

WASTE STREAM	9A27	Sludge
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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.....	13.5 m ³
Total future arisings:		0 m ³
Total waste volume:		13.5 m ³
Comment on volumes:	Station operation ceased in March 1989. For Inventory purposes wastes arising during or after 1989 are also included in this waste stream.	
Uncertainty factors on volumes:	Stock (upper): x 1.1	Arisings (upper) x
	Stock (lower): x 0.9	Arisings (lower) x

WASTE SOURCE The sludge originates from routine filtration of liquid effluents and cooling pond water and from special clean-up operations on cooling ponds at Berkeley Power Station and Berkeley Centre.

PHYSICAL CHARACTERISTICS

General description: The waste consists of debris washed from persons, floors and clothing, corrosion products such as magnesium hydroxide and carbonate detached from fuel elements and extraneous materials such as flakes of paint. Also there is some filter sand. Sludge particles may be up to millimetre size, and there will probably be 50-450 kg/m³ of dry material. Once fluidised the sludges should be readily transferred by pumping but reconcentration may be time consuming. Some caesium resin beads are anticipated. There are no large items that may require special handling.

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

Sealed sources: The waste does not contain sealed sources.

Bulk density (t/m³): ~1.1

Comment on density: The density of sludge typically ranges from 1.05 to 1.15 t/m³.

CHEMICAL COMPOSITION

General description and components (%wt): Sand, magnesium hydroxide, magnesium carbonate and a range of other materials. Wt% has not been assessed.

Chemical state: Alkali

Chemical form of radionuclides:

- H-3: Most tritium is expected to be present as water but some may be present in the form of other organic or inorganic compounds.
- C-14: Carbon 14 may be present as graphite.
- Cl-36: The chemical form of chlorine 36 has not been assessed.
- Se-79: The selenium content is insignificant.
- Tc-99: The technetium content is insignificant.
- Ra: The radium isotope content is insignificant.
- Th: The thorium isotope content is insignificant.
- U: The chemical form of uranium isotopes has not been determined but may be present as uranium oxides.
- Np: The neptunium content is insignificant.
- Pu: The chemical form of plutonium isotopes has not been determined but may be present as plutonium oxides.

Metals and alloys (%wt): No bulk metal items present.

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	(%wt)	Type(s) / Grade(s) with proportions	% of total C14 activity
Stainless steel.....	NE		
Other ferrous metals.....	NE		
Iron.....			
Aluminium.....	<0.50		
Beryllium.....	TR		
Cobalt.....			
Copper.....	NE		
Lead.....	TR		
Magnox/Magnesium.....	<4.0		
Nickel.....			
Titanium.....			
Uranium.....			
Zinc.....	NE		
Zircaloy/Zirconium.....	NE		
Other metals.....	NE	The presence of "other" metals has not been fully assessed.	

Organics (%wt): A detailed assessment of organic materials in the waste has not been made. There may be some oil and grease. Some caesium resin beads are present.

	(%wt)	Type(s) and comment	% of total C14 activity
Total cellulosics.....	NE		
Paper, cotton.....	NE		
Wood.....	NE		
Halogenated plastics	<1.0	Halogenated plastics and rubbers might be present in small quantities.	
Total non-halogenated plastics.....	NE		
Condensation polymers.....	NE		
Others.....	NE		
Organic ion exchange materials....	NE		
Total rubber.....	NE		
Halogenated rubber	<1.0	Halogenated plastics and rubbers might be present in small quantities.	
Non-halogenated rubber.....	NE		
Hydrocarbons.....			
Oil or grease			
Fuel.....			
Asphalt/Tarmac (cont.coal tar)...			
Asphalt/Tarmac (no coal tar)....			
Bitumen.....			
Others.....			
Other organics.....	NE		

Other materials (%wt): -

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	(%wt)	Type(s) and comment	% of total C14 activity
Inorganic ion exchange materials..	NE		
Inorganic sludges and flocs.....	<93.5		
Soil.....	NE		
Brick/Stone/Rubble.....	NE		
Cementitious material.....	NE		
Sand.....			
Glass/Ceramics.....	NE		
Graphite.....	NE		
Desiccants/Catalysts.....			
Asbestos.....	0		
Non/low friable.....			
Moderately friable.....			
Highly friable.....			
Free aqueous liquids.....	P		
Free non-aqueous liquids.....	P		
Powder/Ash.....	0		

Inorganic anions (%wt): The presence of inorganic anions shown in the table has not been fully assessed.

	(%wt)	Type(s) and comment
Fluoride.....	NE	
Chloride.....	NE	
Iodide.....	NE	
Cyanide.....	0	
Carbonate.....	5.0	
Nitrate.....	NE	
Nitrite.....	NE	
Phosphate.....	NE	
Sulphate.....	0.90	
Sulphide.....	NE	

Materials of interest for waste acceptance criteria: The waste is unlikely to present a fire hazard but this requires confirmation since Magnox may be present and will ignite under appropriate conditions. There might be trace quantities of biological material.

	(%wt)	Type(s) and comment
Combustible metals.....	<4.0	
Low flash point liquids.....	0	
Explosive materials.....	0	
Phosphorus.....	0	
Hydrides.....	0	
Biological etc. materials.....	TR	
Biodegradable materials.....	0	
Putrescible wastes.....	0	
Non-putrescible wastes.....		

