

WASTE STREAM	5B339	PIE Facility LLW
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SITE Dounreay

SITE OWNER Nuclear Decommissioning Authority

WASTE CUSTODIAN Nuclear Restoration Services Ltd (NRS)

WASTE TYPE LLW

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	132.5		
	1.4.2026 - 31.3.2027	170.6		
	1.4.2027 - 31.3.2028	154.2		
	1.4.2028 - 31.3.2029	237.4		
	1.4.2029 - 31.3.2030	110.1		
Total future arisings:		804.7		
Total waste volume:		804.7		

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

Comment on arising rates: Arisings dates are based on the Dounreay 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 Decommissioning of Post Irradiation Examination (PIE) facility.

PHYSICAL CHARACTERISTICS

General description: Metallic cell waste, concrete cell blocks contaminated to LLW levels, and rubble. Items will be size reduced where practicable during decommissioning.

Changes since waste generated: -

Bulk density (t/m³): = 0.60

Comment on density: The Bulk Density is based on consignor's record.

CHEMICAL COMPOSITION

General description and components (%wt): Aluminium (TR), Asbestos (1.86%), Asphalt (3.46%), Batteries and Accumulators (TR), Cementitious material (e.g. concrete) (28.01%), Ceramics (TR), Copper (2.57%), Fabric (TR), Fibreglass (5.34%), Glass (0.11%), Gypsum Plasterboard/ Fibreboard (0.87%), Iron (0.11%), Lead (0.03%), Mild Steel (21.48%), Other (1.50%), Other organics (0.06%), Paper (7.32%), Plastic (20.45%), Rubber (2.29%), Wood/ Wood composite (4.52%),

Chemical state: Neutral

Sheet metal proportion / thickness: 2.57% 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.
0.63% 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.....	0	assumed M316	
Other ferrous metals.....	= 21.5	mild steel	
Iron.....	= 0.11	-	
Aluminium.....	= 0.01	-	
Beryllium.....	0	-	
Cobalt.....	0	-	
Copper.....	= 2.6	-	
Lead.....	= 0.03	-	
Magnox/Magnesium.....	= 0	-	
Nickel.....	= 0	-	
Titanium.....	= 0	-	
Uranium.....	= 0	-	
Zinc.....	= 0	-	
Zircaloy/Zirconium.....	= 0	-	
Other metals.....	< 0.01	others	

Organics (%wt):

	(%wt)	Type(s) and comment	% of total C14 activity
Total cellulose.....	= 11.8	-	
Paper, cotton.....	= 7.3	-	
Wood.....	= 4.5	-	
Halogenated plastics.....	= 10.2	-	
Total non-halogenated plastics.....	= 10.2	-	
Condensation polymers.....	NE	-	
Others.....	NE	-	
Organic ion exchange materials.....	0	-	
Total rubber.....	= 2.3	-	
Halogenated rubber.....	NE	-	
Non-halogenated rubber.....	NE	-	
Hydrocarbons.....	= 3.5	-	
Oil or grease.....	0	-	
Fuel.....	NE	-	
Asphalt/Tarmac (cont.coal tar).....	0	-	
Asphalt/Tarmac (no coal tar).....	= 3.5	-	
Bitumen.....	0	-	
Others.....	NE	-	
Other organics.....	= 1.6	Other organics 0.06%, Other 1.50%,	

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.....	= 0.87	-	
Cementitious material.....	= 28.0	-	
Sand.....	0	-	
Glass/Ceramics.....	= 5.5	Ceramics 0.00%, Glass 0.11%, Fibreglass 5.34%,	
Graphite.....	0	-	
Desiccants/Catalysts.....	0	-	
Asbestos.....	= 1.9	-	
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.....	= 0.87	Gypsum
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.....	= 1	-
EEE Type 2.....	= 1	-
EEE Type 3.....	= 19	-
EEE Type 4.....	= 12	-
EEE Type 5.....	= 0	-

TREATMENT, PACKAGING AND DISPOSAL

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

Treatment	On-site / Off-site	Stream volume %
Size reduction	On-site	= 49.0
Decay storage		
Low force compaction		
Supercompaction (HFC)		
Incineration		
Drying/dewatering/liquid separation	On-site	= 100.0
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% of the waste stream will be supercompacted in 200L drums before being placed in HHISOs. HHISOs filled with bulk waste, compacted drums or a mixture of both will be encapsulated before final disposal.

