

WASTE STREAM	9E25	FED Magnox
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SITE Oldbury

SITE OWNER Nuclear Decommissioning Authority

WASTE CUSTODIAN Magnox Limited

WASTE TYPE ILW

WASTE VOLUMES

Stocks: At 1.4.2013..... 81.4 m³

Total future arisings: 0 m³

Total waste volume: 81.4 m³

Comment on volumes: Future arisings are zero because the vault is full.

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 polyzonal fuel elements prior to dispatch of the elements to Sellafield.

PHYSICAL CHARACTERISTICS

General description: The waste consists of activated Magnox metal and swarf which is contaminated by fission products and actinides. Individual components may weigh up to about 100 g and be approx. 2 mm x 25 mm x (75-900) mm. Some Nimonic springs will also be present (see waste stream 9E41). There are no large items in the waste which will require special handling.

Physical components (%wt): Magnox (>99.5% wt). The waste volume will include some fuel element top end fittings which will incorporate highly active Nimonic springs together with some zirconium alloy - see waste stream 9E41.

Bulk density (t/m³): 0.35

Comment on density: The bulk density of the waste ranges from 0.1 to 1.7 t/m³ with an average value of 0.35 t/m³. The average density of 0.35 assumes a packing factor of 5 times the displacement volume. The packing factor will be variable.

CHEMICAL COMPOSITION

General description and components (%wt): Magnox Metal (>99.5% wt including impurities). Activation of trace components within the Magnox. Fission product and actinide contamination. It is anticipated that the waste will include some fuel element top end fittings which will incorporate highly active Nimonic springs (waste stream 9E41) together with some zirconium alloy.

Chemical state: The waste is not acid nor alkaline. It is known to be a reducing agent.

Chemical form of radionuclides: H-3: Tritium is expected to be present as surface contamination, possibly as water, or perhaps in the form of other inorganic or organic compounds.
 C-14: Carbon 14 will 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: Thorium 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 plutonium isotopes has not been determined but may be plutonium oxides.

Metals and alloys (%wt): Magnox with impurities which may include beryllium. Also some zirconium as alloy in the Magnox and as a 'free' metal. No bulk metallic items present.

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Stainless steel.....	0	Bronze.....	0
Other ferrous metals.....	0	Inconel.....	0
Aluminium.....	0	Nimonic.....	0
Copper.....	0	Stellite.....	0
Lead.....	0	Boral.....	0
Zinc.....	0	Dural.....	0
Magnox/Magnesium.....	>99.5	Monel.....	0
Zircaloy.....	<0.50	Uranium.....	
Brass.....	0	Beryllium.....	TR
		Other metals (below).....	0

Other metals: No "other" metals present.

Inorganic anions (%wt): Inorganic anions are not expected to be present at greater than trace concentrations.

Fluoride.....	TR	Nitrate.....	TR
Chloride.....	TR	Nitrite.....	TR
Iodide.....	0	Phosphate.....	TR
Cyanide.....	0	Sulphate.....	TR
Carbonate.....	TR	Sulphide.....	0

Listed substances: Not present.

Hazardous and problematic materials (%wt): Magnox will ignite under appropriate conditions.

Combustible metals.....	>99.5	Strong oxidising agents.....	0
Low flash point liquids.....	0	Pyrophoric materials.....	0
Explosive materials.....	0	Generating toxic gases.....	0
Phosphorus.....	0	Reacting with water.....	>99.5
Hydrides.....	0	Asbestos.....	0
Putrescible wastes.....	0	Free aqueous liquids.....	TR
Biological etc. materials.....	0	Free non-aqueous liquids.....	0
Powder.....	NE		

Asbestos types and proportions: -

Complexing agents (%wt): Not yet determined. Only trace quantities, if any, are expected.

Complexing agents..... TR

Organics (%wt): There may be organics present in trace quantities.

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
Other organics.....	TR

Halogenated plastics and rubber (%wt): There are no halogenated plastics or rubbers present.

Other materials (%wt): -

Inorganic ion exchange materials..	0
Inorganic sludges and flocs.....	0
Soil.....	0
Rubble.....	0
Concrete, cement and sand.....	0
Glass.....	0
Ceramics.....	0
Graphite.....	TR

PACKAGING AND CONDITIONING

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Conditioning method: Although characterisation of this waste stream has shown that the waste could be classified as LLW, the baseline method for conditioning is currently encapsulation of the Magnox in BFS/OPC, in a 3m³ box. However, dissolution has been determined to be a better option and it is hoped to change the baseline strategy as soon as the details are finalised. The waste is likely to be mixed with Nimonic springs, stream 9E41.

