

<b>WASTE STREAM</b>	<b>9A43</b>	<b>FED Magnox</b>
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**SITE** Berkeley  
**SITE OWNER** Nuclear Decommissioning Authority  
**WASTE CUSTODIAN** Magnox Limited  
**WASTE TYPE** ILW

**WASTE VOLUMES**

		Reported
Stocks:	At 1.4.2019.....	7.0 m <sup>3</sup>
Total future arisings:		0 m <sup>3</sup>
Total waste volume:		7.0 m <sup>3</sup>

Comment on volumes: Station operation ceased in March 1989. This waste stream was accumulated between May 1991 and December 1993. The volume quoted is the estimated bulk volume of the waste if separated from other wastes with which it is mixed. The range in the volume of Magnox debris is estimated to be between 5.2m<sup>3</sup> and 8.4 m<sup>3</sup>.

Uncertainty factors on volumes: Stock (upper): x 1.3 Arisings (upper) x  
 Stock (lower): x 0.8 Arisings (lower) x

**WASTE SOURCE** The source of the waste is the removal of splitters and top end guides from fuel elements prior to dispatch of the elements to Sellafield.

**PHYSICAL CHARACTERISTICS**

General description: The waste comprises Magnox splitters and top end guides removed from fuel elements prior to dispatch of the element to Sellafield. These sections were removed during the desplitting operation. The desplitting process can distort the splitter assemblies and splitters, and can break the top end guide. The Magnox splitters and top end guide are 496mm and 107mm in length respectively. Components may weigh up to about 30g. The total weight of Magnox removed from each element was 118g. From the dimensions and masses quoted above and recognising that the components will be broken and distorted during the desplitting operation it is therefore unlikely that there will be any large items which will require special handling.

Physical components (%vol): Magnox is the only constituent identified (>99%vol).

Sealed sources: -

Bulk density (t/m<sup>3</sup>): 0.57

Comment on density: The average bulk density of 0.57 t/m<sup>3</sup> assumes a packing factor to give an overall volume of about three times the displacement volume of the waste.

**CHEMICAL COMPOSITION**

General description and components (%wt): Magnox metal (Type AL80) >99% wt. Fission product and actinide contamination. Also graphite contamination. Activation of impurities within the Magnox.

Chemical state: Alkali

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 or 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 (barium chloride). Other chlorine 36 may be associated with surface contamination.  
 Se-79: The selenium content is insignificant.  
 Tc-99: The technetium content is insignificant.  
 Ra: Radium isotope content is insignificant.  
 Th: The thorium isotope content is insignificant.  
 U: Chemical form of U isotopes has not been determined but may be oxides.  
 Np: The neptunium content is insignificant.  
 Pu: Chemical form of Pu isotopes has not been determined but may be oxides.

Metals and alloys (%wt): The thickness of some 75% wt of the waste will be of the order of a mm or less, the other 25% wt of the waste will be a few mm thick.

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Stainless steel..... 0  
 Other ferrous metals..... 0  
 Iron.....  
 Aluminium.....  
 Beryllium..... TR  
 Cobalt.....  
 Copper..... 0  
 Lead..... 0  
 Magnox/Magnesium..... >99.0

The waste is Magnox AL80 which includes 0.8% wt aluminium as an alloying constituent.

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

The waste is entirely Magnox.

## Organics (%wt):

The Magnox may be contaminated with trace quantities of organic material.

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 materials (%wt):

Other organics..... TR  
 Contamination by graphite.  
 Inorganic ion exchange materials. 0  
 Inorganic sludges and flocs..... 0  
 Soil..... 0  
 Brick/Stone/Rubble..... 0  
 Cementitious material..... 0

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	Sand.....	
	Glass/Ceramics.....	0
	Graphite.....	TR
	Desiccants/Catalysts.....	
	Asbestos.....	0
	Non/low friable.....	
	Moderately friable.....	
	Highly friable.....	
	Free aqueous liquids.....	TR
	Free non-aqueous liquids.....	0
	Powder/Ash.....	P
Inorganic anions (%wt):	Inorganic anions are not expected to be present at greater than trace concentrations.	
	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:	There are no identified materials likely to represent a fire or other non-radiological hazard.	
	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.....	

**WASTE STREAM****9A43****FED Magnox**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**

Conditioning method:

This stream is to be co-packaged with 9A63, 9A64, 9A83, 9A84, 9A33, 9A34, 9A35, 9A41, 9A42, 9A49, 9A50, 9A51, 9A54, 9A55, 9A56, 9A74. Packages are assigned to 9A33/C, 9A34, 9A74.

