

WASTE STREAM	5B304	Dounreay Fast Reactor ILW
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SITE Dounreay

SITE OWNER Nuclear Decommissioning Authority

WASTE CUSTODIAN Nuclear Restoration Services Ltd (NRS)

WASTE TYPE ILW

WASTE VOLUMES

	Reported (m ³)	OR	Conditioned (m ³)	Packaged (m ³)
Stocks:	At 1.4.2025	0		
Future arisings:	1.4.2025 - 31.3.2026	= 0.2		
	1.4.2026 - 31.3.2027	= 0.4		
	1.4.2027 - 31.3.2028	= 0.1		
	1.4.2028 - 31.3.2029	= 0.4		
	1.4.2032 - 31.3.2033	= 5.0		
	1.4.2033 - 31.3.2034	= 24.0		
	1.4.2034 - 31.3.2035	= 6.1		
	1.4.2035 - 31.3.2036	= 0.1		
	1.4.2037 - 31.3.2038	= 15.2		
	1.4.2038 - 31.3.2039	= 35.7		
	1.4.2039 - 31.3.2040	= 0.8		
	1.4.2040 - 31.3.2041	= 7.2		
	1.4.2042 - 31.3.2043	= 14.2		
	1.4.2043 - 31.3.2044	= 13.5		
	1.4.2045 - 31.3.2046	= 119.4		
	1.4.2046 - 31.3.2047	= 7.3		
Total future arisings:		249.6		
Total waste volume:		249.6		

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

Comment on arising rates: Waste arisings dates are based on Dounreay's Lifetime Plan 2024 as generated at December 2023.

Additional information on quantities: -

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: The waste will include reactor components, mainly irradiated steels, graphite, pipework which has been NaK cleaned and fuel cladding. Some items may be size reduced during decommissioning operations. There may be items of a large or heavy nature requiring special consideration.

Changes since waste generated: -

Bulk density (t/m³): = 1.4

Comment on density: The bulk density is based on Consignor's records.

CHEMICAL COMPOSITION

General description and components (%wt): Aluminium (0.04%), Asbestos (TR), Copper (TR), Graphite (50.73%), Lead (0.05%), Mild Steel (1.84%), Other (2.55%), Rubber (TR), Stainless steel (44.78%).

Chemical state: Neutral

Sheet metal proportion / thickness: 0.32% 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.
1.37% 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.....	= 44.8	-	
Other ferrous metals.....	= 1.8	-	
Iron.....	0	-	
Aluminium.....	= 0.04	-	
Beryllium.....	0	-	
Cobalt.....	0	-	
Copper.....	< 0.01	-	
Lead.....	= 0.05	-	
Magnox/Magnesium.....	= 0	-	
Nickel.....	= 0	-	
Titanium.....	= 0	-	
Uranium.....	= 0	-	
Zinc.....	= 0	-	
Zircaloy/Zirconium.....	= 0	-	
Other metals.....	= 0	-	

Organics (%wt):

	(%wt)	Type(s) and comment	% of total C14 activity
Total cellulotics.....	= 0	-	
Paper, cotton.....	= 0	-	
Wood.....	= 0	-	
Halogenated plastics.....	= 0	-	
Total non-halogenated plastics.....	= 0	-	
Condensation polymers.....	NE	-	
Others.....	NE	-	
Organic ion exchange materials.....	0	-	
Total rubber.....	< 0.01	-	
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.....	= 2.5	-	

Other materials (%wt):

	(%wt)	Type(s) and comment	% of total C14 activity
Inorganic ion exchange materials.....	= 0	-	100.0
Inorganic sludges and flocs.....	= 0	-	
Soil.....	= 0	-	
Brick/Stone/Rubble.....	= 0	-	
Cementitious material.....	= 0	-	
Sand.....	= 0	-	
Glass/Ceramics.....	= 0	-	
Graphite.....	= 50.7	Reactor Component	
Desiccants/Catalysts.....	0	-	
Asbestos.....	< 0.01	-	
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	-
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.....	NE	-
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.....	NE	-

Complexing agents (%wt):

