

<b>WASTE STREAM</b>	<b>5B28</b>	<b>Graphite/THTR Waste</b>
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**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**

Stocks:	At 1.4.2022.....	Reported 88.6 m <sup>3</sup>
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Total future arisings:		0 m <sup>3</sup>
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Total waste volume:		88.6 m <sup>3</sup>
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Comment on volumes: There will be no further arisings. 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.

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

Sealed sources: The waste does not contain sealed sources.

Bulk density (t/m<sup>3</sup>): 1.25

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

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.

Metals and alloys (%wt): 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.

	(%wt)	Type(s) / Grade(s) with proportions	% of total C14 activity
Stainless steel.....	0		
Other ferrous metals.....	33.9		
Iron.....			
Aluminium.....	P		
Beryllium.....	0		
Cobalt.....	0		
Copper.....	0		

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Lead.....	0	
Magnox/Magnesium.....	0	
Nickel.....	0	
Titanium.....		
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.....			
Oil or grease .....			
Fuel.....			
Asphalt/Tarmac (cont.coal tar)...			
Asphalt/Tarmac (no coal tar)....			
Bitumen.....			
Others.....			
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.....			
Asbestos.....	0		

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Non/low friable.....

Moderately friable.....

Highly friable.....

Free aqueous liquids..... 0

Free non-aqueous liquids..... 0

Powder/Ash..... 0

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.....

Benzene..... NE

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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
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):

	(%wt)	Type(s) and comment
EDTA.....		
DPTA.....		
NTA.....		
Polycarboxylic acids.....		
Other organic complexants.....		
Total complexing agents.....	0	

Potential for the waste to contain discrete items:      No.

**PACKAGING AND CONDITIONING**

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

Plant Name: Not established

Location: Dounreay

Plant startup date: TBC

Total capacity (m<sup>3</sup>/y incoming waste): -

Target start date for packaging this stream: -

Throughput for this stream (m<sup>3</sup>/y incoming waste): -

Other information: -

Likely container type:	Container	Waste packaged (%vol)	Waste loading (m <sup>3</sup> )	Payload (m <sup>3</sup> )	Number of packages
	500 l drum	100.0	0.2	0.5	443

Likely container type comment: Stainless steel M316 drum

Range in container waste volume: -

Other information on containers: The use of 6m<sup>3</sup> Concrete boxes had previously been proposed.

Likely conditioning matrix: Cement

Other information: may include a polymer to immobilise the graphite waste

Conditioned density (t/m<sup>3</sup>): ~1.85

Conditioned density comment: -

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

Opportunities for alternative disposal routing: Yes

Baseline Management Route	Opportunity Management Route	Stream volume (%)	Estimated Date that Opportunity will be realised	Opportunity Confidence	Comment
Disposal at a Near Surface / Near Site Disposal Facility	Onsite disposal	100.0	-	Low	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
Disposal at a Near Surface / Near Site Disposal Facility	Packaging as LLW	100.0		Low	Alternative LLW Disposal being investigated

**RADIOACTIVITY**

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

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

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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:

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 consignors records. Other alpha and other beta/gamma are undefined. Decay products have been estimated by calculation.

Other information:

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**5B28**

**Graphite/THTR Waste**

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					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	1.37E-09	AA 2		
Co 60					Bi 208				
Ni 59					Bi 210m				
Ni 63					Po 210	1.34E-09	AA 2		
Zn 65					Ra 223	1.07E-08	AA 2		
Se 79					Ra 225				
Kr 81					Ra 226	3.22E-09	AA 2		
Kr 85					Ra 228	7.65E-06	AA 2		
Rb 87					Ac 227	1.08E-08	AA 2		
Sr 90					Th 227	1.06E-08	AA 2		
Zr 93					Th 228	7.65E-06	AA 2		
Nb 91					Th 229				
Nb 92					Th 230	2.39E-07	AA 2		
Nb 93m					Th 232	7.65E-06	AA 2		
Nb 94					Th 234	1.45E-07	AA 2		
Mo 93					Pa 231	1.90E-08	AA 2		
Tc 97					Pa 233				
Tc 99					U 232				
Ru 106					U 233				
Pd 107					U 234	4.19E-04	AA 2		
Ag 108m					U 235	1.42E-05	AA 2		
Ag 110m					U 236	3.21E-07	AA 2		
Cd 109					U 238	1.45E-07	AA 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					Other a				
Eu 152					Other b/g				
Eu 154					<b>Total a</b>	<b>4.49E-04</b>	<b>BB 2</b>	<b>0</b>	
Eu 155					<b>Total b/g</b>	<b>7.81E-06</b>	<b>BB 2</b>	<b>0</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