

WASTE STREAM	9A31	FED Graphite
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SITE Berkeley

SITE OWNER Nuclear Decommissioning Authority

WASTE CUSTODIAN Nuclear Restoration Services Ltd (NRS)

WASTE TYPE ILW

WASTE VOLUMES

	Reported (m ³)	OR	Conditioned (m ³)	Packaged (m ³)
Stocks:	At 1.4.2025			
Future arisings:	= 56.7			
Total future arisings:	0.0			
Total waste volume:	56.7			

Number of waste packages in stock: At 1.4.2025..... - packages

Comment on arising rates: -

Additional information on quantities: 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 1.10 Arisings (upper): x -
Stock (lower): x 0.90 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.

Changes since waste generated: -

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

Sheet metal proportion / thickness: There are no metallic items present.

Metals and alloys (%wt):

	(%wt)	Type(s) / Grades(s) with proportions	% of total C14 activity
Stainless steel.....	= 0	-	There are no "other" metals present. Only trace quantities of metals as impurities incorporated into the graphite are expected.
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	-	

Organics (%wt):

	(%wt)	Type(s) and comment	% of total C14 activity
Total cellulotics.....	= 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):

	(%wt)	Type(s) and comment	% of total C14 activity
Inorganic ion exchange materials.....	TR	-	99.0
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	-	

COMPONENTS OF MATERIALS, WASTE PROPERTIES, MATERIALS NOT CONTRIBUTING TO MASS

Inorganic anions (%wt):

	(%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:

	(%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.....	-	-
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.....	0	-
Benzene.....		-
Chlorinated solvents.....		-
Formaldehyde.....		-
Organometallics.....		-
Phenol.....		-
Styrene.....		-
Tri-butyl phosphate.....		-
Other organophosphates.....		-
Vinyl chloride.....		-
Arsenic.....		-
Barium.....		-
Boron.....		-
Boron (in Boral).....		-
Boron (non-Boral).....		-
Cadmium.....		-
Caesium.....		-
Selenium.....		-
Chromium.....		-
Molybdenum.....		-
Thallium.....		-
Tin.....		-
Vanadium.....		-
Mercury compounds.....		-
Others.....		-

Complexing agents (%wt):

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

Physical components:

	Number	Type(s) and comment
Sources.....		-
Electronic & Electrical Equipment (EEE)		-
EEE Type 1.....		-
EEE Type 2.....		-
EEE Type 3.....		-
EEE Type 4.....		-
EEE Type 5.....		-

TREATMENT, PACKAGING AND DISPOSAL

Planned on-site / off-site treatment(s):

Treatment	On-site / Off-site	Stream volume %
Size reduction Decay storage Low force compaction Supercompaction (HFC) Incineration Drying/dewatering/liquid separation Tie down/fixatives/strippable coating/painting application Decontamination Metal treatment Recycling / reuse Thermal treatment, including vitrification Encapsulation Polymer encapsulation Other physical treatment Other chemical treatment Containerisation Treatment not yet determined None		

Comments on planned treatments:

-

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.

Conditioning plants:

Plant Name	Location

Likely conditioning matrix:

-

Further information on the conditioning matrix:

-

Waste Packaging:

Likely container type:

Container	Waste packaged (vol%)	Waste loading (m³)	Payload (m³)	Number of packages	Estimated start date for packaging
-	-	-	-	-	-

Range in container waste loading: -

Other information on packaging and conditioning:

-

Conditioned density (t/m³):

-

Conditioned density comment:

-

Management Routes:

Disposal Route	Stream volume %	Raw density t/m³	Start date
Expected to be consigned to a Near Site, Near Surface Disposal Facility (Scotland)			
Expected to be Non-NSD HAW managed under Scottish Government's policy			
Expected to be disposed to LLW Vaults NRS Dounreay			
Expected to be consigned to the Geological Disposal Facility			
Expected to be consigned to a Near Surface Disposal Facility			
Expected to be consigned to the LLW Repository			
Expected to be consigned to a Landfill Facility			
Expected to be disposed On-Site			
Expected to be managed by In-Situ Disposal			
Expected to be consigned to an Incineration Facility			
Expected to be consigned to a Metal Treatment Facility			
Expected to be Out of Scope			
Expected to be recycled / reused			
Disposal route not known			

Classification codes for waste expected to be consigned to a landfill facility:

Opportunities for alternative disposal routing: No

Baseline Management Route	Opportunity Management Route	Stream volume (%)	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.

