

WASTE STREAM	9B82/C	FED Magnox Dissolution Secondary Waste (Sludge)
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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.....	1.4 m ³	7.9 m ³
Total future arisings:		0 m ³	0 m ³
Total waste volume:		1.4 m ³	7.9 m ³
Number of waste packages in stock:	At 1.4.2019.....	6 package(s)	
Comment on volumes:	-		
Uncertainty factors on volumes:	Stock (upper): x 1.1	Arisings (upper)	x
	Stock (lower): x 0.9	Arisings (lower)	x

WASTE SOURCE The sludge and ion exchange material originate from the abatement of the dissolution plant discharges. During the abatement process, constituents that are insoluble in acid will be containerised in sludge tank(s).

PHYSICAL CHARACTERISTICS

General description: The waste consists of insoluble constituents of Magnox arising following the pH correction of FED dissolution discharges. There are no large items that may require special handling. Sludge particles (includes un-dissolved material) may be up to 3 millimetres in size.

Physical components (%wt): Sludge (99%) and ion exchange resin (TR)

Sealed sources: -

Bulk density (t/m³): ~0.7

Comment on density: -

CHEMICAL COMPOSITION

General description and components (%wt): Insoluble residues from chemical dissolution of Magnox (including Fe, Ce, Co, Zn, Zr and Al). Siliceous materials including sand, some oil contamination and a range of other materials.

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 inorganic compounds or as organic compounds.
C-14: Carbon 14 may be present as graphite.
Cl-36: The chemical form of chlorine 36 may be inorganic chloride.
U: The chemical form of uranium isotopes has not been determined but will probably be uranium oxides.
Pu: The chemical form of plutonium isotopes has not been determined but will probably be plutonium oxides.

Metals and alloys (%wt): No bulk or sheet metal items (the sludge has not been transferred in its container).

Stainless steel.....	NE
Other ferrous metals.....	NE
Iron.....	
Aluminium.....	NE
Beryllium.....	TR
Cobalt.....	
Copper.....	NE
Lead.....	TR
Magnox/Magnesium.....	TR

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Nickel.....

Titanium.....

Uranium.....

Zinc..... NE

Zircaloy/Zirconium..... NE

Other metals..... NE

The "other" metal content has not been fully assessed.

Organics (%wt):

The cellulosic material content of the waste has not been assessed. Ion exchange materials would be expected in only trace amounts. There are no halogenated plastics or rubbers present.

Total cellulose..... NE

Paper, cotton..... NE

Wood..... NE

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..... ~1.0

Other materials (%wt):

These figures relate only to the assumed composition of the sludge and ion exchange material. The sludge may contain traces of ion exchange resin. The composition of the modules has not been included as the modules will be handled and disposed separately. The sludge is assumed to consist of less than 10% magnesium compounds.

Inorganic ion exchange materials. TR

Inorganic sludges and flocs..... ~99.0

Soil..... 0

Brick/Stone/Rubble..... 0

Cementitious material..... 0

Sand.....

Glass/Ceramics..... 0

Graphite..... NE

Desiccants/Catalysts.....

Asbestos..... 0

Non/low friable.....

Moderately friable.....

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	Highly friable.....	
	Free aqueous liquids.....	0
	Free non-aqueous liquids.....	TR
	Powder/Ash.....	0
Inorganic anions (%wt):	Not fully assessed. Carbonates are expected to be present.	
	Fluoride.....	NE
	Chloride.....	NE
	Iodide.....	NE
	Cyanide.....	0
	Carbonate.....	NE
	Nitrate.....	NE
	Nitrite.....	NE
	Phosphate.....	NE
	Sulphate.....	NE
	Sulphide.....	NE
Materials of interest for waste acceptance criteria:	There might be trace quantities of biological material. The possible presence is to be determined.	
	Combustible metals.....	<1.0
	Low flash point liquids.....	0
	Explosive materials.....	0
	Phosphorus.....	0
	Hydrides.....	0
	Biological etc. materials.....	TR
	Biodegradable materials.....	
	Putrescible wastes.....	0
	Non-putrescible wastes.....	
	Corrosive materials.....	0
	Pyrophoric materials.....	0
	Generating toxic gases.....	NE
	Reacting with water.....	<1.0
	Active particles.....	
	Soluble solids as bulk chemical compounds.....	
Hazardous substances / non hazardous pollutants:	-	
	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

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	0.24	0.24	6

Container type comment: -

Range in container waste volume: -

Other information on containers: The container material is cast iron.

Conditioned density (t/m³): -

Conditioned density comment: -

Other information on conditioning: The sludge has been conditioned using a thermal vacuum drying process. The conditioning process was cyclical and required alternate addition of sludge to the DCIC and drying of the contents of the DCIC until the required sludge packing density and dryness was achieved.

