WASTE STREAM 9A32 FED Graphite

SITE	Berkeley
SITE OWNER	Nuclear Decommissioning Authority
WASTE CUSTODIAN	Magnox Limited
WASTE TYPE	ILW
Is the waste subject to Scottish Policy:	No

WASTE VOLUMES

		Reported
Stocks:	At 1.4.2022.....	225.2 m^3
Total future arisings:		0 m^3
Total waste volume:		225.2 m^3

Comment on volumes: Station operation ceased in March 1989. This waste stream was accumulated between April 1967 and October 1972. 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, two per fuel element. 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 (100 vol%).

Sealed sources: The waste does not contain sealed sources.

Bulk density (t/m^3): 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 all of the waste. 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. Only trace quantities of metals as impurities incorporated into the graphite are expected.

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	(%wt)	Type(s) / Grade(s) with proportions	% of total C14 activity
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	0	There are no "other" metals.	

Organics (%wt): This loose graphite is currently stored in the same vault as the drums of ion exchange material, although in different sub-sections. It may be possible that the graphite has been contaminated with the ion exchange material that has leaked from the drums.

	(%wt)	Type(s) and comment	% of total C14 activity
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	TR		

Other materials (%wt): Principally graphite.

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	(%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.....			
Glass/Ceramics.....	0		
Graphite.....	>99.0		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.

	(%wt)	Type(s) and comment
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.

	(%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	

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Non-putrescible wastes.....		
Corrosive materials.....	0	
Pyrophoric materials.....	0	
Generating toxic gases.....	0	
Reacting with water.....	0	
Higher activity particles.....		
Soluble solids as bulk chemical compounds.....		

Hazardous substances / non hazardous pollutants: -

	(%wt)	Type(s) and comment
Acrylamide.....		
Benzene.....		
Chlorinated solvents.....		
Formaldehyde.....		
Organometallics.....		
Phenol.....		
Styrene.....		
Tri-butyl phosphate.....		
Other organophosphates.....		
Vinyl chloride.....		
Arsenic.....		
Barium.....		
Boron.....	0	
Boron (in Boral).....		
Boron (non-Boral).....		
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.....		

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Complexing agents (%wt): Yes

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

Potential for the waste to contain discrete items: Yes. Fuel Sleeves assumed to be DIs

PACKAGING AND CONDITIONING

Conditioning method: This stream will be co-packaged together in Concrete boxes (9A61, 9A62, 9A67, 9A40, 9A48, 9A53, 9A73). The remainder of vault 1 waste will be co-packaged together in Type VI DCIC containers (9A25, 9A31, 9A39, 9A47, 9A52, 9A60 and 9A66). 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
6m^3 concrete box (SD)	100.0	~2.619	5.8	86

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: -

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Baseline Management Route	Opportunity Management Route	Stream volume (%)	Estimated Date that Opportunity will be realised	Opportunity Confidence	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'.
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 1.4.2022	Bands and Code	Future arisings	Bands and Code	Nuclide	Mean radioactivity, TBq/m³ Waste at 1.4.2022	Bands and Code	Future arisings	Bands and Code
H 3	1.29E-02	C C 2			Gd 153		8		
Be 10		8			Ho 163		8		
C 14	2.00E-03	C C 2			Ho 166m	7.94E-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	2E-05	C C 2			Pt 193		8		
Mn 53		8			Tl 204		8		
Mn 54		8			Pb 205		8		
Fe 55	8.74E-09	C C 2			Pb 210		8		
Co 60	4.17E-05	C C 2			Bi 208		8		
Ni 59	2E-07	C C 2			Bi 210m		8		
Ni 63	1.80E-05	C C 2			Po 210		8		
Zn 65		8			Ra 223		8		
Se 79	5E-09	C C 2			Ra 225		8		
Kr 81		8			Ra 226		8		
Kr 85		8			Ra 228		8		
Rb 87		8			Ac 227		8		
Sr 90	3.50E-04	C C 2			Th 227		8		
Zr 93		8			Th 228		8		
Nb 91		8			Th 229		8		
Nb 92		8			Th 230		8		
Nb 93m	9.14E-09	C C 2			Th 232		8		
Nb 94	8.00E-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	4E-09	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	2.94E-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	3.31E-07	C C 2			Np 237	4.16E-08	C C 2		
Sn 119m		8			Pu 236		8		
Sn 121m	2.47E-07	C C 2			Pu 238	7.11E-05	C C 2		
Sn 123		8			Pu 239	2E-04	C C 2		
Sn 126	7E-09	C C 2			Pu 240	2.00E-04	C C 2		
Sb 125		8			Pu 241	1.46E-03	C C 2		
Sb 126		8			Pu 242	6E-08	C C 2		
Te 125m		8			Am 241	3.44E-04	C C 2		
Te 127m		8			Am 242m	3.71E-07	C C 2		
I 129		8			Am 243	8.00E-08	C C 2		
Cs 134		8			Cm 242	3.06E-07	C C 2		
Cs 135	6E-09	C C 2			Cm 243	4.25E-08	C C 2		
Cs 137	4.95E-04	C C 2			Cm 244	2.25E-07	C C 2		
Ba 133	1.49E-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	3.33E-07	C C 2			Cf 250		8		
Pm 147	3.81E-09	C C 2			Cf 251		8		
Sm 147		8			Cf 252		8		
Sm 151	8.90E-06	C C 2			Other a				
Eu 152	1.39E-04	C C 2			Other b/g				
Eu 154	5.95E-05	C C 2			**Total a**	**8.17E-04**	**C C 2**	**0**	
Eu 155	3.59E-07	C C 2			**Total b/g**	**1.75E-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