

<b>WASTE STREAM</b>	<b>4B313</b>	<b>Decommissioning Stage 3: Graphite ILW</b>
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**SITE** Hunterston B

**SITE OWNER** EDFE NGL

**WASTE CUSTODIAN** EDFE NGL

**WASTE TYPE** ILW

**WASTE VOLUMES**

		Reported
Stocks:	At 1.4.2019.....	0 m <sup>3</sup>
Future arisings -	1.4.2019 - 31.3.2110.....	0 m <sup>3</sup>
	1.4.2110 - 31.3.2111.....	72.0 m <sup>3</sup>
	1.4.2111 - 31.3.2112.....	700.9 m <sup>3</sup>
	1.4.2112 - 31.3.2113.....	700.9 m <sup>3</sup>
	1.4.2113 - 31.3.2114.....	356.8 m <sup>3</sup>
Total future arisings:		1830.5 m <sup>3</sup>
Total waste volume:		1830.5 m <sup>3</sup>

Comment on volumes: Waste volumes will be variable depending on station operating conditions.

Uncertainty factors on volumes: Stock (upper): x Arisings (upper) x 1.25  
 Stock (lower): x Arisings (lower) x 0.75

**WASTE SOURCE** Moderator and reflector graphite from reactor dismantling.

**PHYSICAL CHARACTERISTICS**

General description: Graphite blocks and other graphite components. Waste can be packaged in standard NDA packages.

Physical components (%wt): Graphite (~100%).

Sealed sources: The waste does not contain sealed sources.

Bulk density (t/m<sup>3</sup>): ~1.28

Comment on density: Future arisings based on envelope volume, density calculated on this basis.

**CHEMICAL COMPOSITION**

General description and components (%wt): Graphite and possible traces of ferrous metals.

Chemical state: -

Chemical form of radionuclides: H-3: Diffused into matrix  
 C-14: Incorporated in the graphite.  
 Cl-36: Incorporated in the graphite  
 Se-79: Not significant  
 Tc-99: Not determined  
 I-129: Not significant  
 Ra: Radium content is insignificant  
 Th: Thorium content is Insignificant  
 U: Uranium content is insignificant  
 Np: Neptunium content is insignificant  
 Pu: Plutonium content is insignificant

Metals and alloys (%wt): -

Stainless steel.....	NE
Other ferrous metals.....	NE
Iron.....	0
Aluminium.....	0
Beryllium.....	0
Cobalt.....	0
Copper.....	0
Lead.....	0

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	Magnox/Magnesium.....	0
	Nickel.....	0
	Titanium.....	0
	Uranium.....	0
	Zinc.....	0
	Zircaloy/Zirconium.....	0
	Other metals.....	0
Organics (%wt):	None expected.	
	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 .....	
	Fuel.....	
	Asphalt/Tarmac (cont.coal tar)...	
	Asphalt/Tarmac (no coal tar)....	
	Bitumen.....	
	Others.....	
	Other organics.....	0
Other materials (%wt):	-	
	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.....	100.0
	Desiccants/Catalysts.....	0
	Asbestos.....	0
	Non/low friable.....	
	Moderately friable.....	
	Highly friable.....	
	Free aqueous liquids.....	0
	Free non-aqueous liquids.....	0

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	Powder/Ash.....	0	
Inorganic anions (%wt):	None likely to be present.		
	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:	No materials likely to pose a fire or other non-radiological hazard have been identified. Graphite presents a low fire risk; it is difficult but not impossible to ignite.		
	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	
	Active particles.....	P	May be present.
	Soluble solids as bulk chemical compounds.....	0	
Hazardous substances / non hazardous pollutants:	-		
	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	

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Barium..... NE  
 Boron..... NE  
 Cadmium..... NE  
 Caesium..... NE  
 Selenium..... NE  
 Chromium..... NE  
 Molybdenum..... NE  
 Thallium..... NE  
 Tin..... NE  
 Vanadium..... NE  
 Mercury compounds..... NE  
 Others..... NE  
 Electronic Electrical Equipment (EEE)  
   EEE Type 1..... 0  
   EEE Type 2..... 0  
   EEE Type 3..... 0  
   EEE Type 4..... 0  
   EEE Type 5..... 0

Complexing agents (%wt): Not yet determined  
 EDTA..... NE  
 DPTA..... NE  
 NTA..... NE  
 Polycarboxylic acids..... NE  
 Other organic complexants..... NE  
 Total complexing agents..... NE

Only trace quantities, if any.

