

WASTE STREAM	5B02	Low Alpha RHILW
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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:	1.4.2038 - 31.3.2039	= 85.8		
	1.4.2039 - 31.3.2040	= 90.3		
	1.4.2040 - 31.3.2041	= 90.6		
	1.4.2041 - 31.3.2042	= 90.3		
	1.4.2042 - 31.3.2043	= 90.3		
	1.4.2043 - 31.3.2044	= 32.8		
Total future arisings:		480.1		
Total waste volume:		480.1		

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

Comment on arising rates: The waste will be retrieved from a former storage facility for packaging and interim storage at about 137 m³/year. Programme is from Dounreay's provisional Lifetime Plan 2024 as at December 2023.

Additional information on quantities: The volume quoted is the recorded disposal volume of the solid waste plus an assessment of the sludge volume.

Uncertainty factors on volumes: Stock (upper): x - Arisings (upper): x 1.05
Stock (lower): x - Arisings (lower): x 0.95

WASTE SOURCE Redundant and waste items from various cell operations including PIE, analytical, defuelling, POCO as well as routine operations.

PHYSICAL CHARACTERISTICS

General description: A range of solid wastes is included in the stream. These are redundant metallic reactor components, metallic fuel element debris and cladding, redundant equipment and tools, discarded plastics from bag posting operations and wrappings on undrummed components and gaiters, and metallic components from plant decommissioning and refurbishment work. Small items include manipulator jaws and tools etc. Sludge is thought to be present from direct consignments and from degradation of some of the solid wastes. A number of items were contained in steel drums or cans. Large items and heavy items are known to have been consigned to the Silo. The solid wastes will normally be shredded prior to radiological characterisation.

Changes since waste generated: The waste will have undergone changes in the water filled silo, the current form of much of it is unknown.

Bulk density (t/m³): = 1.4

Comment on density: The density has been determined through total estimated mass of waste / volume of waste. From S&S ILoC Table 1.

CHEMICAL COMPOSITION

General description and components (%wt): Glass (1.5%), PVC (13.1%), Polythene (0.6%), Paper (1.5%), Aluminium (3.5%), Mild Steel (41.8%), Stainless Steel (35.4%), Lead (2.2%), Concrete/rubble (0.4%). Composition of solid waste only.

Chemical state: Neutral

Sheet metal proportion / thickness: Both sheet and bulk metals are likely to be present, proportions not specified.

Metals and alloys (%wt):

	(%wt)	Type(s) / Grades(s) with proportions	% of total C14 activity
Stainless steel.....	= 35.4	-	The waste is known to contain approximately 95 kg of niobium.
Other ferrous metals.....	= 41.8	-	
Iron.....		-	
Aluminium.....	= 3.5	-	
Beryllium.....	P	-	
Cobalt.....	TR	-	
Copper.....	TR	-	
Lead.....	= 2.2	-	
Magnox/Magnesium.....	= 0	-	
Nickel.....	NE	-	
Titanium.....	NE	-	
Uranium.....	P	-	
Zinc.....	NE	-	
Zircaloy/Zirconium.....	P	-	
Other metals.....	TR	-	

Organics (%wt):

	(%wt)	Type(s) and comment	% of total C14 activity
Total cellulotics.....	~ 1.5	-	
Paper, cotton.....	~ 1.5	-	
Wood.....	NE	-	
Halogenated plastics.....	~ 13.1	-	
Total non-halogenated plastics.....	~ 0.60	-	
Condensation polymers.....	= 0	-	
Others.....	~ 0.60	-	
Organic ion exchange materials.....	P	-	
Total rubber.....	NE	-	
Halogenated rubber.....	NE	-	
Non-halogenated rubber.....	NE	-	
Hydrocarbons.....	NE	-	
Oil or grease.....	NE	-	
Fuel.....	NE	-	
Asphalt/Tarmac (cont.coal tar).....	NE	-	
Asphalt/Tarmac (no coal tar).....	NE	-	
Bitumen.....	NE	-	
Others.....	NE	-	
Other organics.....	TR	-	

Other materials (%wt):

