WASTE STREAM 9A31 FED Graphite

SITE	Berkeley
SITE OWNER	Nuclear Decommissioning Authority
WASTE CUSTODIAN	Magnox Limited
WASTE TYPE	ILW

WASTE VOLUMES

		Reported
Stocks:	At 1.4.2019.....	150.7 m³
Total future arisings:		0 m³
Total waste volume:		150.7 m³

Comment on volumes: Station operation ceased in March 1989. This waste stream was accumulated between May 1964 and December 1967. The volume quoted is the estimated bulk volume of the waste if separated from other wastes with which it is mixed.

Uncertainty factors on volumes:

Stock (upper):	x 1.1	Arisings (upper)	x
Stock (lower):	x 0.9	Arisings (lower)	x

WASTE SOURCE The source of the waste is the removal of graphite struts from fuel elements prior to dispatch of the elements to Sellafield. There may be a few stabilising wedges and support frames.

PHYSICAL CHARACTERISTICS

General description: This waste comprises graphite struts. It was generated during the destrutting operations performed on the cooled fuel elements. The struts (two per element) were each originally 575mm x 25mm x 27mm and weighed 556g. The two graphite support struts are often fractured in more than one place, resulting in a number of different lengths of graphite debris. A pair of struts often remain connected by stainless steel or zirconium bridge pieces. The graphite strut was broken during the destrutting operation. It is therefore unlikely that there will be any large items which will require special handling. The waste is loose in the vaults.

Physical components (%vol): Graphite struts (>99 vol%). Stabilising wedges (<1 vol%). No other constituent identified.

Sealed sources: -

Bulk density (t/m³): 0.57

Comment on density: The bulk density of 0.57 t/m3 assumes a packing factor to give an overall volume of about three times the displacement volume of the waste. The packing factor will be variable and the bulk density can be up to 1.7 t/m3.

CHEMICAL COMPOSITION

General description and components (%wt): Graphite will account for approximately 99% of the waste, with 1% stabilising wedges. The graphite will be contaminated with fission products and actinides and there may be activation of impurities within the graphite.

Chemical state: Neutral

Chemical form of radionuclides:
H-3: Some tritium may be chemically bound with the graphite. Other tritium may be present as water.
C-14: Carbon 14 will probably be present as graphite.
Cl-36: Chlorine 36 will probably be chemically bound to the graphite. Some may be linked chemically with impurities within the graphite.
Se-79: The selenium content is insignificant.
Tc-99: The technetium content is insignificant.
Ra: Radium isotope content is insignificant.
Th: The thorium isotope content is insignificant.
U: Chemical form of uranium isotopes has not been determined but may be uranium oxides.
Np: The neptunium content is insignificant.
Pu: Chemical form of plutonium isotopes has not been determined but may be plutonium oxides.

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

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Stainless steel	0	
Other ferrous metals	0	
Iron		
Aluminium	0	
Beryllium	TR	
Cobalt		
Copper	0	
Lead	0	
Magnox/Magnesium	0	
Nickel		
Titanium		
Uranium		
Zinc	0	
Zircaloy/Zirconium	0	
Other metals	TR	There are no "other" metals present. Only trace quantities of metals as impurities incorporated into the graphite are expected.

Organics (%wt): The loose graphite is currently stored under the drums of ion exchange material in the vaults, which will have corroded to an extent. Therefore, it is likely to be contaminated with spilt Lewatit DN, the organic ion exchange material.

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	TR
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	TR

Other materials (%wt): Principally graphite.

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Inorganic ion exchange materials.	TR
Inorganic sludges and flocs.....	0
Soil.....	0
Brick/Stone/Rubble.....	0
Cementitious material.....	0
Sand.....	
Glass/Ceramics.....	0
Graphite.....	>99.0
Desiccants/Catalysts.....	
Asbestos.....	0
Non/low friable.....	
Moderately friable.....	
Highly friable.....	
Free aqueous liquids.....	TR
Free non-aqueous liquids.....	0
Powder/Ash.....	P

Inorganic anions (%wt): None of the inorganic anions listed in the table is 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: The risk of a graphite dust explosion is very low as the dust is mixed with other materials which will inhibit an explosion. Graphite blocks, although very difficult to ignite, will burn in air.

Combustible metals.....	0
Low flash point liquids.....	0
Explosive materials.....	0
Phosphorus.....	0
Hydrides.....	0
Biological etc. materials.....	0
Biodegradable materials.....	
Putrescible wastes.....	0
Non-putrescible wastes.....	
Corrosive materials.....	0
Pyrophoric materials.....	0
Generating toxic gases.....	0
Reacting with water.....	0

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Active particles.....

Soluble solids as bulk chemical compounds.....

Hazardous substances / non hazardous pollutants: None expected.

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): Yes

EDTA.....

