

WASTE STREAM	5C18/C	Encapsulated ILW Liquors
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SITE Harwell

SITE OWNER Nuclear Decommissioning Authority

WASTE CUSTODIAN Magnox Limited

WASTE TYPE ILW

WASTE VOLUMES

		Conditioned	Packaged
Stocks:	At 1.4.2019.....	16.4 m ³	23.4 m ³
Total future arisings:		0 m ³	0 m ³
Total waste volume:		16.4 m ³	23.4 m ³
Number of waste packages in stock:	At 1.4.2019.....	41 package(s)	

Comment on volumes: All the Stored Legacy ILW liquors (5C18) have been encapsulated. Some of the conditioned liquors have been re-characterised as LLW and consigned to LLWR. Volume is well defined because all waste is encapsulated in 500L drums.

Uncertainty factors on volumes:
 Stock (upper): x 1.05 Arisings (upper) x
 Stock (lower): x 0.95 Arisings (lower) x

WASTE SOURCE Encapsulation of laboratory wastes from development of fuel processing, the fast reactor programme and various radiochemical investigations.

PHYSICAL CHARACTERISTICS

General description: Solid waste made up of primarily cement grouting contaminated with fission products, activation products and actinides. The waste was acidic with the original liquors having a pH of 0.36 to 0.98. After mixing with grout it is alkaline.

Physical components (%vol): Solids 100%

Sealed sources: -

Bulk density (t/m³): ~2

Comment on density: This is the mean bulk density at 100% solids (as stored).

CHEMICAL COMPOSITION

General description and components (%wt): Encapsulated solid waste containing uranium(21% w/v), nitrate (1.3-4.0% w/v), thorium (up to 3.0% w/v), sulphate (0.1-0.3% w/v) and chloride (0.1% w/v).

Chemical state: Alkali

Chemical form of radionuclides:
 H-3: Incorporated in cement grouting
 Cl-36: Soluble salts incorporated in cement grouting
 I-129: Soluble salts incorporated in cement grouting
 Ra: Soluble salts incorporated in cement grouting
 Th: Soluble salts incorporated in cement grouting
 U: Soluble salts and U235 present as depleted uranium, incorporated in cement grouting
 Pu: Soluble salts incorporated in cement grouting

Metals and alloys (%wt):

-
Stainless steel..... 0
Other ferrous metals..... 0
Iron.....
Aluminium..... 0
Beryllium..... 0
Cobalt.....
Copper..... 0
Lead..... 0
Magnox/Magnesium..... 0
Nickel.....

WASTE STREAM**5C18/C****Encapsulated ILW Liquors**

Titanium.....
 Uranium..... 0
 Zinc..... 0
 Zircaloy/Zirconium..... 0
 Other metals..... 0

Uranium and thorium are present, but are incorporated with grout minerals and so not present as pure metals.

Organics (%wt):

-
 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.... 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..... 0

Other materials (%wt):

-
 Inorganic ion exchange materials. 0
 Inorganic sludges and flocs..... 0
 Soil..... 0
 Brick/Stone/Rubble..... 0
 Cementitious material..... 100.0
 Sand.....
 Glass/Ceramics..... 0
 Graphite..... 0
 Desiccants/Catalysts.....
 Asbestos..... 0
 Non/low friable.....
 Moderately friable.....
 Highly friable.....
 Free aqueous liquids..... 0
 Free non-aqueous liquids..... 0

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	Powder/Ash.....	0
Inorganic anions (%wt):	Values given are from sampling and analysis of the liquors, and by taking into account the change in density of the waste following encapsulation.	
	Fluoride.....	
	Chloride.....	0.10
	Iodide.....	
	Cyanide.....	
	Carbonate.....	
	Nitrate.....	4.0
	Nitrite.....	
	Phosphate.....	0.20
	Sulphate.....	0.30
	Sulphide.....	
Materials of interest for waste acceptance criteria:	Encapsulated free liquids will not present any non-radiological hazard.	
	Combustible metals.....	0
	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.....	0
	Active particles.....	
	Soluble solids as bulk chemical compounds.....	
Hazardous substances / non hazardous pollutants:	There are no toxic metals present.	
	Acrylamide.....	
	Benzene.....	
	Chlorinated solvents.....	
	Formaldehyde.....	
	Organometallics.....	
	Phenol.....	
	Styrene.....	
	Tri-butyl phosphate.....	
	Other organophosphates.....	
	Vinyl chloride.....	
	Arsenic.....	