Not yet determined		
	(%wt)	Type(s) and comment
EDTA.....	NE	-
DPTA.....	NE	-
NTA.....	NE	-
Polycarboxylic acids.....	NE	-
Other organic complexants.....	NE	-
Total complexing agents.....	NE	-

Physical components:

	Number	Type(s) and comment
Sources.....	= 0	-
Electronic & Electrical Equipment (EEE)		
EEE Type 1.....	= 0	-
EEE Type 2.....	= 0	-
EEE Type 3.....	= 0	-
EEE Type 4.....	= 0	-
EEE Type 5.....	= 0	-

TREATMENT, PACKAGING AND DISPOSAL

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

Treatment	On-site / Off-site	Stream volume %
Size reduction Decay storage Low force compaction Supercompaction (HFC) Incineration 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	On-site	= 100.0

Comments on planned treatments:

ILW waste will be packaged into 6m³ Robust Concrete Boxes and grouted in a new facility at DFR.

Conditioning method:

Current reference strategy is for packaging of ILW into 6m³ Robust Concrete Boxes and grouted in a new facility at DFR.

Conditioning plants:

Plant Name	Location
DFR Waste Packaging Plant	Dounreay

Likely conditioning matrix:

Non-standard

Further information on the conditioning matrix:

Dounreay will use: Cement OPC 1:3 PFA (~41% water).

Waste Packaging:

Likely container type:

Container	Waste packaged (vol%)	Waste loading (m ³)	Payload (m ³)	Number of packages	Estimated start date for packaging
6 m ³ concrete box (SD)	100.0	3.5	5.7	73	-

Range in container waste loading:

Not established.

Other information on packaging and conditioning:

Suitability for disposal in a Near Surface Disposal Facility has yet to be confirmed.

Conditioned density (t/m³):

~ 2.5

Conditioned density comment:

The density is likely to be around 2-3t/m³.

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
Non-NSDF HAW	Dounreay LLWDV	< 53.0	RED	It is possible that further characterisation will show that the Primary Circuit & Graphite can be categorised as Low Level Waste and will be suitable for Metal Treatment or disposal at Dounreay's Low Level Waste Disposal Facility
Non-NSDF HAW	Metal treatment facility	~ 47.0	AMBER	It is possible that further characterisation will show that the Primary Circuit & Graphite can be categorised as Low Level Waste and will be suitable for Metal Treatment or disposal at Dounreay's Low Level Waste Disposal Facility. The metallic waste treatment route % remains indicative and is subject to further review and characterisation by NRS Dounreay

RADIOACTIVITY

Source: The main sources of activity are activated and contaminated equipment/structures.

Uncertainty: -

Measurement of radioactivities: Data taken from LoC

Chemical form of radionuclides:

- H-3: May be present in tritiated steel and graphite.
- C-14: Will be present in graphite.
- Cl-36: Likely to be present.
- Se-79: -
- Tc-99: -
- I-129: Likely to be present.
- Ra: Not expected to be present.
- Th: Not expected to be present.
- U: Expected to be present at low levels as oxide.
- Np: -
- Pu: Expected to be present at low levels as oxide.

