

WASTE STREAM	5B28	Graphite/THTR Waste
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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	= 88.6		
Future arisings:				
Total future arisings:		0.0		
Total waste volume:		88.6		

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

Comment on arising rates: There will be no further arisings.

Additional information on quantities: The waste strategy for this stream is under review including alternative disposal options.

Uncertainty factors on volumes: Stock (upper): x 1.02 Arisings (upper): x -
Stock (lower): x 0.98 Arisings (lower): x -

WASTE SOURCE The waste consists of crushed graphite spheres contaminated with uranium and thorium.

PHYSICAL CHARACTERISTICS

General description: The waste consists of crushed graphite spheres contaminated with uranium and thorium. It is currently stored in mild steel drums held within FHISO containers.

Changes since waste generated: -

Bulk density (t/m³): = 1.3

Comment on density: The density is derived from consignor's records.

CHEMICAL COMPOSITION

General description and components (%wt): Graphite (65.92%), ferroboration (22.87%), mild steel (11.04%), thorium (0.15%), uranium (0.02%).

Chemical state: Neutral

Sheet metal proportion / thickness: Ferroboration is an iron-boron alloy used in steel production which typically consists of up to 12-20% of boron, 3% of silicon, 2% aluminium, and 1% of carbon.

Metals and alloys (%wt):

	(%wt)	Type(s) / Grades(s) with proportions	% of total C14 activity
Stainless steel.....	= 0	-	
Other ferrous metals.....	= 33.9	-	
Iron.....	= 0	-	
Aluminium.....	P	-	
Beryllium.....	= 0	-	
Cobalt.....	= 0	-	
Copper.....	= 0	-	
Lead.....	= 0	-	
Magnox/Magnesium.....	= 0	-	
Nickel.....	= 0	-	
Titanium.....	= 0	-	
Uranium.....	= 0.02	-	
Zinc.....	= 0	-	
Zircaloy/Zirconium.....	= 0	-	
Other metals.....	= 0.15	Thorium	

Organics (%wt):

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

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	-	
Cementitious material.....	= 0	-	
Sand.....	= 0	-	
Glass/Ceramics.....	= 0	-	
Graphite.....	= 65.9	-	
Desiccants/Catalysts.....	= 0	-	
Asbestos.....	= 0	-	
Non/low friable.....	= 0	-	
Moderately friable.....	= 0	-	
Highly friable.....	= 0	-	
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.....	= 0	-
Iodide.....	= 0	-
Cyanide.....	= 0	-
Carbonate.....	= 0	-
Nitrate.....	= 0	-
Nitrite.....	= 0	-
Phosphate.....	= 0	-
Sulphate.....	= 0	-
Sulphide.....	= 0	-

Materials of interest for waste acceptance criteria:

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

Hazardous substances / non hazardous pollutants:

	(%wt)	Type(s) and comment
Acrylamide.....	NE	-
Benzene.....	= 0	-
Chlorinated solvents.....	= 0	-
Formaldehyde.....	= 0	-
Organometallics.....	NE	-
Phenol.....	= 0	-
Styrene.....	NE	-
Tri-butyl phosphate.....	= 0	-
Other organophosphates.....	NE	-
Vinyl chloride.....	NE	-
Arsenic.....	= 0	-
Barium.....	NE	-
Boron.....	= 0	-
Boron (in Boral).....	= 0	-
Boron (non-Boral).....	NE	-
Cadmium.....	= 0	-
Caesium.....	NE	-
Selenium.....	NE	-
Chromium.....	NE	-
Molybdenum.....	= 0	-
Thallium.....	NE	-
Tin.....	NE	-
Vanadium.....	= 0	-
Mercury compounds.....	NE	-
Others.....	= 0	-

Complexing agents (%wt):

No		
	(%wt)	Type(s) and comment
EDTA.....	= 0	-
DPTA.....	= 0	-
NTA.....	= 0	-
Polycarboxylic acids.....	= 0	-
Other organic complexants.....	= 0	-
Total complexing agents.....	= 0	-

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	On-site	= 100.0
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		

Comments on planned treatments:

A final waste strategy for this waste stream is still to be confirmed. However, current strategy expects waste to be grouted into the 200L drums they are currently stored in. The grouted 200L drums will then be placed into 500L drums.