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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..... 0.01
 Total complexing agents..... 0.01

The waste contains tributyl
 phosphate (0.01%)

PACKAGING AND CONDITIONING

Container type:	Container	Waste packaged (%vol)	Waste loading (m ³)	Payload (m ³)	Number of packages
	500 l drum (pre-cast annular)	100.0	0.4	0.4	41

Container type comment: -

Range in container waste volume: -

Other information on containers: -

Conditioned density (t/m³): 2.0

Conditioned density comment: Weight of conditioned waste in each drum = 772kg. Volume of original waste in each drum = 386 litres. Density range 1.95 to 2.03 t/m³.

Other information on conditioning: -

RADIOACTIVITY

Source: -

Uncertainty: Tritium, mixed fission products, activation products and actinides from MTR operations, laboratory investigations and decontamination operations.

WASTE STREAM**5C18/C****Encapsulated ILW Liquors**

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 specific activities have been derived measurements of the liquors. Activity data needs to be reassessed post-2019 UKRWI due to changes noted in Magnox Technical Note 462/TN/1379.

Other information:

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WASTE STREAM

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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	1.31E-03	AA 1			Gd 153		8		
Be 10		8			Ho 163		8		
C 14		8			Ho 166m		8		
Na 22		8			Tm 170		8		
Al 26		8			Tm 171		8		
Cl 36		8			Lu 174		8		
Ar 39		8			Lu 176		8		
Ar 42		8			Hf 178n		8		
K 40		8			Hf 182		8		
Ca 41		8			Pt 193		8		
Mn 53		8			Tl 204		8		
Mn 54		8			Pb 205		8		
Fe 55		8			Pb 210	2.64E-04	AA 1		
Co 60	3.98E-04	AA 1			Bi 208		8		
Ni 59		8			Bi 210m		8		
Ni 63	3.57E-06	AA 1			Po 210	2.56E-04	AA 1		
Zn 65		8			Ra 223	1.08E-06	BB 2		
Se 79		8			Ra 225		8		
Kr 81		8			Ra 226	7.10E-04	BB 1		
Kr 85		8			Ra 228	1.03E-04	AA 1		
Rb 87		8			Ac 227	1.09E-06	BB 1		
Sr 90	2.39E-03	AA 1			Th 227	1.07E-06	BB 2		
Zr 93		8			Th 228	9.78E-05	BB 1		
Nb 91		8			Th 229		8		
Nb 92		8			Th 230	1.92E-07	BB 2		
Nb 93m		8			Th 232	1.14E-04	BB 1		
Nb 94		8			Th 234	2.48E-03	BB 1		
Mo 93		8			Pa 231	2.88E-06	BB 1		
Tc 97		8			Pa 233	7.26E-08	BB 2		
Tc 99		8			U 232		8		
Ru 106		8			U 233		8		
Pd 107		8			U 234	2.32E-03	BB 1		
Ag 108m		8			U 235	1.14E-04	BB 1		
Ag 110m		8			U 236	7.77E-09	BB 2		
Cd 109		8			U 238	2.48E-03	BB 1		
Cd 113m		8			Np 237	7.35E-08	BB 2		
Sn 119m		8			Pu 236		8		
Sn 121m		8			Pu 238	5.85E-03	BB 1		
Sn 123		8			Pu 239	2.83E-02	BB 1		
Sn 126		8			Pu 240	2.92E-02	BB 1		
Sb 125		8			Pu 241	2.36E-01	AA 1		
Sb 126		8			Pu 242	4.04E-05	BB 1		
Te 125m		8			Am 241	2.70E-02	BB 1		
Te 127m		8			Am 242m		8		
I 129		8			Am 243		8		
Cs 134		8			Cm 242		8		
Cs 135		8			Cm 243		8		
Cs 137	5.55E-02	AA 1			Cm 244	4.39E-04	BB 1		
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		8			Cf 251		8		
Sm 147		8			Cf 252		8		
Sm 151		8			Other a				
Eu 152	2.06E-05	AA 1			Other b/g				
Eu 154	1.3E-05	AA 1			Total a	9.69E-02	BB 1	0	
Eu 155	6.58E-07	AA 1			Total b/g	2.99E-01	BB 1	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