

<b>WASTE STREAM</b>	<b>5B25</b>	<b>ILW Shaft (Contents)</b>
---------------------	-------------	-----------------------------

**SITE** Dounreay  
**SITE OWNER** Nuclear Decommissioning Authority  
**WASTE CUSTODIAN** Dounreay Site Restoration Limited

**WASTE TYPE** ILW

Is the waste subject to Scottish Policy: Yes

**WASTE VOLUMES**

		Reported
Stocks:	At 1.4.2022.....	0 m <sup>3</sup>
Future arisings -	1.4.2028 - 31.3.2029.....	61.7 m <sup>3</sup>
	1.4.2029 - 31.3.2030.....	184.6 m <sup>3</sup>
	1.4.2030 - 31.3.2031.....	184.6 m <sup>3</sup>
	1.4.2031 - 31.3.2032.....	184.6 m <sup>3</sup>
	1.4.2032 - 31.3.2033.....	123.4 m <sup>3</sup>
Total future arisings:		738.9 m <sup>3</sup>
Total waste volume:		738.9 m <sup>3</sup>

Comment on volumes: The waste will be retrieved from a former disposal facility for packaging and interim storage at about 185 m<sup>3</sup>/year. 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 m<sup>3</sup> of solid waste and about 93m<sup>3</sup> 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 1977, 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 undrummed 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.

Physical components (%vol): Mild/stainless steel (57.2%), PVC (12.3%), aluminium (6.4%), concrete/rubble (5.0%), sludge/ash (4.2%), glass (2.7%), polythene (2.5%), paper (2.5%), wood (2.4%), other (4.8%).

Sealed sources: Not yet determined.

Bulk density (t/m<sup>3</sup>): <4.3

Comment on density: The density of the waste has been determined from the volume of waste and its composition. This is assumed to be the upper limit.

**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

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.

**WASTE STREAM      5B25      ILW Shaft (Contents)**

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.

Metals and alloys (%wt):      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.

	(%wt)	Type(s) / Grade(s) with proportions	% of total C14 activity
Stainless steel.....	~23.3		
Other ferrous metals.....	~23.3	Mild steel	
Iron.....			
Aluminium.....	~24.6	Most of the aluminium is likely to be present in small pieces from the milling of the cladding material	
Beryllium.....	P		
Cobalt.....	NE		
Copper.....	TR		
Lead.....	TR		
Magnox/Magnesium.....	0.12		
Nickel.....	NE		
Titanium.....			
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):      The waste contains various organic materials i.e. rubber gloves, PVC, paper, tissues, polythene, manipulator gaiters, grinding and polishing discs, polythene bottles, swabs, cardboard, cables etc. from glovebox operations. These wastes were usually contained in cans or bags. The presence of halogenated rubbers has yet to be confirmed. PVC is present.

	(%wt)	Type(s) and comment	% of total C14 activity
Total cellulosics.....	~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.....			
Oil or grease .....			
Fuel.....			

<b>WASTE STREAM</b>	<b>5B25</b>	<b>ILW Shaft (Contents)</b>
---------------------	-------------	-----------------------------

Asphalt/Tarmac (cont.coal tar)...

Asphalt/Tarmac (no coal tar).....

Bitumen.....

Others.....

Other organics..... TR

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.....			
Glass/Ceramics.....	~4.6		
Graphite.....	0		
Desiccants/Catalysts.....			
Asbestos.....	NE		
Non/low friable.....			
Moderately friable.....			
Highly friable.....			
Free aqueous liquids.....	P		
Free non-aqueous liquids.....	P		
Powder/Ash.....	NE		

Inorganic anions (%wt): The weight percentage of inorganic anions is likely to be very low. It is known that CuSO<sub>4</sub>, SrCl<sub>2</sub>, RaCl<sub>2</sub> and soda ash have been disposed of to the Shaft. High expansion foam was added to the Shaft. The presence of soaps and decontamination agents cannot be discounted. BaCO<sub>3</sub> may have been added to the Shaft.

	(%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: It is possible that there are traces of sodium/potassium alloy present in the waste. It is known that zirconium alloys are present.

<b>WASTE STREAM</b>	<b>5B25</b>	<b>ILW Shaft (Contents)</b>
---------------------	-------------	-----------------------------

	(%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:      The presence of toxic metals has yet to be confirmed. However, if present amounts are likely to be low. Up to ~5 kg of liquid mercury may be present in sealed containers. The composition of the various sealed sources includes beryllium.

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

<b>WASTE STREAM</b>	<b>5B25</b>	<b>ILW Shaft (Contents)</b>
---------------------	-------------	-----------------------------

Vanadium..... NE  
 Mercury compounds.....  
 Others..... NE  
 Electronic Electrical Equipment (EEE)  
 EEE Type 1.....  
 EEE Type 2.....  
 EEE Type 3.....  
 EEE Type 4.....  
 EEE Type 5.....

Complexing agents (%wt): Not yet determined

	(%wt)	Type(s) and comment
EDTA.....		
DPTA.....		
NTA.....		
Polycarboxylic acids.....		
Other organic complexants.....		
Total complexing agents.....	NE	

Potential for the waste to contain discrete items: No.

