

WASTE STREAM	5B25	ILW Shaft (Contents)
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SITE Dounreay

SITE OWNER Nuclear Decommissioning Authority

WASTE CUSTODIAN Nuclear Restoration Services Ltd (NRS)

WASTE TYPE ILW

WASTE VOLUMES

Stocks:
Future arisings:

	Reported (m ³)
At 1.4.2025	0
1.4.2038 - 31.3.2039	= 97.8
1.4.2039 - 31.3.2040	= 103.0
1.4.2040 - 31.3.2041	= 103.3
1.4.2041 - 31.3.2042	= 103.0
1.4.2042 - 31.3.2043	= 103.0
1.4.2043 - 31.3.2044	= 103.0
1.4.2044 - 31.3.2045	= 103.3
1.4.2045 - 31.3.2046	= 22.5

OR

Conditioned (m ³)	Packaged (m ³)

Total future arisings: **738.8**
Total waste volume: **738.8**

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

Comment on arising rates: The waste will be received from a former disposal facility for packaging and interim storage at about 103m³ per year. Dates are based on the Dounreay Life Time Plan 2024 as at December 2023.

Additional information on quantities: Disposals to the Shaft have ceased. The volume quoted is the bulk volume of the solid waste. It is estimated that there is about 645 m³ of solid waste and about 93m³ of dry sludge.

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

WASTE SOURCE Miscellaneous waste disposals from all operations at Dounreay from 1959 to 1977, mainly from early reprocessing operations and supporting operations i.e. PIE etc. Additionally, there is waste from other sites notably HMS Vulcan and Harwell. Post 1971, some "special" waste was disposed of to the Shaft; this included large items and a number of breeder and dummy breeder elements.

PHYSICAL CHARACTERISTICS

General description: A range of solid wastes is included in the waste 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 undrugged components and gaiters, and metallic components from plant decommissioning and refurbishment work. Small items include manipulator jaws and tools etc. The waste contains 23 sea disposal drums. These drums may be size reduced both for retrieval and packaging. Other large "special" items have been disposed of.

Changes since waste generated: -

Bulk density (t/m³): = 1.0

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): Mild/stainless steel (46.65%), lead (4.9%), PVC (4.02%), aluminium (24.63%), concrete/rubble (0.57%), sludge/ash (3.35%), glass (4.59%), polythene (3.09%), paper (3.87%), wood (0.08%), others (4.25%).

Chemical state: Neutral

Sheet metal proportion / thickness: There are a number of cans, drums etc. in the Shaft. The construction of these varied both in terms of thicknesses and sizes. The bulk metal items are also very varied. The uranium was alloyed with aluminium, chromium and molybdenum for various reactors at Dounreay. A nominal 50/50 split between stainless and mild steels is assumed.

Metals and alloys (%wt):

	(%wt)	Type(s) / Grades(s) with proportions	% of total C14 activity
Stainless steel.....	~ 23.3	-	Most of the aluminium is likely to be present in small pieces from the milling of the cladding material
Other ferrous metals.....	~ 23.3	Mild steel	
Iron.....	= 0	-	
Aluminium.....	~ 24.6	-	
Beryllium.....	P	-	
Cobalt.....	NE	-	
Copper.....	TR	-	
Lead.....	= 4.9	-	
Magnox/Magnesium.....	= 0.12	-	
Nickel.....	NE	-	
Titanium.....	= 0	-	
Uranium.....	P	-	
Zinc.....	NE	-	
Zircaloy/Zirconium.....	P	-	
Other metals.....	= 1.3	Given the varied operational history of the Shaft and the wastes disposed of, the presence of other metals cannot be discounted.	

Organics (%wt):

	(%wt)	Type(s) and comment	% of total C14 activity
Total cellulotics.....	~ 4.0	-	
Paper, cotton.....	~ 3.9	-	
Wood.....	~ 0.08	-	
Halogenated plastics.....	~ 4.0	-	
Total non-halogenated plastics.....	~ 3.1	-	
Condensation polymers.....	0	-	
Others.....	~ 3.1	-	
Organic ion exchange materials.....	~ 0.06	-	
Total rubber.....	NE	-	
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.....	= 0	-	
Other organics.....	~ 2.8	-	

Other materials (%wt):

	(%wt)	Type(s) and comment	% of total C14 activity
Inorganic ion exchange materials.....	NE	-	
Inorganic sludges and flocs.....	~ 3.4	-	
Soil.....	NE	-	
Brick/Stone/Rubble.....	P	-	
Cementitious material.....	~ 0.57	-	
Sand.....	= 0	-	
Glass/Ceramics.....	~ 4.6	-	
Graphite.....	= 0	-	
Desiccants/Catalysts.....	= 0	-	
Asbestos.....	NE	-	
Non/low friable.....	NE	-	
Moderately friable.....	NE	-	
Highly friable.....	NE	-	
Free aqueous liquids.....	P	-	
Free non-aqueous liquids.....	P	-	
Powder/Ash.....	NE	-	

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

Inorganic anions (%wt):

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

Materials of interest for waste acceptance criteria:

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

Hazardous substances / non hazardous pollutants:

-

	(%wt)	Type(s) and comment
Acrylamide.....	NE	-
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	-
Total complexing agents.....	NE	-

Physical components:

	Number	Type(s) and comment
Sources.....		-
Electronic & Electrical Equipment (EEE)		-
EEE Type 1.....		-
EEE Type 2.....		-
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	= 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:

Waste will be segregated into sludge and solid components. The solids will be shredded and packaged into 200L drums. The sludge will be solidified in a 200L Annular drum. The 200L drums will be supercompacted and packaged into 500L drums

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 PFA 3:1 OPC 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	0.50	0.40	74	2038
500 l drum (pucks)	95.0	0.50	0.40	1406	-

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.