Plant Name:

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Location:

Berkeley Site

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Plant startup date: -  
 Total capacity (m<sup>3</sup>/y incoming waste): -  
 Target start date for packaging this stream: -  
 Throughput for this stream (m<sup>3</sup>/y incoming waste): -  
 Other information: -

Likely container type:	Container	Waste packaged (%vol)	Waste loading (m <sup>3</sup> )	Payload (m <sup>3</sup> )	Number of packages

Likely container type comment: -  
 Range in container waste volume: -  
 Other information on containers: -  
 Likely conditioning matrix:  
 Other information: -  
 Conditioned density (t/m<sup>3</sup>): -  
 Conditioned density comment: -  
 Other information on conditioning: -  
 Opportunities for alternative disposal routing:

Treatment	Stream volume (%)	Comment
-	-	-

**RADIOACTIVITY**

Source: Activation, when the associated fuel elements were irradiated, of nuclides incorporated into the Magnox. Contamination by fission products and actinides when the fuel elements were in the fuel pond.

Uncertainty: The values quoted 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: Specific activity is a function of Station operating history. Values were derived from measurements, calculations of induced activity and estimates of likely contamination.

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	1.53E-03	CC 2			Gd 153			8	
Be 10	2E-07	CC 2			Ho 163			8	
C 14	2.00E-04	CC 2			Ho 166m			8	
Na 22		8			Tm 170			8	
Al 26	4E-05	CC 2			Tm 171			8	
Cl 36	3E-04	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	<2E-05	C 3			Pt 193			8	
Mn 53		8			Tl 204			8	
Mn 54		8			Pb 205			8	
Fe 55	9.40E-05	CC 2			Pb 210			8	
Co 60	<1.03E-03	C 3			Bi 208			8	
Ni 59	2E-05	CC 2			Bi 210m			8	
Ni 63	2.76E-03	CC 2			Po 210			8	
Zn 65		8			Ra 223			8	
Se 79		8			Ra 225			8	
Kr 81		8			Ra 226			8	
Kr 85		8			Ra 228			8	
Rb 87		8			Ac 227			8	
Sr 90	5.26E-05	CC 2			Th 227			8	
Zr 93	5E-08	CC 2			Th 228			8	
Nb 91		8			Th 229			8	
Nb 92		8			Th 230			8	
Nb 93m	2.58E-08	CC 2			Th 232			8	
Nb 94		8			Th 234	5E-08	CC 2		
Mo 93		8			Pa 231			8	
Tc 97		8			Pa 233	6.29E-09	CC 2		
Tc 99	2E-07	CC 2			U 232			8	
Ru 106		8			U 233			8	
Pd 107		8			U 234	5.08E-08	CC 2		
Ag 108m	3.92E-06	CC 2			U 235	1E-09	CC 2		
Ag 110m		8			U 236	7.00E-09	CC 2		
Cd 109		8			U 238	5E-08	CC 2		
Cd 113m	<1.65E-04	C 3			Np 237	6.29E-09	CC 2		
Sn 119m		8			Pu 236			8	
Sn 121m	<2.56E-04	C 3			Pu 238	1.82E-05	CC 2		
Sn 123		8			Pu 239	2E-05	CC 2		
Sn 126		8			Pu 240	3.00E-05	CC 2		
Sb 125	1.93E-06	CC 2			Pu 241	1.13E-03	CC 2		
Sb 126		8			Pu 242	2E-08	CC 2		
Te 125m	4.84E-07	CC 2			Am 241	8.77E-05	CC 2		
Te 127m		8			Am 242m	1.88E-07	CC 2		
I 129		8			Am 243	5.00E-08	CC 2		
Cs 134	1.78E-09	CC 2			Cm 242	1.55E-07	CC 2		
Cs 135		8			Cm 243	4.55E-08	CC 2		
Cs 137	5.30E-05	CC 2			Cm 244	3.79E-07	CC 2		
Ba 133	<9.12E-05	C 3			Cm 245			8	
La 137	<5E-06	C 3			Cm 246			8	
La 138		8			Cm 248			8	
Ce 144		8			Cf 249			8	
Pm 145		8			Cf 250			8	
Pm 147	<1.68E-04	C 3			Cf 251			8	
Sm 147		8			Cf 252			8	
Sm 151	1.82E-07	CC 2			Other a				
Eu 152	1.62E-09	CC 2			Other b/g				
Eu 154	1.91E-07	CC 2			<b>Total a</b>	<b>1.57E-04</b>		<b>0</b>	
Eu 155	3.65E-08	CC 2			<b>Total b/g</b>	<b>7.92E-03</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