WASTE STREAM 5B304 Dounreay Fast Reactor ILW									
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			= 1.51E-01	C C 2	Gd 153				
Be 10			= 4.15E-07	C C 2	Ho 163			= 3.81E-07	C C 2
C 14			= 2.36E-02	C C 2	Ho 166m			= 4.08E-05	C C 2
Na 22			= 9.48E-08	C C 2	Tm 170				
Al 26					Tm 171			= 7.03E-09	C C 2
Cl 36			= 1.94E-05	C C 2	Lu 174			= 6.11E-08	C C 2
Ar 39			= 6.98E-02	C C 2	Lu 176			= 1.55E-10	C C 2
Ar 42			= 1.02E-09	C C 2	Hf 178n			= 6.84E-06	C C 2
K 40			= 5.65E-08	C C 2	Hf 182			= 2.49E-12	C C 2
Ca 41			= 7.97E-05	C C 2	Pt 193			= 2.43E-04	C C 2
Mn 53			= 1.09E-08	C C 2	Ti 204			= 2.75E-04	C C 2
Mn 54					Pb 205			= 6.41E-09	C C 2
Fe 55			= 1.06E-02	C C 2	Pb 210			= 1.31E-09	C C 2
Co 60			= 3.54E-01	C C 2	Bi 208			= 4.27E-08	C C 2
Ni 59			= 3.35E-02	C C 2	Bi 210m			= 7.43E-09	C C 2
Ni 63			= 1.67E+00	C C 2	Po 210			= 1.33E-09	C C 2
Zn 65					Ra 223			= 4.82E-08	C C 2
Se 79			= 1.06E-06	C C 2	Ra 225			= 2.33E-08	C C 2
Kr 81			= 4.93E-07	C C 2	Ra 226			= 1.45E-12	C C 2
Kr 85			= 3.14E-04	C C 2	Ra 228			= 1.91E-08	C C 2
Rb 87			= 5.10E-08	C C 2	Ac 227			= 4.91E-08	C C 2
Sr 90			= 4.47E-08	C C 2	Th 227			= 4.79E-08	C C 2
Zr 93			= 6.06E-07	C C 2	Th 228			= 1.28E-05	C C 2
Nb 91			= 2.20E-04	C C 2	Th 229			= 2.34E-08	C C 2
Nb 92			= 3.32E-08	C C 2	Th 230			= 9.16E-11	C C 2
Nb 93m			= 1.51E+00	C C 2	Th 232			= 1.92E-08	C C 2
Nb 94			= 1.91E-02	C C 2	Th 234			= 3.54E-08	C C 2
Mo 93			= 4.99E-02	C C 2	Pa 231			= 2.82E-07	C C 2
Tc 97			= 5.52E-09	C C 2	Pa 233			= 3.06E-09	C C 2
Tc 99			= 1.50E-03	C C 2	U 232			= 1.39E-05	C C 2
Ru 106			= 1.75E-19	C C 2	U 233			= 6.08E-06	C C 2
Pd 107			= 9.68E-10	C C 2	U 234			= 1.21E-07	C C 2
Ag 108m			= 5.38E-05	C C 2	U 235			= 1.61E-09	C C 2
Ag 110m					U 236			= 2.43E-10	C C 2
Cd 109			= 1.99E-11	C C 2	U 238			= 3.55E-08	C C 2
Cd 113m			= 2.51E-03	C C 2	Np 237			= 3.06E-09	C C 2
Sn 119m					Pu 236			= 3.81E-12	C C 2
Sn 121m			= 3.89E-04	C C 2	Pu 238			= 8.32E-06	C C 2
Sn 123					Pu 239			= 3.48E-05	C C 2
Sn 126			= 3.47E-12	C C 2	Pu 240			= 2.87E-06	C C 2
Sb 125			= 1.42E-06	C C 2	Pu 241			= 6.10E-06	C C 2
Sb 126			= 3.47E-12	C C 2	Pu 242			= 6.93E-11	C C 2
Te 125m			= 3.37E-07	C C 2	Am 241			= 1.26E-06	C C 2
Te 127m					Am 242m			= 4.70E-09	C C 2
I 129			= 3.58E-10	C C 2	Am 243			= 7.87E-11	C C 2
Cs 134			= 8.11E-08	C C 2	Cm 242			= 3.92E-09	C C 2
Cs 135			= 1.40E-09	C C 2	Cm 243			= 2.75E-10	C C 2
Cs 137			= 2.95E-06	C C 2	Cm 244			= 4.35E-10	C C 2
Ba 133			= 2.10E-03	C C 2	Cm 245			= 8.89E-14	C C 2
La 137			= 7.20E-06	C C 2	Cm 246			= 2.78E-15	C C 2
La 138			= 2.67E-12	C C 2	Cm 248			= 7.75E-21	C C 2
Ce 144					Cf 249				
Pm 145			= 3.89E-06	C C 2	Cf 250				
Pm 147			= 2.11E-08	C C 2	Cf 251				
Sm 147			= 2.54E-10	C C 2	Cf 252				
Sm 151			= 7.99E-05	C C 2	Unsp a				
Eu 152			= 5.29E-04	C C 2	Unsp b/g				
Eu 154			= 2.35E-04	C C 2	Total a	0	*	8.07E-05	*
Eu 155			= 5.38E-06	C C 2	Total b/g	0	*	3.90E+00	*

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