Plant Name: Magnox Encapsulation Plant

Location: Oldbury Power Station

Plant startup date: 2020

Total capacity (m³/y incoming waste): ~200.0

Target start date for packaging this stream: 2020

Throughput for this stream (m³/y incoming waste): ~27.0

Other information: Processing of the waste is assumed to commence after defuelling.

Likely container type:	Container	Waste packaged (%vol)	Waste loading (m ³)	Payload (m ³)	Container displacement volume (m ³)
	3m ³ box (round corners)	100.0	2.65	2.65	3.273

Likely container type comment: The waste is likely to be mixed with stream 9E41 Nimonic Springs.

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

Other information on containers: The 3m³ box is expected to be made from stainless steel.

Likely conditioning matrix: BFS/OPC

Other information: The best option for conditioning matrix is currently under discussion.

Conditioned density (t/m³): ~2.0

Conditioned density comment: The encapsulated waste density is estimated as being approximately 2.0 t/m³.

Other information on conditioning: If any of the waste has degraded from metal to sludge it will have to be encapsulated in a 3m³ drum with a conditioning factor of about 2.

RADIOACTIVITY

Source: The source of the waste is the removal of splitters from fuel prior to dispatch of the elements to Sellafield. Activation of trace nuclides in the Magnox and contamination by fission products and actinides will be main sources of activity.

Accuracy: The values quoted are indicative of the activities that might be expected.

Definition of total alpha and total beta/gamma: Totals shown on table of radionuclide activities are the sums of the listed alpha or beta/gamma emitting radionuclides plus 'other alpha' or 'other beta/gamma.'

Measurement of specific activities: Values were derived from measurements.

Other information: Although the gross beta/gamma activity in the FED material is LLW, this waste stream is not discrete. The FED material is intimately mixed with highly active Niomonic Springs.

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Nuclide	Average specific activity, TBq/m ³		Nuclide	Average specific activity, TBq/m ³	
	Waste at 1.4.2013	Bands and Code		Waste at 1.4.2013	Bands and Code
H 3	2.53E-04	CC 2	Ho 163		8
Be 10		8	Ho 166m		8
C 14	1E-04	CC 2	Tm 170		8
Cl 36		8	Tm 171		8
Ar 39		8	Lu 174		8
Ar 42		8	Lu 176		8
K 40		8	Hf 178n		8
Ca 41		8	Hf 182		8
Mn 53		8	Pt 193		8
Mn 54	<1.76E-09	C 3	Tl 204		8
Fe 55	2.31E-06	CC 2	Pb 205		8
Co 60	2.02E-05	CC 2	Pb 210		8
Ni 59		8	Bi 208		8
Ni 63	1.96E-04	CC 2	Bi 210m		8
Zn 65		8	Po 210		8
Se 79		8	Ra 223		8
Kr 81		8	Ra 225		8
Kr 85		8	Ra 226		8
Rb 87		8	Ra 228		8
Sr 90	7.45E-05	CC 2	Ac 227		8
Zr 93	<2E-06	C 3	Th 227		8
Nb 91		8	Th 228		8
Nb 92		8	Th 229		8
Nb 93m	4.15E-07	CC 2	Th 230		8
Nb 94		8	Th 232		8
Mo 93		8	Th 234		8
Tc 97		8	Pa 231		8
Tc 99		8	Pa 233		8
Ru 106		8	U 232		8
Pd 107		8	U 233		8
Ag 108m	8.96E-06	CC 2	U 234		8
Ag 110m		8	U 235		8
Cd 109		8	U 236		8
Cd 113m		8	U 238		8
Sn 119m		8	Np 237		8
Sn 121m		8	Pu 236		8
Sn 123		8	Pu 238	2.93E-07	CC 2
Sn 126		8	Pu 239	7E-07	CC 2
Sb 125	<9.33E-08	C 3	Pu 240	9E-07	CC 2
Sb 126		8	Pu 241	1.73E-05	CC 2
Te 125m	9.91E-08	CC 2	Pu 242		8
Te 127m		8	Am 241	3.07E-06	CC 2
I 129		8	Am 242m		8
Cs 134	3.65E-08	CC 2	Am 243		8
Cs 135		8	Cm 242		8
Cs 137	4.67E-05	CC 2	Cm 243		8
Ba 133	<6.57E-07	C 3	Cm 244	1.78E-08	CC 2
La 137		8	Cm 245		8
La 138		8	Cm 246		8
Ce 144		8	Cm 248		8
Pm 145		8	Cf 249		8
Pm 147		8	Cf 250		8
Sm 147		8	Cf 251		8
Sm 151		8	Cf 252		8
Eu 152		8	Other a		8
Eu 154	<4.71E-07	C 3	Other b/g		8
Eu 155	<3.94E-07	C 3	Total a	4.98E-06	CC 2
Gd 153		8	Total b/g	7.23E-04	CC 2

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 the average specific activity.

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