Conditioning method:

For LLW, waste will be grouted into non IP2 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	12.8	15.6	63	-

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: There is an opportunity that when the facility's cell blocks are decommissioned their waste category may change to Demolition LLW and as such, would not be disposed in containers, but as blocks. The waste will consist of large uncompactable items and 200 litre drums that have already been compacted. The waste will be loaded into an alternative non-IP2 rated LLW Disposal HHISO for transfer to the Dounreay LLW Disposal Facility. Each HHISO may have LLW items from other wastestreams 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/m³	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	< 49.0	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 49% is theoretical maximum based on 100% drummed LLW being suitable for incineration. The 49% is subject to further review by NRS Dounreay.

RADIOACTIVITY

Source: The north cell has handled PFR wrapper sections and other materials which contain cobalt 60 from irradiation in PFR. Analysis of samples from the cells in 2005 indicated a low percentage of a activity and significant quantities of europium radionuclides. These europium radionuclides are the result of destructive examination of capsules containing europium hexaboride after irradiation in DFR. The south cell has handled DFR breeder elements with the dominant beta/gamma radionuclides being caesium 137 and strontium 90. All other radionuclides are expected to be negligible by comparison.

Uncertainty: The estimates are within a factor of ten.

Measurement of radioactivities: The activity is taken from waste consignor's declarations.

Chemical form
of radionuclides:

H-3: -
C-14: -
Cl-36: Not likely to be present.
Se-79: -
Tc-99: -
I-129: Not likely to be present.
Ra: -
Th: -
U: Likely to be present as oxides.
Np: -
Pu: Likely to be present as oxides.

WASTE STREAM 5B339 PIE Facility 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					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					Ti 204				
Mn 54					Pb 205				
Fe 55					Pb 210			= 7.13E-17	C C 2
Co 60			= 4.97E-06	C C 2	Bi 208				
Ni 59					Bi 210m				
Ni 63					Po 210			= 5.46E-17	C C 2
Zn 65					Ra 223			= 7.33E-15	C C 2
Se 79					Ra 225			= 8.59E-23	C C 2
Kr 81					Ra 226			= 1.20E-15	C C 2
Kr 85					Ra 228			= 2.82E-20	C C 2
Rb 87					Ac 227			= 7.62E-15	C C 2
Sr 90			= 3.50E-05	C C 2	Th 227			= 7.34E-15	C C 2
Zr 93					Th 228			= 1.34E-20	C C 2
Nb 91					Th 229			= 8.85E-23	C C 2
Nb 92					Th 230			= 9.26E-13	C C 2
Nb 93m					Th 232			= 9.78E-20	C C 2
Nb 94					Th 234			= 2.27E-09	C C 2
Mo 93					Pa 231			= 8.50E-14	C C 2
Tc 97					Pa 233			= 3.81E-14	C C 2
Tc 99					U 232				
Ru 106					U 233			= 4.81E-19	C C 2
Pd 107					U 234			= 1.68E-08	C C 2
Ag 108m					U 235			= 6.70E-10	C C 2
Ag 110m					U 236			= 3.30E-10	C C 2
Cd 109					U 238			= 2.27E-09	C C 2
Cd 113m					Np 237			= 3.88E-14	C C 2
Sn 119m					Pu 236				
Sn 121m					Pu 238			= 9.40E-09	C C 2
Sn 123					Pu 239			= 1.01E-06	C C 2
Sn 126					Pu 240			= 1.40E-07	C C 2
Sb 125					Pu 241			= 2.01E-07	C C 2
Sb 126					Pu 242				
Te 125m					Am 241			= 2.09E-08	C C 2
Te 127m					Am 242m				
I 129					Am 243				
Cs 134					Cm 242			= 4.94E-14	C C 2
Cs 135					Cm 243				
Cs 137			= 2.62E-05	C C 2	Cm 244				
Ba 133					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			= 9.44E-06	C C 2	Unsp b/g				
Eu 154			= 7.24E-06	C C 2	Total a	0	*	1.20E-06	*
Eu 155			= 3.84E-08	C C 2	Total b/g	0	*	8.31E-05	*

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