

<b>WASTE STREAM</b>	<b>9B02/C</b>	<b>Ion Exchange Material</b>
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**SITE** Bradwell

**SITE OWNER** Nuclear Decommissioning Authority

**WASTE CUSTODIAN** Magnox Limited

**WASTE TYPE** ILW

**WASTE VOLUMES**

		Conditioned	Packaged
Stocks:	At 1.4.2019.....	16.4 m <sup>3</sup>	54.0 m <sup>3</sup>
Total future arisings:		0 m <sup>3</sup>	0 m <sup>3</sup>
Total waste volume:		16.4 m <sup>3</sup>	54.0 m <sup>3</sup>
Number of waste packages in stock:	At 1.4.2019.....	41 package(s)	
Comment on volumes:	-		
Uncertainty factors on volumes:	Stock (upper):	x 1.2	Arisings (upper) x
	Stock (lower):	x 0.8	Arisings (lower) x

**WASTE SOURCE** Pond water treatment plant. Pre-treatment cation (predominantly Caesium) exchange unit.

**PHYSICAL CHARACTERISTICS**

**General description:** Waste consists of spent ion exchange (IX) material from the treatment of pond waters. This includes natural zeolite (Attapulugus clay) and synthetic zeolites (AW 500, Duocil and Decalso Y), as well as organic (phenol formaldehyde-based cation resins (Lewatit DN and Duolite C3). Ion exchange resins are dried, prior to packaging, to remove all interstitial water.

**Physical components (%wt):** The following breakdown is approximate for waste in waste packages- ion exchange material ~35 %wt and bound water ~65 %wt.

**Sealed sources:** -

**Bulk density (t/m<sup>3</sup>):** ~0.7

**Comment on density:** The bulk density of the dried waste ranges from 0.36 to 0.90 (t/m<sup>3</sup>)

**CHEMICAL COMPOSITION**

**General description and components (%wt):** Ion exchange materials that have been used include: Lewatit DN Bead (organic), Decalso Y Synthetic Zeolite (inorganic), Decalso Duocil (inorganic), Duolite C3 (organic), AW 500 Synthetic Zeolite (inorganic) and Attapulugus Clay (inorganic).

**Chemical state:** Alkali

**Chemical form of radionuclides:**  
 H-3: Most tritium is expected to be present as water but some may be in the form of other inorganic compounds or as organic compounds.  
 C-14: Carbon 14 will probably be present as graphite.  
 Cl-36: Chlorine 36 will probably be present as inorganic chloride.  
 Se-79: The chemical form of selenium has not been determined.  
 Tc-99: The chemical form of technetium has not been determined.  
 U: The chemical form of uranium isotopes has not been assessed.  
 Np: The chemical form of neptunium has not been determined.  
 Pu: The chemical form of plutonium isotopes has not been assessed.

**Metals and alloys (%wt):** -

Stainless steel.....	NE
Other ferrous metals.....	<0.01
Iron.....	
Aluminium.....	<3.0
Beryllium.....	TR
Cobalt.....	
Copper.....	NE
Lead.....	TR

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	Magnox/Magnesium.....	TR	
	Nickel.....		
	Titanium.....		
	Uranium.....	NE	
	Zinc.....	NE	
	Zircaloy/Zirconium.....	NE	
	Other metals.....	NE	"Other" metals have not been identified.
Organics (%wt):	Proprietary ion exchange resins are present. There is no oil or grease.		
	Total cellulose.....	0	
	Paper, cotton.....	0	
	Wood.....	0	
	Halogenated plastics .....	0	
	Total non-halogenated plastics.....	0	
	Condensation polymers.....	0	
	Others.....	0	
	Organic ion exchange materials....	~41.9	Lewatit DN Bead (organic) and Duolite C3 (organic) - (of which 27.3% is water chemically bound to the resin)
	Total rubber.....	0	
	Halogenated rubber .....	0	
	Non-halogenated rubber.....	0	
	Hydrocarbons.....		
	Oil or grease .....	0	
	Fuel.....		
	Asphalt/Tarmac (cont.coal tar)...		
	Asphalt/Tarmac (no coal tar)....		
	Bitumen.....		
	Others.....		
	Other organics.....	0	
Other materials (%wt):	-		
	Inorganic ion exchange materials.	~58.1	Decalso Y Synthetic Zeolite (inorganic), Decalso Duocil (inorganic), AW 500 Synthetic Zeolite (inorganic) and Attapulgas Clay (inorganic). - (of which 37.8% is water chemically bound to the resin)
	Inorganic sludges and flocs.....	NE	
	Soil.....	0	
	Brick/Stone/Rubble.....	0	
	Cementitious material.....	0	
	Sand.....		
	Glass/Ceramics.....	0	
	Graphite.....	0	
	Desiccants/Catalysts.....		

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	Asbestos.....	0
	Non/low friable.....	
	Moderately friable.....	
	Highly friable.....	
	Free aqueous liquids.....	0
	Free non-aqueous liquids.....	0
	Powder/Ash.....	0
Inorganic anions (%wt):	Not fully assessed.	
	Fluoride.....	NE
	Chloride.....	NE
	Iodide.....	NE
	Cyanide.....	0
	Carbonate.....	<1.0
	Nitrate.....	NE
	Nitrite.....	NE
	Phosphate.....	NE
	Sulphate.....	0.01
	Sulphide.....	NE
Materials of interest for waste acceptance criteria:	No materials likely to pose a fire or other non-radiological hazard have been identified. There are trace quantities of metallic magnesium.	
	Combustible metals.....	TR
	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.....	TR
	Active particles.....	
	Soluble solids as bulk chemical compounds.....	
Hazardous substances / non hazardous pollutants:	None expected.	
	Acrylamide.....	
	Benzene.....	
	Chlorinated solvents.....	
	Formaldehyde.....	
	Organometallics.....	