RADIOACTIVITY

Source:	Contaminated sludge. Contamination by fission products, actinides and activation products.
Uncertainty:	Specific activities of all 6 waste packages were determined using gamma spectroscopy and fingerprints. The above values (Tbq/m ³) are representative of the waste across the packages and each package's specific activity falls within the quoted uncertainty bands.
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 activities of all 6 waste packages were measured and derived using gamma spectroscopy and the application of fingerprints.
Other information:	-

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Nuclide	Mean radioactivity, TBq/m ³				Nuclide	Mean radioactivity, TBq/m ³			
	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	8.08E-02	CC 2			Gd 153		8		
Be 10		8			Ho 163	6.39E-08	CC 2		
C 14	4.13E-03	CC 2			Ho 166m	2.72E-08	CC 2		
Na 22		8			Tm 170		8		
Al 26		8			Tm 171	2.87E-09	CC 2		
Cl 36	8.45E-05	CC 2			Lu 174		8		
Ar 39	2.00E-03	CC 2			Lu 176		8		
Ar 42	3.30E-07	CC 2			Hf 178n	5.2E-08	CC 2		
K 40	8.40E-08	CC 2			Hf 182		8		
Ca 41	1.15E-03	CC 2			Pt 193	6.31E-03	CC 2		
Mn 53		8			Tl 204	4.70E-08	CC 2		
Mn 54	6.66E-09	CC 2			Pb 205		8		
Fe 55	8.80E-03	CC 2			Pb 210		8		
Co 60	9.78E-03	BB 1			Bi 208		8		
Ni 59	1.05E-04	CC 2			Bi 210m		8		
Ni 63	2.60E-02	CC 2			Po 210		8		
Zn 65	4.20E-09	CC 2			Ra 223		8		
Se 79		8			Ra 225		8		
Kr 81		8			Ra 226		8		
Kr 85	5.49E-06	CC 2			Ra 228		8		
Rb 87		8			Ac 227		8		
Sr 90	5.28E-05	CC 2			Th 227		8		
Zr 93	8.53E-06	CC 2			Th 228	4.81E-09	CC 2		
Nb 91		8			Th 229		8		
Nb 92		8			Th 230		8		
Nb 93m	2.88E-03	CC 2			Th 232		8		
Nb 94	3.88E-06	CC 2			Th 234	7.99E-07	CC 2		
Mo 93	2.85E-06	CC 2			Pa 231		8		
Tc 97		8			Pa 233	9.43E-08	CC 2		
Tc 99	6.19E-05	CC 2			U 232	4.69E-09	CC 2		
Ru 106	3.29E-09	CC 2			U 233	9.32E-09	CC 2		
Pd 107		8			U 234	2.28E-06	CC 2		
Ag 108m	5.10E-04	CC 2			U 235	5.84E-08	CC 2		
Ag 110m		8			U 236	2.16E-07	CC 2		
Cd 109	5.94E-07	CC 2			U 238	7.99E-07	CC 2		
Cd 113m	1.59E-08	CC 2			Np 237	9.43E-08	CC 2		
Sn 119m		8			Pu 236		8		
Sn 121m	8.73E-06	CC 2			Pu 238	1.64E-04	CC 2		
Sn 123		8			Pu 239	2.96E-04	CC 2		
Sn 126		8			Pu 240	2.94E-04	CC 2		
Sb 125	1.78E-07	CC 2			Pu 241	3.9E-03	CC 2		
Sb 126		8			Pu 242	3.89E-07	CC 2		
Te 125m	4.47E-08	CC 2			Am 241	1.12E-03	CC 2		
Te 127m		8			Am 242m	2.52E-06	CC 2		
I 129	6.50E-06	CC 2			Am 243	7.32E-07	CC 2		
Cs 134	2.41E-06	CC 2			Cm 242	2.06E-06	CC 2		
Cs 135	1.67E-09	CC 2			Cm 243	2.87E-07	CC 2		
Cs 137	1.38E-04	BB 1			Cm 244	4.72E-06	CC 2		
Ba 133	4.70E-04	CC 2			Cm 245		8		
La 137	8.79E-08	CC 2			Cm 246		8		
La 138		8			Cm 248		8		
Ce 144		8			Cf 249		8		
Pm 145		8			Cf 250		8		
Pm 147	6.58E-05	CC 2			Cf 251		8		
Sm 147		8			Cf 252		8		
Sm 151	2.50E-04	CC 2			Other a				
Eu 152	1.62E-05	CC 2			Other b/g				
Eu 154	8.92E-05	CC 2			Total a	1.88E-03	CC 2	0	
Eu 155	8.57E-05	CC 2			Total b/g	1.48E-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