Conditioning method:

The waste is currently held in interim storage in 443 200 litre drums within 8 full height ISO containers. It will remain in storage until a conditioning and packaging strategy has been fully developed. UKRWI submission has been based on a historic LoC submission.

Conditioning plants:

Plant Name	Location

Likely conditioning matrix:

Cement (~41% water)

Further information on the conditioning matrix: may include a polymer to immobilise the graphite waste.

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	100.0	0.20	0.50	443	-

Range in container waste loading:

Other information on packaging and conditioning: The 200 l drums would be entombed in the 500 l drum.

Conditioned density (t/m³): ~ 1.9
Conditioned density comment: -

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
Non-NSDF HAW	Dounreay LLWDV	= 100.0	RED	It is possible that further characterisation will show that this waste can be categorised as Low Level Waste and will be suitable for disposal at the Low Level waste Disposal Facility.

RADIOACTIVITY

Source: The activity arises from contamination by uranium and thorium.

Uncertainty: The specific activities are accurate to within a factor of three.

Measurement of radioactivities: The activity for Th232, U235, and U238 are calculated from the data for nuclear material in the Dounreay Nuclear Inventory. Total alpha and total beta/gamma are taken from consignor's records. Decay products have been estimated by calculation.

Chemical form of radionuclides:

- H-3: Not known to be present.
- C-14: Not known to be present.
- Cl-36: Not known to be present.
- Se-79: Not known to be present.
- Tc-99: Not known to be present.
- I-129: Not known to be present.
- Ra: May be present in trace amounts.
- Th: Thorium (168 kg) contamination on graphite.
- U: Highly enriched uranium contamination on graphite.
- Np: Not known to be present.
- Pu: Not known to be present.

WASTE STREAM		5B28		Graphite/THTR Waste					
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					Tl 204				
Mn 54					Pb 205				
Fe 55					Pb 210	= 1.55E-09	A A 2		
Co 60					Bi 208				
Ni 59					Bi 210m				
Ni 63					Po 210	= 1.51E-09	A A 2		
Zn 65					Ra 223	= 1.70E-09	A A 2		
Se 79					Ra 225				
Kr 81					Ra 226	= 3.53E-09	A A 2		
Kr 85					Ra 228	= 7.65E-06	A A 2		
Rb 87					Ac 227	= 1.77E-09	A A 2		
Sr 90					Th 227	= 1.71E-09	A A 2		
Zr 93					Th 228	= 7.65E-06	A A 2		
Nb 91					Th 229				
Nb 92					Th 230	= 2.51E-07	A A 2		
Nb 93m					Th 232	= 7.65E-06	A A 2		
Nb 94					Th 234	= 1.45E-07	A A 2		
Mo 93					Pa 231	= 1.99E-08	A A 2		
Tc 97					Pa 233				
Tc 99					U 232				
Ru 106					U 233				
Pd 107					U 234	= 4.19E-04	A A 2		
Ag 108m					U 235	= 1.42E-05	A A 2		
Ag 110m					U 236	= 3.21E-07	A A 2		
Cd 109					U 238	= 1.45E-07	A A 2		
Cd 113m					Np 237				
Sn 119m					Pu 236				
Sn 121m					Pu 238				
Sn 123					Pu 239				
Sn 126					Pu 240				
Sb 125					Pu 241				
Sb 126					Pu 242				
Te 125m					Am 241				
Te 127m					Am 242m				
I 129					Am 243				
Cs 134					Cm 242				
Cs 135					Cm 243				
Cs 137					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					Unsp b/g				
Eu 154					Total a	4.49E-04	*	0	*
Eu 155					Total b/g	7.80E-06	*	0	*

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