WASTE STREAM 2A310 Final Dismantling & Site Clearance: Graphite ILW

SITE Calder Hall

SITE OWNER Nuclear Decommissioning Authority

WASTE CUSTODIAN Sellafield Limited

WASTE TYPE ILW

WASTE VOLUMES

		Reported
Stocks:	At 1.4.2019.....	0 m³
Future arisings -	1.4.2019 - 31.3.2108.....	0 m³
	1.4.2108 - 31.3.2112.....	3633.2 m³
Total future arisings:		3633.2 m³
Total waste volume:		3633.2 m³

Comment on volumes: For inventory purposes the arisings are assumed to arise at a uniform rate over four years. Final Dismantling & Site Clearance is assumed to commence in 2105, with reactor dismantling commencing in 2107, and lasting for ten years. Volumes and radioactivity have been calculated for 100 years after reactor shutdown, i.e. 2103, but the volume in this stream would not change for decommissioning in 2108.

Uncertainty factors on volumes:

Stock (upper):	x	Arisings (upper)	x 1.2
Stock (lower):	x	Arisings (lower)	x 0.8

WASTE SOURCE Moderator graphite from reactor dismantling.

PHYSICAL CHARACTERISTICS

General description: Graphite blocks and other graphite components.

Physical components (%vol): Graphite (100%).

Sealed sources: The waste does not contain sealed sources.

Bulk density (t/m³): 1.25

Comment on density: Density estimate based upon the assumed packing efficiency of the waste. The density is the effective density for packaging assuming 90% of the graphite is in blocks and 10% is rubble.

CHEMICAL COMPOSITION

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

Chemical state: Neutral

Chemical form of radionuclides:
H-3: Tritium may be chemically bound with the graphite.
C-14: The carbon 14 will be present as graphite.
Cl-36: The chlorine content is insignificant.
Se-79: The selenium content is insignificant.
Tc-99: The technetium content is insignificant.
I-129: The Iodine content is insignificant.
Ra: The radium content is insignificant.
Th: The thorium content is insignificant.
U: There may be traces of uranium as metal or oxide.
Np: The neptunium content is insignificant.
Pu: There may be traces of plutonium as metal or oxide.

Metals and alloys (%wt): There are no metallic items present.

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

WASTE STREAM 2A310 Final Dismantling & Site Clearance: Graphite ILW

	Lead	0
	Magnox/Magnesium	0
	Nickel	0
	Titanium	
	Uranium	0
	Zinc	0
	Zircaloy/Zirconium	0
	Other metals	0
Organics (%wt):	No organic wastes are expected.	
	Total cellulosics	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):	Only graphite is expected.	
	Inorganic ion exchange materials.	0
	Inorganic sludges and flocs	0
	Soil	0
	Brick/Stone/Rubble	0
	Cementitious material	0
	Sand	
	Glass/Ceramics	0
	Graphite	100.0
	Desiccants/Catalysts	
	Asbestos	0
	Non/low friable	
	Moderately friable	
	Highly friable	
	Free aqueous liquids	0

	Free non-aqueous liquids	0
	Powder/Ash	0
Inorganic anions (%wt):	None of the inorganic anions listed in the table below are expected to be present at greater than trace concentration.	
	Fluoride	TR
	Chloride	TR
	Iodide	0
	Cyanide	0
	Carbonate	TR
	Nitrate	TR
	Nitrite	TR
	Phosphate	TR
	Sulphate	TR
	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	
	Corrosive materials	0
	Pyrophoric materials	0
	Generating toxic gases	0
	Reacting with water	0
	Active particles	
	Soluble solids as bulk chemical compounds	
Hazardous substances / non hazardous pollutants:	-	
	Acrylamide	
	Benzene	
	Chlorinated solvents	
	Formaldehyde	
	Organometallics	
	Phenol	
	Styrene	
	Tri-butyl phosphate	
	Other organophosphates	
	Vinyl chloride	

Arsenic.....

Barium.....

Boron.....

Cadmium.....

Caesium.....

Selenium.....

Chromium.....

Molybdenum.....

Thallium.....

Tin.....

Vanadium.....

Mercury compounds.....

Others.....

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

EDTA.....

DPTA.....

NTA.....

Polycarboxylic acids……

Other organic complexants.....

Total complexing agents..... NE

PACKAGING AND CONDITIONING

Conditioning method: The exact method of waste conditioning has not yet been established.

Plant Name: Not yet established.