**PACKAGING AND CONDITIONING**

Conditioning method: Waste will be retrieved and 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 500ltr drums

Plant Name: Shaft Retrieval and Processing Facility

Location: Dounreay

Plant startup date: 2028

Total capacity (m³/y incoming waste): ~305.0

Target start date for packaging this stream: 2028

Throughput for this stream (m³/y incoming waste): ~185.0

Other information: -

Likely container type:	Container	Waste packaged (%vol)	Waste loading (m³)	Payload (m³)	Number of packages
	500 l drum	100.0	0.500	0.5	1480

Likely container type comment: -

Range in container waste volume: There will be different waste loadings in the 500 l drum dependant if being used for compacted solids, non-compacted solids or sludge waste. Data presented is for compacted solids.

Other information on containers: -

<b>WASTE STREAM</b>	<b>5B25</b>	<b>ILW Shaft (Contents)</b>
---------------------	-------------	-----------------------------

Likely conditioning matrix: Not Specified  
 Other information: TBC  
 Conditioned density (t/m<sup>3</sup>): ~  
 Conditioned density comment: -  
 Other information on conditioning: -  
 Opportunities for alternative disposal routing: No

Baseline Management Route	Opportunity Management Route	Stream volume (%)	Estimated Date that Opportunity will be realised	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 volume of the waste.

Definition of total alpha and total beta/gamma: Where totals are shown on the table of radionuclide activities they are the sums of the listed alpha or beta/gamma emitting radionuclides plus 'other alpha' or 'other beta/gamma'.

Measurement of radioactivities: Records have been kept for fissile material which have 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.

Other information: Specific Activity uses UKRWI 2019 data decayed at 2022.

**WASTE STREAM 5B25 ILW Shaft (Contents)**

Nuclide	Mean radioactivity, TBq/m <sup>3</sup>				Nuclide	Mean radioactivity, TBq/m <sup>3</sup>			
	Waste at 1.4.2022	Bands and Code	Future arisings	Bands and Code		Waste at 1.4.2022	Bands and Code	Future arisings	Bands and Code
H 3			<6.73E-04	A 3	Gd 153				
Be 10					Ho 163				
C 14			<8.32E-08	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					Tl 204				
Mn 54					Pb 205				
Fe 55					Pb 210		<5.80E-12	A 3	
Co 60			<1.57E-03	A 3	Bi 208				
Ni 59					Bi 210m				
Ni 63			<8.62E-11	A 3	Po 210		<5.27E-12	A 3	
Zn 65					Ra 223		<4.13E-09	A 3	
Se 79			<1.32E-07	A 3	Ra 225		<3.98E-14	A 3	
Kr 81					Ra 226		<3.75E-11	A 3	
Kr 85					Ra 228		<2.50E-15	A 3	
Rb 87					Ac 227		<4.30E-09	A 3	
Sr 90			<6.73E-01	A 3	Th 227		<4.14E-09	A 3	
Zr 93			<3.28E-05	A 3	Th 228		<1.93E-15	A 3	
Nb 91					Th 229		<4.01E-14	A 3	
Nb 92					Th 230		<1.02E-08	A 3	
Nb 93m			<2.95E-05	A 3	Th 232		<4.36E-15	A 3	
Nb 94			<1.33E-02	A 3	Th 234		<1.75E-05	A 3	
Mo 93					Pa 231		<4.74E-08	A 3	
Tc 97					Pa 233		<6.89E-07	A 3	
Tc 99			<2.67E-02	A 3	U 232				
Ru 106			<4.30E-13	A 3	U 233		<5.19E-11	A 3	
Pd 107			2.59E-07		U 234		<6.66E-05	A 3	
Ag 108m					U 235		<8.65E-06	A 3	
Ag 110m					U 236		<5.19E-06	A 3	
Cd 109					U 238		<1.75E-05	A 3	
Cd 113m			<2.54E-05	A 3	Np 237		<6.90E-07	A 3	
Sn 119m					Pu 236				
Sn 121m			<1.43E-04	A 3	Pu 238		<9.86E-04	A 3	
Sn 123					Pu 239		<7.35E-03	A 3	
Sn 126			<1.34E-06	A 3	Pu 240		<1.71E-03	A 3	
Sb 125			<2.28E-06	A 3	Pu 241		<4.85E-03	A 3	
Sb 126			<1.34E-06	A 3	Pu 242				
Te 125m			<5.38E-07	A 3	Am 241		<1.61E-03	A 3	
Te 127m					Am 242m				
I 129			<4.75E-07	A 3	Am 243				
Cs 134			<2.58E-07	A 3	Cm 242				
Cs 135			<1.8E-05	A 3	Cm 243				
Cs 137			<6.29E-01	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			<5.29E-05	A 3	Cf 251				
Sm 147			<1.16E-13	A 3	Cf 252				
Sm 151			<1.29E-02	A 3	Other a		<1.25E-08	A 3	
Eu 152			<5.97E-06	A 3	Other b/g		<2.32E+00	A 3	
Eu 154			<7.37E-04	A 3	<b>Total a</b>	<b>0</b>	<b>&lt;1.18E-02</b>	<b>A 3</b>	
Eu 155			<8.65E-05	A 3	<b>Total b/g</b>	<b>0</b>	<b>&lt;3.68E+00</b>	<b>A 3</b>	

**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 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