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 radioactivity 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 volume of the waste.

Measurement of radioactivities: Records have been kept for fissile material which has been used to estimate the activity in the waste. No account of leaching from the waste into water routinely pumped from the Shaft has been considered. Activity derived from HIT Shaft Radionuclide Inventory. Values quoted are upper bound.

Chemical form of radionuclides:

- H-3: May be present in stainless steel. Levels not expected to be significant.
- C-14: May be present in steels, PVC, polythene etc. Levels not expected to be significant.
- Cl-36: Not known to be present.
- Se-79: Likely to be present.
- Tc-99: Likely to be present.
- I-129: Likely to be present.
- Ra: Present as a bottle of radium chloride.
- Th: Not known to be present.
- U: Present as metal, also alloyed with Cr, Mo, Al, oxides and within the sludge.
- Np: Likely to be present.
- Pu: Present associated with uranium and as cemented liquor.

WASTE STREAM 5B25 ILW Shaft (Contents)									
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			< 4.06E-04	A A 3	Gd 153				
Be 10					Ho 163				
C 14			< 8.31E-08	A 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			< 1.98E-11	A A 3
Co 60			< 4.81E-04	A A 3	Bi 208				
Ni 59					Bi 210m				
Ni 63			< 8.13E-11	A A 3	Po 210			< 1.86E-11	A A 3
Zn 65					Ra 223			< 2.37E-08	A A 3
Se 79			< 7.66E-07	A A 3	Ra 225			< 9.83E-14	A A 3
Kr 81					Ra 226			< 8.88E-11	A A 3
Kr 85					Ra 228			< 4.62E-15	A A 3
Rb 87					Ac 227			< 2.38E-08	A A 3
Sr 90			< 5.40E-01	A A 3	Th 227			< 2.35E-08	A A 3
Zr 93			< 3.28E-05	A A 3	Th 228			< 3.96E-15	A A 3
Nb 91					Th 229			< 9.88E-14	A A 3
Nb 92					Th 230			< 1.59E-08	A A 3
Nb 93m			< 2.99E-05	A A 3	Th 232			< 6.65E-15	A A 3
Nb 94			< 1.33E-02	A A 3	Th 234			< 1.75E-05	A A 3
Mo 93					Pa 231			< 4.91E-08	A A 3
Tc 97					Pa 233			< 6.94E-07	A A 3
Tc 99			< 2.67E-02	A A 3	U 232				
Ru 106			< 1.03E-15	A A 3	U 233			< 8.81E-11	A A 3
Pd 107			< 2.59E-07	A A 3	U 234			< 6.67E-05	A A 3
Ag 108m					U 235			< 8.65E-06	A A 3
Ag 110m					U 236			< 5.19E-06	A A 3
Cd 109					U 238			< 1.75E-05	A A 3
Cd 113m			< 1.66E-05	A A 3	Np 237			< 6.94E-07	A A 3
Sn 119m					Pu 236				
Sn 121m			< 1.27E-04	A A 3	Pu 238			< 9.16E-04	A A 3
Sn 123					Pu 239			< 7.35E-03	A A 3
Sn 126			< 3.08E-06	A A 3	Pu 240			< 1.71E-03	A A 3
Sb 125			< 2.35E-07	A A 3	Pu 241			< 3.13E-03	A A 3
Sb 126			< 3.08E-06	A A 3	Pu 242				
Te 125m			< 5.56E-08	A A 3	Am 241			< 1.63E-03	A A 3
Te 127m					Am 242m				
I 129			< 4.75E-07	A A 3	Am 243				
Cs 134			< 1.27E-08	A A 3	Cm 242				
Cs 135			< 1.80E-05	A A 3	Cm 243				
Cs 137			< 5.11E-01	A A 3	Cm 244				
Ba 133					Cm 245				
La 137					Cm 246				
La 138					Cm 248				
Ce 144					Cf 249				
Pm 145					Cf 250				
Pm 147			< 4.90E-06	A A 3	Cf 251				
Sm 147			< 1.17E-13	A A 3	Cf 252				
Sm 151			< 1.21E-02	A A 3	Unsp a				
Eu 152			< 3.79E-06	A A 3	Unsp b/g				
Eu 154			< 3.51E-04	A A 3	Total a	0	*	1.17E-02	*
Eu 155			< 2.19E-05	A A 3	Total b/g	0	*	1.11E+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