WASTE STREAM 9B59/C FED Magnox

SITE Bradwell

SITE OWNER Nuclear Decommissioning Authority

WASTE CUSTODIAN Magnox Limited

WASTE TYPE ILW

WASTE VOLUMES

		Conditioned	Packaged
Stocks:	At 1.4.2019.....	5.2 m³	13.2 m³
Total future arisings:		0 m³	0 m³
Total waste volume:		5.2 m³	13.2 m³
Number of waste packages in stock:	At 1.4.2019.....	10 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 The source of the waste is the removal of splitters from fuel elements prior to dispatch of the elements for reprocessing. This waste was processed through the FED dissolution plant.

PHYSICAL CHARACTERISTICS

General description: The waste consists of Magnox metal and swarf which may be contaminated by fission products and actinides. Individual components may weigh up to about 100 g and be approx 2 mm x 25 mm x 900 mm. Complete splitter frames weighing about 600 g may have been compressed into a cylinder about 225 mm long by 100 mm diameter. There are no large items in the waste which will require special handling.

Physical components (%vol): The packages will contain discrete waste components from Magnox splitters.

Sealed sources: -

Bulk density (t/m³): 0.28

Comment on density: The maximum density is 1.7 t/m3, being the density of the Magnox. The average density assumes a packing factor of approximately 6 times the displacement volume of the material.

CHEMICAL COMPOSITION

General description and components (%wt): Magnox metal (type ZR55) (>99%). Fission product and actinide contamination. It is anticipated that the waste volume will include a small fraction of Nimonic and zirconium alloys. It is assumed that the waste will contain a small amount of fuel fragments.

Chemical state: Neutral

Chemical form of radionuclides: H-3: Tritium is expected to be present as surface contamination possibly as water but perhaps 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 incorporated in the Magnox may be associated with barium impurity (BaCl2). Other chlorine 36 may be associated with surface contamination.
U: Chemical form of U isotopes has not been determined but may be oxides.
Pu: Chemical form of Pu isotopes has not been determined but may be oxides.

Metals and alloys (%wt): The thickness of some of the waste will be of the order of a mm or less.

Stainless steel.....	0
Other ferrous metals.....	0
Iron.....	0
Aluminium.....	0
Beryllium.....	
Cobalt.....	
Copper.....	0
Lead.....	0

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	Magnox/Magnesium.....	>99.0	The waste is Magnox ZR55 which contains 0.55 wt% zirconium as an alloying constituent.
	Nickel.....	P	Small quantities of Nimonic, a high nickel content alloy,
	Titanium.....		
	Uranium.....		
	Zinc.....		
	Zircaloy/Zirconium.....		
	Other metals.....	TR	Manganese
Organics (%wt):	-		
	Total cellulosics.....	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.....	TR	
Other materials (%wt):	Graphite contamination on the surface of the Magnox metal.		
	Inorganic ion exchange materials.	0	
	Inorganic sludges and flocs.....	NE	
	Soil.....	0	
	Brick/Stone/Rubble.....	0	
	Cementitious material.....	0	
	Sand.....		
	Glass/Ceramics.....	0	
	Graphite.....	TR	
	Desiccants/Catalysts.....		
	Asbestos.....	0	
	Non/low friable.....		
	Moderately friable.....		
	Highly friable.....		

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	Free aqueous liquids	TR
	Free non-aqueous liquids	0
	Powder/Ash	TR
Inorganic anions (%wt):	-	
	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: Magnox will ignite under appropriate conditions.

Combustible metals	>99.0
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	>99.0
Active particles	
Soluble solids as bulk chemical compounds	

Hazardous substances / non hazardous pollutants: None expected.

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	0.516	0.516	10

Container type comment: -

Range in container waste volume: -

Other information on containers: -

Conditioned density (t/m³): -

Conditioned density comment: -

Other information on conditioning: -

RADIOACTIVITY

Source: The source of the waste is the removal of splitters from fuel elements prior to dispatch of

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	the elements to Sellafield. Activation of trace nuclides in the Magnox and contamination by fission products and actinides will be main sources of activity. In addition activity in waste packages will also be derived from activated fuel element components e.g. nimonic springs and fuel fragments.
Uncertainty:	Specific activities of all 10 waste packages were determined using gamma spectroscopy and fingerprints. The above values (Tbq/m3) 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 10 waste packages were measured and derived using gamma spectroscopy and the application of fingerprints.
Other information:	The activities quoted do not include any allowance for the activity of Nimonic springs or zirconium alloy in top end fittings. However, the resulting average activities in the waste are thought to lie within the uncertainties associated with the average activity of the Magnox.