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.

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.
I-129: -
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.

WASTE STREAM			9A31		FED Graphite				
Nuclide	Mean radioactivity, TBq/m³				Nuclide	Mean radioactivity, TBq/m³			
	Waste at 1.4.2025	Bands and Code	Future Arisings	Bands and Code		Waste at 1.4.2025	Bands and Code	Future Arisings	Bands and Code
H 3	1.09E-02	C C 2			Gd 153		8		
Be 10					Ho 163		8		
C 14	9.99E-04	C C 2			Ho 166m	5.94E-06	C C 2		
Na 22					Tm 170		8		
Al 26					Tm 171		8		
Cl 36	2.00E-05	C C 2			Lu 174		8		
Ar 39					Lu 176		8		
Ar 42					Hf 178n		8		
K 40					Hf 182		8		
Ca 41	1.00E-05	C C 2			Pt 193		8		
Mn 53					Tl 204		8		
Mn 54					Pb 205		8		
Fe 55	2.05E-09	C C 2			Pb 210		8		
Co 60	1.88E-05	C C 2			Bi 208		8		
Ni 59	1.00E-07	C C 2			Bi 210m		8		
Ni 63	8.82E-06	C C 2			Po 210		8		
Zn 65					Ra 223		8		
Se 79					Ra 225		8		
Kr 81					Ra 226		8		
Kr 85					Ra 228		8		
Rb 87					Ac 227		8		
Sr 90	3.26E-04	C C 2			Th 227		8		
Zr 93	4.00E-08	C C 2			Th 228		8		
Nb 91					Th 229		8		
Nb 92					Th 230		8		
Nb 93m	3.26E-08	C C 2			Th 232		8		
Nb 94	7.00E-07	C C 2			Th 234	7.00E-07	C C 2		
Mo 93	2.00E-08	C C 2			Pa 231		8		
Tc 97					Pa 233	4.25E-08	C C 2		
Tc 99	2.00E-07	C C 2			U 232		8		
Ru 106					U 233		8		
Pd 107					U 234	6.05E-07	C C 2		
Ag 108m	2.93E-06	C C 2			U 235	2.00E-08	C C 2		
Ag 110m					U 236	5.01E-08	C C 2		
Cd 109					U 238	7.00E-07	C C 2		
Cd 113m	1.62E-07	C C 2			Np 237	4.25E-08	C C 2		
Sn 119m					Pu 236		8		
Sn 121m	1.58E-07	C C 2			Pu 238	6.94E-05	C C 2		
Sn 123					Pu 239	2.00E-04	C C 2		
Sn 126	3.04E-09	C C 2			Pu 240	2.00E-04	C C 2		
Sb 125					Pu 241	1.27E-03	C C 2		
Sb 126					Pu 242	6.00E-08	C C 2		
Te 125m					Am 241	4.45E-04	C C 2		
Te 127m					Am 242m	3.66E-07	C C 2		
I 129					Am 243	7.99E-08	C C 2		
Cs 134					Cm 242	3.02E-07	C C 2		
Cs 135	6.00E-09	C C 2			Cm 243	3.31E-08	C C 2		
Cs 137	3.97E-04	C C 2			Cm 244	2.01E-07	C C 2		
Ba 133	6.15E-08	C C 2			Cm 245		8		
La 137					Cm 246		8		
La 138					Cm 248		8		
Ce 144					Cf 249		8		
Pm 145	1.98E-07	C C 2			Cf 250		8		
Pm 147					Cf 251		8		
Sm 147					Cf 252		8		
Sm 151	8.70E-06	C C 2			Unsp a				
Eu 152	1.19E-04	C C 2			Unsp b/g				
Eu 154	4.67E-05	C C 2			Total a	9.17E-04	*	0	*
Eu 155	1.55E-07	C C 2			Total b/g	1.41E-02	*	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 the 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
* Total calculated from the 114 declared radionuclides