	(%wt)	Type(s) and comment	% of total C14 activity
Inorganic ion exchange materials.....	P	-	
Inorganic sludges and flocs.....	P	-	
Soil.....	= 0	-	
Brick/Stone/Rubble.....	P	-	
Cementitious material.....	= 0.40	-	
Sand.....	NE	-	
Glass/Ceramics.....	= 1.5	-	
Graphite.....	= 0	-	
Desiccants/Catalysts.....	NE	-	
Asbestos.....	NE	-	
Non/low friable.....	NE	-	
Moderately friable.....	NE	-	
Highly friable.....	NE	-	
Free aqueous liquids.....	NE	-	
Free non-aqueous liquids.....	NE	-	
Powder/Ash.....	NE	-	

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

Inorganic anions (%wt):

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

Materials of interest for waste acceptance criteria:

	(%wt)	Type(s) and comment
Combustible metals.....	NE	-
Low flash point liquids.....	= 0	-
Explosive materials.....	= 0	-
Phosphorus.....	= 0	-
Hydrides.....	NE	-
Biological etc. materials.....	= 0	-
Biodegradable materials.....	P	-
Putrescible wastes.....	NE	-
Non-putrescible wastes.....	NE	-
Corrosive materials.....	NE	-
Pyrophoric materials.....	P	May be trace quantities
Generating toxic gases.....	= 0	-
Reacting with water.....	NE	-
Higher activity particles.....	P	Active swarf known to have been disposed - quantity not determined
Soluble solids as bulk chemical compounds.....	NE	-

Hazardous substances / non hazardous pollutants:

-

	(%wt)	Type(s) and comment
Acrylamide.....	-	-
Benzene.....	NE	-
Chlorinated solvents.....	NE	-
Formaldehyde.....	NE	-
Organometallics.....	NE	-
Phenol.....	NE	-
Styrene.....	NE	-
Tri-butyl phosphate.....	NE	-
Other organophosphates.....	NE	-
Vinyl chloride.....	NE	-
Arsenic.....	NE	-
Barium.....	NE	-
Boron.....	NE	-
Boron (in Boral).....	NE	-
Boron (non-Boral).....	NE	-
Cadmium.....	NE	-
Caesium.....	NE	-
Selenium.....	NE	-
Chromium.....	NE	-
Molybdenum.....	NE	-
Thallium.....	NE	-
Tin.....	NE	-
Vanadium.....	NE	-
Mercury compounds.....	NE	-
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	Decontamination reagents on swabs may be present.
Total complexing agents.....	NE	-

Physical components:

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

TREATMENT, PACKAGING AND DISPOSAL

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

Treatment	On-site / Off-site	Stream volume %
Size reduction	On-site	= 95.0
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	On-site	= 95.0
Encapsulation		
Polymer encapsulation		
Other physical treatment		
Other chemical treatment		
Containerisation		
Treatment not yet determined		
None		

Comments on planned treatments:

Majority of items will go through shredder and supercompaction prior to encapsulation in 500L drums. Some items will bypass the initial stage to prevent damage to shredder / compactor or from wastes that pose additional challenges to consignment (such as fissile limits).

Conditioning method:

-

Conditioning plants:

Plant Name	Location
Shaft & Silo Retrieval and Processing Facility	Dounreay

Likely conditioning matrix:

Non-standard

Further information on the conditioning matrix:

Dounreay uses OPC 1:3 PFA 42% water.

Waste Packaging:

Likely container type:

Container	Waste packaged (vol%)	Waste loading (m³)	Payload (m³)	Number of packages	Estimated start date for packaging
500 l drum	5.0	0.55	0.50	44	-
500 l drum (pucks)	95.0	0.55	0.50	835	-

Range in container waste loading:

There will be different waste loadings in the 500 l drums dependant if being used for compacted solids, non-compacted solids or sludge waste. Presented likely container type is for compacted solids.

Other information on packaging and conditioning:

Data will be confirmed or amended as necessary as the plant design and process are further developed.

Conditioned density (t/m³):

~ 3.0

Conditioned density comment:

Average conditioned 500L drum mass to be ~1.5 te. Max conditioned 500L drum mass to be <2te. This gives 3-4 te/m³. From S&S ILoC.

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: No

Baseline Management Route	Opportunity Management Route	Stream volume (%)	Opportunity Confidence	Comment
-	-	-	-	-

RADIOACTIVITY

Source: The main sources of activity are activated reactor components, activated and contaminated fuel element debris and cladding, and contaminated redundant equipment and small tools.

Uncertainty: The specific activity is based on the estimated total activity divided by the bulk volume of the solid waste. This assumes that the sludge occupies the voidage in the solid waste.