Location: -

Plant startup date: -

Total capacity (m^3/y incoming waste): -

Target start date for packaging this stream: 2108

Throughput for this stream (m^3/y incoming waste): -

Other information: -

Likely container type:

Container	Waste packaged (%vol)	Waste loading (m^3)	Payload (m^3)	Number of packages
Sellafield 3m^3 box	100.0	1.33	2.8	2732

WASTE STREAM 2A310 Final Dismantling & Site Clearance: Graphite ILW

Likely container type comment:	-
Range in container waste volume:	Waste loading estimated based on the total volume of Calder Hall FSC wastes (2A310, 2A311, 2A312 & 2A313) being packaged into 3,300 Sellafield 3m3 boxes.
Other information on containers:	The packaged waste will be in a form suitable for disposal at a GDF.
Likely conditioning matrix:	
Other information:	-
Conditioned density (t/m³):	-
Conditioned density comment:	-
Other information on conditioning:	-
Opportunities for alternative disposal routing:	Not yet determined

Treatment	Stream volume (%)	Comment
-	-	-

RADIOACTIVITY

Source:	Activation of the graphite and impurities.
Uncertainty:	The values quoted were derived by calculation from available material specification and are indicative of the activities that are expected. The major source of uncertainty is the impurity levels.
Definition of total alpha and total beta/gamma:	Total beta/gamma is defined as the sum of the listed activities of all nuclides other than alpha emitters. Activity estimates for individual alpha emitting nuclides have not been provided but an estimate of total alpha activity is given.
Measurement of radioactivities:	The specific activities have been estimated using a neutron activation calculation.
Other information:	Other beta/gamma represents Sm146 activity. There may also be some contamination by Cs137. The activities quoted are those at 100 years after reactor shutdown, i.e. in 2103. Fission of trace uranium impurity in the graphite may result in some fission product and actinide activity.

WASTE STREAM 2A310 Final Dismantling & Site Clearance: Graphite ILW

Nuclide	Mean radioactivity, TBq/m³				Nuclide	Mean radioactivity, TBq/m³			
	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			9.29E-04	C C 2	Gd 153				8
Be 10				8	Ho 163				8
C 14			1.42E-01	C C 2	Ho 166m			2.19E-05	C C 2
Na 22					Tm 170				8
Al 26					Tm 171				8
Cl 36			3.17E-04	C C 2	Lu 174				8
Ar 39				8	Lu 176				8
Ar 42				8	Hf 178n				8
K 40				8	Hf 182				8
Ca 41			3.82E-04	C C 2	Pt 193				8
Mn 53				8	Tl 204				8
Mn 54				8	Pb 205				8
Fe 55			9.06E-13	C C 2	Pb 210				8
Co 60			4.37E-07	C C 2	Bi 208				8
Ni 59			6.60E-05	C C 2	Bi 210m				8
Ni 63			4.58E-03	C C 2	Po 210				8
Zn 65				8	Ra 223				8
Se 79				8	Ra 225				8
Kr 81				8	Ra 226				8
Kr 85				8	Ra 228				8
Rb 87				8	Ac 227				8
Sr 90				8	Th 227				8
Zr 93				8	Th 228				8
Nb 91				8	Th 229				8
Nb 92				8	Th 230				8
Nb 93m				8	Th 232				8
Nb 94			1.99E-05	C C 2	Th 234				8
Mo 93				8	Pa 231				8
Tc 97				8	Pa 233				8
Tc 99				8	U 232				8
Ru 106				8	U 233				8
Pd 107				8	U 234				8
Ag 108m			8.85E-07	C C 2	U 235				8
Ag 110m				8	U 236				8
Cd 109				8	U 238				8
Cd 113m				8	Np 237				8
Sn 119m				8	Pu 236				8
Sn 121m			1.64E-04	C C 2	Pu 238				8
Sn 123				8	Pu 239				8
Sn 126				8	Pu 240				8
Sb 125				8	Pu 241				8
Sb 126				8	Pu 242				8
Te 125m				8	Am 241				8
Te 127m				8	Am 242m				8
I 129				8	Am 243				8
Cs 134			4.39E-19	C C 2	Cm 242				8
Cs 135				8	Cm 243				8
Cs 137				8	Cm 244				8
Ba 133			2.22E-07	C C 2	Cm 245				8
La 137				8	Cm 246				8
La 138				8	Cm 248				8
Ce 144				8	Cf 249				8
Pm 145			3.98E-08	C C 2	Cf 250				8
Pm 147				8	Cf 251				8
Sm 147				8	Cf 252				8
Sm 151			3.33E-07	C C 2	Other a				8
Eu 152			7.03E-14	C C 2	Other b/g			7.27E-13	C C 2
Eu 154			1.74E-07	C C 2	**Total a**	**0**		**0**	**8**
Eu 155			3.80E-10	C C 2	**Total b/g**	**0**		**1.49E-01**	**C C 2**

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