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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):

EDTA.....  
 DPTA.....  
 NTA.....  
 Polycarboxylic acids.....  
 Other organic complexants.....  
 Total complexing agents..... TR

**PACKAGING AND CONDITIONING**

Container type:	Container	Waste packaged (%vol)	Waste loading (m³)	Payload (m³)	Number of packages
	500 l RS drum (0mm Pb)	100.0	0.4	0.4	41

Container type comment: -

Range in container waste volume: No significant variability is expected.

Other information on containers: -

Conditioned density (t/m³): ~0.7

Conditioned density comment: The bulk density of the dried waste ranges from 0.36 to 0.90 (t/m3)

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Other information on conditioning:

-

**RADIOACTIVITY**

Source:

Spent ion exchange materials from the treatment of pond water to remove soluble cationic species, Predominantly caesium-137. Contamination by fission products, actinides and activation products.

Uncertainty:

The values for the radionuclides are taken from characterisation data based on sampling and analysis and as such are accurate to within sampling errors.

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:

Values were determined from sampling data.

Other information:

-

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Nuclide	Mean radioactivity, TBq/m <sup>3</sup>				Nuclide	Mean radioactivity, TBq/m <sup>3</sup>			
	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	1.72E-05	BB 1			Gd 153		8		
Be 10		8			Ho 163	2.03E-06	CC 2		
C 14	2.56E-06	BB 1			Ho 166m		8		
Na 22		8			Tm 170		8		
Al 26		8			Tm 171		8		
Cl 36	1.13E-09	CC 2			Lu 174		8		
Ar 39	2.31E-07	CC 2			Lu 176	3.66E-06	CC 2		
Ar 42		8			Hf 178n		8		
K 40		8			Hf 182	1.49E-07	CC 2		
Ca 41	4.13E-09	CC 2			Pt 193	8.98E-07	CC 2		
Mn 53		8			Tl 204		8		
Mn 54		8			Pb 205		8		
Fe 55	1.74E-08	BB 1			Pb 210	7.64E-08	CC 2		
Co 60	1.98E-05	BB 1			Bi 208		8		
Ni 59	9.11E-09	CC 2			Bi 210m		8		
Ni 63	9.6E-07	BB 1			Po 210	6.86E-08	CC 2		
Zn 65		8			Ra 223		8		
Se 79	6.85E-09	CC 2			Ra 225		BB 1		
Kr 81		8			Ra 226	5.38E-07	CC 2		
Kr 85	2.29E-04	CC 2			Ra 228		8		
Rb 87		8			Ac 227		8		
Sr 90	1.83E-01	BB 1			Th 227		8		
Zr 93		8			Th 228	8.64E-09	CC 2		
Nb 91		8			Th 229		8		
Nb 92		8			Th 230		8		
Nb 93m	7.08E-08	CC 2			Th 232		8		
Nb 94	1.16E-08	CC 2			Th 234	1.29E-08	CC 2		
Mo 93		8			Pa 231		8		
Tc 97		8			Pa 233	4.74E-08	CC 2		
Tc 99	2.74E-06	CC 2			U 232	1.4E-08	CC 2		
Ru 106		8			U 233		8		
Pd 107	1.67E-08	CC 2			U 234	1.01E-09	CC 2		
Ag 108m	9.3E-09	CC 2			U 235	1.95E-09	CC 2		
Ag 110m		8			U 236	4.4E-07	BB 1		
Cd 109		8			U 238	1.29E-08	CC 2		
Cd 113m	7.75E-07	CC 2			Np 237	4.74E-08	CC 2		
Sn 119m		8			Pu 236	1.5E-07	CC 2		
Sn 121m	1.02E-09	CC 2			Pu 238	7.28E-06	CC 2		
Sn 123		8			Pu 239		8		
Sn 126	6.22E-08	CC 2			Pu 240	5.59E-05	BB 1		
Sb 125	5.22E-07	CC 2			Pu 241	6.6E-05	BB 1		
Sb 126	8.71E-09	CC 2			Pu 242	8.33E-05	BB 1		
Te 125m	1.31E-07	CC 2			Am 241	6.8E-07	CC 2		
Te 127m		8			Am 242m	2.56E-04	BB 1		
I 129	5.8E-09	CC 2			Am 243	1.61E-07	CC 2		
Cs 134	3.07E-04	BB 1			Cm 242	2.11E-04	BB 1		
Cs 135	2.2E-05	CC 2			Cm 243	1.12E-07	BB 1		
Cs 137	1.57E+00	BB 1			Cm 244	1.79E-06	BB 1		
Ba 133	5.98E-08	CC 2			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	2.09E-05	BB 1			Cf 251		8		
Sm 147	2.08E-05	BB 1			Cf 252		8		
Sm 151	2.84E-09	CC 2			Other a				
Eu 152	5.05E-07	BB 1			Other b/g	1.49E-07	CC 2		
Eu 154	4.68E-06	CC 2			<b>Total a</b>	<b>3.82E-04</b>	<b>CC 2</b>	<b>0</b>	
Eu 155		8			<b>Total b/g</b>	<b>1.75E+00</b>	<b>CC 2</b>	<b>0</b>	

**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