Measurement of radioactivities: Records have been kept for fissile material which have been used to estimate the activity in the waste. Data for Cm246-Cf252 inferred from PFR raffinate data (FISPIN results).

Chemical form of radionuclides: H-3: Likely to be present in corrosion resistant stainless steel from reactor operations.
C-14: Possibly present in steels, PVC and polythene. Unlikely to be present in significant quantities.

Cl-36: -

Se-79: -

Tc-99: -

I-129: -

Ra: Possibly present in sources.

Th: Likely to be present.

U: Likely to be present as metal, alloyed with Cr, Mo and possibly Al, oxides and also within the sludge.

Np: -

Pu: Likely to be associated with uranium and in cemented liquors.

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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			< 1.25E-04	A 3	Gd 153				
Be 10					Ho 163				
C 14			< 6.27E-05	A 3	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			< 2.44E-12	A 3
Co 60			< 1.66E-01	A 3	Bi 208				
Ni 59			< 1.55E-02	A 3	Bi 210m				
Ni 63			< 4.43E-01	A 3	Po 210			< 2.29E-12	A 3
Zn 65					Ra 223			< 1.26E-09	A 3
Se 79			< 4.13E-07	A 3	Ra 225			< 9.03E-10	A 3
Kr 81					Ra 226			< 1.10E-11	A 3
Kr 85					Ra 228			< 4.39E-16	A 3
Rb 87					Ac 227			< 1.28E-09	A 3
Sr 90			< 5.56E-02	A 3	Th 227			< 1.25E-09	A 3
Zr 93			< 4.03E-06	A 3	Th 228			< 5.03E-10	A 3
Nb 91					Th 229			< 9.05E-10	A 3
Nb 92					Th 230			< 1.97E-09	A 3
Nb 93m			< 2.75E-06	A 3	Th 232			< 6.32E-16	A 3
Nb 94			< 1.70E-02	A 3	Th 234			< 3.87E-06	A 3
Mo 93					Pa 231			< 7.46E-09	A 3
Tc 97					Pa 233			< 1.32E-07	A 3
Tc 99			< 1.90E-03	A 3	U 232			< 4.89E-10	A 3
Ru 106			< 1.18E-10	A 3	U 233			< 3.69E-07	A 3
Pd 107			< 3.27E-07	A 3	U 234			< 8.40E-06	A 3
Ag 108m			< 5.52E-23	A 3	U 235			< 1.40E-06	A 3
Ag 110m					U 236			< 4.93E-07	A 3
Cd 109					U 238			< 3.88E-06	A 3
Cd 113m			< 3.32E-06	A 3	Np 237			< 1.32E-07	A 3
Sn 119m					Pu 236				
Sn 121m			< 6.61E-05	A 3	Pu 238			< 3.54E-03	A 3
Sn 123					Pu 239			< 2.54E-03	A 3
Sn 126			< 1.51E-06	A 3	Pu 240			< 4.25E-03	A 3
Sb 125			< 3.80E-06	A 3	Pu 241			< 6.87E-02	A 3
Sb 126			< 1.51E-06	A 3	Pu 242			< 3.73E-06	A 3
Te 125m			< 8.98E-07	A 3	Am 241			< 8.40E-03	A 3
Te 127m					Am 242m				
I 129			< 7.80E-08	A 3	Am 243			< 1.09E-05	A 3
Cs 134			< 6.95E-07	A 3	Cm 242			< 1.29E-32	A 3
Cs 135			< 3.42E-06	A 3	Cm 243			< 3.10E-05	A 3
Cs 137			< 7.16E-02	A 3	Cm 244			< 2.33E-04	A 3
Ba 133					Cm 245			< 4.08E-08	A 3
La 137					Cm 246			< 1.95E-09	A 3
La 138					Cm 248			< 4.10E-22	A 3
Ce 144					Cf 249			< 9.58E-14	A 3
Pm 145					Cf 250			< 3.18E-18	A 3
Pm 147			< 3.29E-05	A 3	Cf 251			< 2.05E-17	A 3
Sm 147			< 7.83E-13	A 3	Cf 252			< 5.98E-20	A 3
Sm 151			< 4.40E-03	A 3	Unsp a				
Eu 152			< 1.97E-07	A 3	Unsp b/g				
Eu 154			< 2.68E-04	A 3	Total a	0	*	1.90E-02	*
Eu 155			< 1.12E-04	A 3	Total b/g	0	*	8.45E-01	*

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