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Corrosive materials.....	0
Pyrophoric materials.....	0
Generating toxic gases.....	NE
Reacting with water.....	<4.0
Higher activity particles.....	
Soluble solids as bulk chemical compounds.....	

Hazardous substances / Toxic metals may be present in trace quantities.
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: No. In & of itself not a DI; assumed not likely to contain any "rogue" items that could be.

PACKAGING AND CONDITIONING

- Conditioning method: -
- Plant Name: -
- Location: Berkeley Site
- Plant startup date: -
- Total capacity (m³/y incoming waste): -
- Target start date for packaging this stream: -
- Throughput for this stream (m³/y incoming waste): -
- Other information: -

Likely container type:	Container	Waste packaged (%vol)	Waste loading (m³)	Payload (m³)	Number of packages
	3m³ RS box	100.0	3.375	2.5	4

Likely container type comment: The waste has now been transferred to Mules awaiting conditioning.

- Range in container waste volume: -
- Other information on containers: -
- Likely conditioning matrix: -
- Other information: -
- Conditioned density (t/m³): -
- Conditioned density comment: -
- Other information on conditioning: -
- Opportunities for alternative disposal routing: -

Baseline Management Route	Opportunity Management Route	Stream volume (%)	Estimated Date that Opportunity will be realised	Opportunity Confidence	Comment
-	-	-	-	-	-

RADIOACTIVITY

Source:	Sludge contaminated by fission products and activation products including actinides.
Uncertainty:	Specific activity is a function of Station operating history. The values 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:	The values quoted were derived by extrapolation from available measurements.
Other information:	-

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Nuclide	Mean radioactivity, TBq/m ³				Nuclide	Mean radioactivity, TBq/m ³			
	Waste at 1.4.2022	Bands and Code	Future arisings	Bands and Code		Waste at 1.4.2022	Bands and Code	Future arisings	Bands and Code
H 3	1.29E-04	CC 2			Gd 153			8	
Be 10	2E-08	CC 2			Ho 163			8	
C 14	4.00E-04	CC 2			Ho 166m			8	
Na 22		8			Tm 170			8	
Al 26	5E-06	CC 2			Tm 171			8	
Cl 36	2E-05	CC 2			Lu 174			8	
Ar 39		8			Lu 176			8	
Ar 42		8			Hf 178n			8	
K 40		8			Hf 182			8	
Ca 41	3E-06	CC 2			Pt 193			8	
Mn 53		8			Tl 204			8	
Mn 54		8			Pb 205			8	
Fe 55	1.97E-06	CC 2			Pb 210			8	
Co 60	4.17E-05	CC 2			Bi 208			8	
Ni 59	3E-06	CC 2			Bi 210m			8	
Ni 63	4.51E-04	CC 2			Po 210			8	
Zn 65		8			Ra 223			8	
Se 79	1.72E-08	CC 2			Ra 225			8	
Kr 81		8			Ra 226			8	
Kr 85		8			Ra 228			8	
Rb 87		8			Ac 227			8	
Sr 90	1.39E-02	CC 2			Th 227			8	
Zr 93	6E-07	CC 2			Th 228			8	
Nb 91		8			Th 229			8	
Nb 92		8			Th 230			8	
Nb 93m	3.85E-07	CC 2			Th 232			8	
Nb 94		8			Th 234	2E-06	CC 2		
Mo 93		8			Pa 231			8	
Tc 97		8			Pa 233	9E-06	CC 2		
Tc 99	2E-07	CC 2			U 232			8	
Ru 106		8			U 233			8	
Pd 107	3E-08	CC 2			U 234	1.00E-06	CC 2		
Ag 108m	9.75E-09	CC 2			U 235	5E-08	CC 2		
Ag 110m		8			U 236	2.00E-07	CC 2		
Cd 109		8			U 238	2E-06	CC 2		
Cd 113m	9.45E-08	CC 2			Np 237	9E-06	CC 2		
Sn 119m		8			Pu 236			8	
Sn 121m	8.21E-04	CC 2			Pu 238	2.66E-04	CC 2		
Sn 123		8			Pu 239	7.00E-04	CC 2		
Sn 126	8.7E-08	CC 2			Pu 240	7.00E-04	CC 2		
Sb 125	2.04E-08	CC 2			Pu 241	1.46E-03	CC 2		
Sb 126	1.22E-08	CC 2			Pu 242	6E-07	CC 2		
Te 125m	5.12E-09	CC 2			Am 241	4.41E-04	CC 2		
Te 127m		8			Am 242m	3.71E-06	CC 2		
I 129	9E-09	CC 2			Am 243	2.00E-06	CC 2		
Cs 134	2.60E-08	CC 2			Cm 242	3.06E-06	CC 2		
Cs 135	2E-06	CC 2			Cm 243	4.95E-06	CC 2		
Cs 137	1.41E-01	CC 2			Cm 244	2.83E-06	CC 2		
Ba 133		8			Cm 245			8	
La 137		8			Cm 246			8	
La 138		8			Cm 248			8	
Ce 144		8			Cf 249			8	
Pm 145		8			Cf 250			8	
Pm 147	9.46E-07	CC 2			Cf 251			8	
Sm 147		8			Cf 252			8	
Sm 151	7.12E-05	CC 2			Other a				
Eu 152	1.39E-06	CC 2			Other b/g				
Eu 154	5.95E-05	CC 2			Total a	2.13E-03	CC 2	0	
Eu 155	3.59E-06	CC 2			Total b/g	1.59E-01	CC 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