DPTA.....

NTA.....

Polycarboxylic acids……

Other organic complexants.....

Total complexing agents..... TR

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PACKAGING AND CONDITIONING

Conditioning method: This stream will be co-packaged with 9A25, 9A39, 9A47, 9A52, 9A60 and 9A66 in Type VI DCIC containers. Remainder of vault 1 waste streams will be co-packaged together in Concrete boxes (9A61, 9A62, 9A67, 9A32, 9A40, 9A48, 9A53, 9A73). Packages for vault 1 are assigned to 9A25, 9A32 & 9A73.

Plant Name: -

Location: Berkeley Site

Plant startup date: -

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

Target start date for packaging this stream: -

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

Likely container type comment: -

Range in container waste volume: -

Other information on containers: -

Likely conditioning matrix:

Other information: -

Conditioned density (t/m^3): -

Conditioned density comment: -

Other information on conditioning: -

Opportunities for alternative disposal routing:

Treatment	Stream volume (%)	Comment
-	-	-

RADIOACTIVITY

Source: Activation, when the associated fuel elements were irradiated, of nuclides incorporated into the graphite. Contamination by fission products and actinides when the fuel elements were in the fuel pond.

Uncertainty: The values quoted are indicative of the activities that might be expected.

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'.

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Measurement of radioactivities:	Specific activity is a function of Station operating history. Estimates were derived from theoretical assessments of activation product activity and from experimental measurements of the contamination of Magnox.
Other information:	-

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Nuclide	Mean radioactivity, TBq/m³ Waste at 1.4.2019	Bands and Code	Future arisings	Bands and Code	Nuclide	Mean radioactivity, TBq/m³ Waste at 1.4.2019	Bands and Code	Future arisings	Bands and Code
H 3	1.53E-02	C C 2			Gd 153		8		
Be 10		8			Ho 163		8		
C 14	1.00E-03	C C 2			Ho 166m	5.96E-06	C C 2		
Na 22		8			Tm 170		8		
Al 26		8			Tm 171		8		
Cl 36	2E-05	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	1E-05	C C 2			Pt 193		8		
Mn 53		8			Tl 204		8		
Mn 54		8			Pb 205		8		
Fe 55	9.40E-09	C C 2			Pb 210		8		
Co 60	4.13E-05	C C 2			Bi 208		8		
Ni 59	1E-07	C C 2			Bi 210m		8		
Ni 63	9.20E-06	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	3.76E-04	C C 2			Th 227		8		
Zr 93	4E-08	C C 2			Th 228		8		
Nb 91		8			Th 229		8		
Nb 92		8			Th 230		8		
Nb 93m	2.57E-08	C C 2			Th 232		8		
Nb 94	7.00E-07	C C 2			Th 234	7E-07	C C 2		
Mo 93	2.00E-08	C C 2			Pa 231		8		
Tc 97		8			Pa 233	4.16E-08	C C 2		
Tc 99	2E-07	C C 2			U 232		8		
Ru 106		8			U 233		8		
Pd 107		8			U 234	6.04E-07	C C 2		
Ag 108m	2.96E-06	C C 2			U 235	2E-08	C C 2		
Ag 110m		8			U 236	5.00E-08	C C 2		
Cd 109		8			U 238	7E-07	C C 2		
Cd 113m	2.2E-07	C C 2			Np 237	4.16E-08	C C 2		
Sn 119m		8			Pu 236		8		
Sn 121m	1.70E-07	C C 2			Pu 238	7.28E-05	C C 2		
Sn 123		8			Pu 239	2E-04	C C 2		
Sn 126	3.04E-09	C C 2			Pu 240	2.00E-04	C C 2		
Sb 125		8			Pu 241	1.69E-03	C C 2		
Sb 126		8			Pu 242	6E-08	C C 2		
Te 125m		8			Am 241	4.36E-04	C C 2		
Te 127m		8			Am 242m	3.76E-07	C C 2		
I 129		8			Am 243	8.00E-08	C C 2		
Cs 134		8			Cm 242	3.11E-07	C C 2		
Cs 135	6E-09	C C 2			Cm 243	3.80E-08	C C 2		
Cs 137	4.56E-04	C C 2			Cm 244	2.52E-07	C C 2		
Ba 133	9.12E-08	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	2.51E-07	C C 2			Cf 250		8		
Pm 147	3.77E-09	C C 2			Cf 251		8		
Sm 147		8			Cf 252		8		
Sm 151	9.11E-06	C C 2			Other a				
Eu 152	1.62E-04	C C 2			Other b/g				
Eu 154	7.58E-05	C C 2			**Total a**	**9.10E-04**	**C C 2**	**0**	
Eu 155	3.65E-07	C C 2			**Total b/g**	**1.92E-02**	**C C 2**	**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 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