING AND DISPOSAL

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

Treatment	On-site / Off-site	Stream volume %
Size reduction	On-site	= 3.7
Decay storage		
Low force compaction	On-site	= 49.3
Supercompaction (HFC)		
Incineration	On-site	= 96.3
Drying/dewatering/liquid separation		
Tie down/fixatives/strippable coating/painting application		
Decontamination		
Metal treatment		
Recycling / reuse		
Thermal treatment, including vitrification		
Encapsulation		
Polymer encapsulation		
Other physical treatment		
Other chemical treatment		
Containerisation		
Treatment not yet determined		
None		

Comments on planned treatments:

49.3 % of 200L drums will be supercompacted before being placed in HHISOs. HHISOs filled with bulk waste, compacted drums, or a mix of both will be encapsulated before final disposal.

NRS Dounreay 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.

Conditioning method:

LLW will be grouted into non IP rated HHISOs through a dedicated grouting facility.

Conditioning plants:

Plant Name	Location

Likely conditioning matrix:

Non-standard

Further information on the conditioning matrix:

Dounreay uses: Cement OPC 1:3 PFA ~35% water content and plasticiser.

Waste Packaging:

Likely container type:

Container	Waste packaged (vol%)	Waste loading (m³)	Payload (m³)	Number of packages	Estimated start date for packaging
Non IP-2 rated 1/2 Height ISO (DC02)	100.0	12.0	15.6	326	-

Range in container waste loading:

The waste loading value is a rough average using previously consigned waste data. Waste loading per ISO can vary significantly, based on how the container is loaded. In general, bulk items leads to a lower waste loading value where as compactable leads to a higher one. Most containers contain a mix of the two.

Other information on packaging and conditioning:

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 NRS Dounreay LLW Disposal Facility. Each HHISO may have other LLW items in the final HHISO.

Conditioned density (t/m³):

~ 2.0

Conditioned density comment:

This value is the midpoint between a range of densities going from 1.49-2.47. These were taken from HHISOs disposed of in NRSD LLW Disposal Vaults

Management Routes:

Disposal Route	Stream volume %	Raw density t/m ³	Start date
Expected to be consigned to a Near Site, Near Surface Disposal Facility (Scotland)	= 100.0		
Expected to be Non-NSD HAW managed under Scottish Government's policy			
Expected to be disposed to LLW Vaults NRS Dounreay			
Expected to be consigned to the Geological Disposal Facility			
Expected to be consigned to a Near Surface Disposal Facility			
Expected to be consigned to the LLW Repository			
Expected to be consigned to a Landfill Facility			
Expected to be disposed On-Site			
Expected to be managed by In-Situ Disposal			
Expected to be consigned to an Incineration Facility			
Expected to be consigned to a Metal Treatment Facility			
Expected to be Out of Scope			
Expected to be recycled / reused			
Disposal route not known			

Classification codes for waste expected to be consigned to a landfill facility:

Opportunities for alternative disposal routing: Yes

Baseline Management Route	Opportunity Management Route	Stream volume (%)	Opportunity Confidence	Comment
Dounreay LLWDV	Incineration facility	< 49.3	GREEN	This opportunity is still at an early stage of development. A small scale trial has taken place. This can potentially divert up to all compactable LLW. The incinerables waste route % is a theoretical maximum based on 100% of drummed LLW being suitable for incineration. This % is subject to further review by NRS Dounreay.
Dounreay LLWDV	Metal treatment facility	~ 20.4	GREEN	This opportunity is still at an early stage of development. A small scale trial has taken place. This can potentially divert up to all compactable LLW. The metallic waste treatment route % remains indicative and is subject to further review and characterisation by NRS Dounreay.

RADIOACTIVITY

Source: The radioactivity arises from contamination of reactor building construction materials.

Uncertainty: Within a factor of 10 for arisings.

Measurement of radioactivities: From modelling results and waste consignor's declarations.

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.
- Se-79: -
- Tc-99: -
- 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.

WASTE STREAM 5B301 Prototype Fast Reactor LLW									
Nuclide	Mean radioactivity, TBq/m³				Nuclide	Mean radioactivity, TBq/m³			
	Waste at 1.4.2025	Bands and Code	Future Arisings	Bands and Code		Waste at 1.4.2025	Bands and Code	Future Arisings	Bands and Code
H 3			= 5.63E-05	C C 2	Gd 153				
Be 10					Ho 163				
C 14					Ho 166m				
Na 22			= 1.18E-08	C C 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					Ti 204				
Mn 54			= 1.84E-13	C C 2	Pb 205				
Fe 55					Pb 210			= 1.52E-21	C C 2
Co 60			= 9.77E-06	C C 2	Bi 208				
Ni 59					Bi 210m				
Ni 63					Po 210			= 1.08E-21	C C 2
Zn 65					Ra 223			= 7.00E-18	C C 2
Se 79					Ra 225			= 3.81E-22	C C 2
Kr 81					Ra 226			= 3.38E-20	C C 2
Kr 85					Ra 228			= 4.76E-25	C C 2
Rb 87					Ac 227			= 7.27E-18	C C 2
Sr 90			= 4.13E-06	C C 2	Th 227			= 7.00E-18	C C 2
Zr 93					Th 228			= 1.82E-25	C C 2
Nb 91					Th 229			= 3.93E-22	C C 2
Nb 92					Th 230			= 3.89E-17	C C 2
Nb 93m					Th 232			= 2.34E-24	C C 2
Nb 94					Th 234			= 5.49E-12	C C 2
Mo 93					Pa 231			= 8.11E-17	C C 2
Tc 97					Pa 233			= 1.82E-13	C C 2
Tc 99					U 232				
Ru 106					U 233			= 2.19E-18	C C 2
Pd 107					U 234			= 1.40E-12	C C 2
Ag 108m					U 235			= 6.40E-13	C C 2
Ag 110m					U 236			= 1.58E-14	C C 2
Cd 109			= 4.11E-13	C C 2	U 238			= 5.49E-12	C C 2
Cd 113m					Np 237			= 1.86E-13	C C 2
Sn 119m					Pu 236				
Sn 121m					Pu 238			= 8.07E-08	C C 2
Sn 123					Pu 239			= 6.09E-08	C C 2
Sn 126					Pu 240			= 9.02E-08	C C 2
Sb 125					Pu 241			= 3.35E-06	C C 2
Sb 126					Pu 242				
Te 125m					Am 241			= 1.13E-07	C C 2
Te 127m					Am 242m				
I 129					Am 243				
Cs 134			= 2.70E-14	C C 2	Cm 242			= 2.12E-14	C C 2
Cs 135					Cm 243				
Cs 137			= 7.50E-05	C C 2	Cm 244			= 1.03E-09	C C 2
Ba 133			= 5.73E-10	C C 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					Unsp a				
Eu 152					Unsp b/g				
Eu 154					Total a	0	*	3.46E-07	*
Eu 155			= 1.78E-10	C C 2	Total b/g	0	*	1.49E-04	*

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 the 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
* Total calculated from the 114 declared radionuclides