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Nuclide	Mean radioactivity, TBq/m³				Nuclide	Mean radioactivity, TBq/m³			
	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	3.88E-02	C C 2			Gd 153		8		
Be 10		8			Ho 163	2.64E-09	C C 2		
C 14	6.01E-04	C C 2			Ho 166m	7.96E-07	C C 2		
Na 22		8			Tm 170		8		
Al 26		8			Tm 171	9.2E-08	C C 2		
Cl 36	5.62E-06	C C 2			Lu 174	1.79E-09	C C 2		
Ar 39	1.06E-04	C C 2			Lu 176		8		
Ar 42	3.37E-09	C C 2			Hf 178n	1.78E-06	C C 2		
K 40	1.22E-09	C C 2			Hf 182		8		
Ca 41	3.83E-05	C C 2			Pt 193	6.93E-05	C C 2		
Mn 53		8			Tl 204	1.94E-06	C C 2		
Mn 54	2.48E-09	C C 2			Pb 205		8		
Fe 55	3.33E-03	C C 2			Pb 210		8		
Co 60	3.42E-03	B B 1			Bi 208		8		
Ni 59	2.75E-05	C C 2			Bi 210m		8		
Ni 63	4.22E-03	C C 2			Po 210		8		
Zn 65	1.33E-09	C C 2			Ra 223		8		
Se 79	2.67E-09	C C 2			Ra 225		8		
Kr 81		8			Ra 226		8		
Kr 85	2.19E-04	C C 2			Ra 228		8		
Rb 87		8			Ac 227		8		
Sr 90	4.74E-02	C C 2			Th 227		8		
Zr 93	1.81E-06	C C 2			Th 228	3.52E-08	C C 2		
Nb 91		8			Th 229		8		
Nb 92		8			Th 230	2.54E-09	C C 2		
Nb 93m	3.08E-06	C C 2			Th 232		8		
Nb 94	1.82E-07	C C 2			Th 234	3.92E-06	C C 2		
Mo 93	5.25E-09	C C 2			Pa 231		8		
Tc 97		8			Pa 233	6.55E-07	C C 2		
Tc 99	4.86E-06	C C 2			U 232	3.44E-08	C C 2		
Ru 106	5.73E-08	C C 2			U 233	6.4E-08	C C 2		
Pd 107	6.5E-09	C C 2			U 234	3.41E-06	C C 2		
Ag 108m	1.16E-05	C C 2			U 235	1.06E-07	C C 2		
Ag 110m		8			U 236	3.91E-07	C C 2		
Cd 109	2.04E-08	C C 2			U 238	3.92E-06	C C 2		
Cd 113m	6.11E-07	C C 2			Np 237	6.55E-07	C C 2		
Sn 119m		8			Pu 236	1.92E-09	C C 2		
Sn 121m	8.80E-08	C C 2			Pu 238	1.94E-03	C C 2		
Sn 123		8			Pu 239	2.23E-03	C C 2		
Sn 126	2.42E-08	C C 2			Pu 240	2.21E-03	C C 2		
Sb 125	3.87E-06	C C 2			Pu 241	3.12E-02	C C 2		
Sb 126	3.39E-09	C C 2			Pu 242	2.76E-06	C C 2		
Te 125m	9.70E-07	C C 2			Am 241	9.78E-03	C C 2		
Te 127m		8			Am 242m	1.82E-05	C C 2		
I 129	2.26E-09	C C 2			Am 243	5.2E-06	C C 2		
Cs 134	2.07E-06	C C 2			Cm 242	1.51E-05	C C 2		
Cs 135	6.09E-08	C C 2			Cm 243	1.63E-06	C C 2		
Cs 137	5.66E-03	B B 1			Cm 244	2.75E-05	C C 2		
Ba 133	7.86E-06	C C 2			Cm 245	2.21E-09	C C 2		
La 137		8			Cm 246		8		
La 138		8			Cm 248		8		
Ce 144	3.13E-09	C C 2			Cf 249		8		
Pm 145		8			Cf 250		8		
Pm 147	9.29E-05	C C 2			Cf 251		8		
Sm 147		8			Cf 252		8		
Sm 151	6.37E-04	C C 2			Other a				
Eu 152	1.95E-06	C C 2			Other b/g				
Eu 154	1.85E-04	C C 2			**Total a**	**1.62E-02**	**C C 2**	**0**	
Eu 155	2.8E-05	C C 2			**Total b/g**	**1.36E-01**	**C C 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