**PACKAGING AND CONDITIONING**

Conditioning method: The waste is not expected to be supercompacted. It will be placed in "baskets" in the waste packages, and is assumed to be encapsulated.  
 Plant Name: -  
 Location: -  
 Plant startup date: 85 years after reactor shut-down.  
 Total capacity (m³/y incoming waste): ~5000.0  
 Target start date for packaging this stream: -  
 Throughput for this stream (m³/y incoming waste): -  
 Other information: Waste will be conditioned when removed from the reactor.

Likely container type:	Container	Waste packaged (%vol)	Waste loading (m³)	Payload (m³)	Number of packages
	4m box (100mm concrete shielding)	100.0	~11.26	14.3	163

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Likely container type comment: -

Range in container waste volume: -

Other information on containers: Stainless Steel.

Likely conditioning matrix: BFS/OPC

Other information: -

Conditioned density (t/m<sup>3</sup>): ~1.82

Conditioned density comment: Assumes waste will be encapsulated, matrix would be likely to be BFS/OPC.

Other information on conditioning: The waste will be in baskets placed in the waste packages. Baskets of different Stage 3 ILW wastes may be in the same waste package.

Opportunities for alternative disposal routing: No

Treatment	Stream volume (%)	Comment
-	-	-

**RADIOACTIVITY**

Source: Activation of the graphite and impurities, Contamination by other activated materials.

Uncertainty: The values quoted were derived by calculation from available material specification and are indicative of the activities that are expected. A major source of uncertainty is the impurity levels.

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: Activation/decay calculations based on neutron flux and projected operating history.

Other information: There may be some contamination by Cs137. The activities quoted are for the time at which this waste will arise (i.e. ~85 years after end of generation).

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Nuclide	Mean radioactivity, TBq/m <sup>3</sup>				Nuclide	Mean radioactivity, TBq/m <sup>3</sup>			
	Waste at 1.4.2019	Bands and Code	Future arisings	Bands and Code		Waste at 1.4.2019	Bands and Code	Future arisings	Bands and Code
H 3			5.57E-04	CC 2	Gd 153				
Be 10			8.62E-10	CC 2	Ho 163				
C 14			3.22E-01	CC 2	Ho 166m		1.04E-06	CC 2	
Na 22				4	Tm 170				
Al 26				4	Tm 171				
Cl 36			3.26E-03	CC 2	Lu 174				
Ar 39					Lu 176				
Ar 42					Hf 178n				
K 40					Hf 182				
Ca 41			7.64E-05	CC 2	Pt 193				
Mn 53					Tl 204				
Mn 54				8	Pb 205				
Fe 55			2.71E-10	CC 2	Pb 210				8
Co 60			5.72E-07	CC 2	Bi 208				
Ni 59			2.55E-05	CC 2	Bi 210m				
Ni 63			2.3E-03	CC 2	Po 210				8
Zn 65				8	Ra 223				
Se 79				8	Ra 225				
Kr 81					Ra 226				8
Kr 85					Ra 228				
Rb 87					Ac 227				
Sr 90				8	Th 227				
Zr 93				8	Th 228				
Nb 91					Th 229				8
Nb 92					Th 230				8
Nb 93m			1.87E-07	CC 2	Th 232				8
Nb 94			2.45E-07	CC 2	Th 234				
Mo 93			4.49E-05	CC 2	Pa 231				8
Tc 97					Pa 233				
Tc 99			5.18E-06	CC 2	U 232				
Ru 106				8	U 233				8
Pd 107				8	U 234				8
Ag 108m			2.53E-06	CC 2	U 235				8
Ag 110m					U 236				8
Cd 109					U 238				8
Cd 113m					Np 237				8
Sn 119m					Pu 236				
Sn 121m			1.05E-07	CC 2	Pu 238				8
Sn 123					Pu 239				8
Sn 126				8	Pu 240				8
Sb 125					Pu 241				8
Sb 126					Pu 242				8
Te 125m					Am 241				8
Te 127m					Am 242m				8
I 129				8	Am 243				8
Cs 134				8	Cm 242				8
Cs 135				8	Cm 243				8
Cs 137				8	Cm 244				8
Ba 133			6.2E-08	CC 2	Cm 245				8
La 137					Cm 246				8
La 138					Cm 248				
Ce 144				8	Cf 249				
Pm 145			2.05E-07	CC 2	Cf 250				
Pm 147				8	Cf 251				
Sm 147					Cf 252				
Sm 151			5.78E-08	CC 2	Other a				8
Eu 152			3.85E-10	CC 2	Other b/g				8
Eu 154			4.13E-08	CC 2	<b>Total a</b>	<b>0</b>	<b>&lt;1E-09</b>		<b>8</b>
Eu 155			8.97E-11	CC 2	<b>Total b/g</b>	<b>0</b>	<b>3.28E-01</b>	<b>CC 2</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