

**WASTE STREAM****9F23****FED Magnox****SITE**

Sizewell A

**SITE OWNER**

Nuclear Decommissioning Authority

**WASTE CUSTODIAN**

Magnox Limited

**WASTE TYPE**

LLW

**WASTE VOLUMES**

		Reported
Stocks:	At 1.4.2019.....	286.0 m <sup>3</sup>
Total future arisings:		0 m <sup>3</sup>
Total waste volume:		286.0 m <sup>3</sup>

Comment on volumes: The process of de-splitting and de-lugging of fuel elements no longer takes place so no further waste arisings will occur.

Uncertainty factors on volumes: Stock (upper): x 1.1 Arisings (upper) x  
 Stock (lower): x 0.9 Arisings (lower) x

**WASTE SOURCE**

The source of the waste is the removal of splitters and lugs from fuel elements prior to dispatch of elements to Sellafield.

**PHYSICAL CHARACTERISTICS**

General description: The waste consists of Magnox metal swarf and sludge which may be contaminated by fission products and actinides. Individual components may weigh up to about 20 g and be approx. 2 mm x 25 mm x (50-100) mm for splitters (after cutting) and 4 mm x 15 mm x 100 mm for lugs. There are some Nimonic springs but these are identified as a different waste stream, 9F43. There are no large items in the waste which will require special handling although there are some splitters of the order 2 mm x 25 mm x 1 m long.

Physical components (%vol): Magnox metal (99% vol), magnesium hydroxide, magnesium carbonate.

Sealed sources: -

Bulk density (t/m<sup>3</sup>): 0.293

Comment on density: Bulk densities of waste in each cell are 0.287 te/m<sup>3</sup> (Cell 2), 0.304 te/m<sup>3</sup> (Cell 3) and 0.249 te/m<sup>3</sup> (Cell 4).

**CHEMICAL COMPOSITION**

General description and components (%wt): Magnox metal, magnesium hydroxide, magnesium carbonate (>99% wt in total including impurities).

Chemical state: Alkali

Chemical form of radionuclides: H-3: The tritium is expected to be present possibly as water but perhaps in the form of other inorganic compounds or as organic compounds.  
 C-14: The carbon 14 will probably be present as graphite.  
 Cl-36: The 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 chemical form of technetium has not been determined.  
 Ra: The radium isotope content is insignificant.  
 Th: The thorium isotope content is insignificant.  
 U: Chemical form of uranium isotopes may be uranium oxides.  
 Np: The chemical form of neptunium has not been determined.  
 Pu: Chemical form of plutonium isotopes may be plutonium oxides.

Metals and alloys (%wt): Magnox metal incorporating impurities which may include beryllium. Magnox splitters will generally be 2 mm x 25 mm x (50-100) mm in size though some may be up to 2 mm x 25 mm x 1 m. Magnox lugs will be about 4 mm x 15 mm x 100 mm. The Magnox FED will constitute >99% of the waste.

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Stainless steel..... 0  
 Other ferrous metals..... 0  
 Iron.....  
 Aluminium..... 0  
 Beryllium..... TR  
 Cobalt.....  
 Copper..... 0  
 Lead..... 0  
 Magnox/Magnesium..... >99.0  
 Nickel.....  
 Titanium.....  
 Uranium.....  
 Zinc..... 0  
 Zircaloy/Zirconium..... P  
 Other metals..... 0

Will consist predominantly of  
 Magnox alloy ZR55. includes  
 0.5% zirconium

No "other" metals present.

## Organics (%wt):

There may be organics present in trace quantities. There are no halogenated plastics or rubbers present.

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):

Magnox debris can form an inorganic sludge in damp conditions. The extent of corrosion is only apparent on retrieval.

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	Inorganic ion exchange materials.	0
	Inorganic sludges and flocs.....	P
	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.....	
	Free aqueous liquids.....	P
	Free non-aqueous liquids.....	0
	Powder/Ash.....	TR
Inorganic anions (%wt):	Not fully assessed. Magnesium carbonate is anticipated.	
	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:	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.....	

**WASTE STREAM****9F23****FED Magnox**Hazardous substances /  
non hazardous pollutants:Soluble solids as bulk chemical  
compounds.....  
Toxic metals may be present as impurities incorporated into the Magnox.

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):

EDTA.....

DPTA.....

NTA.....

Polycarboxylic acids.....

Other organic complexants.....

Total complexing agents..... NE

**TREATMENT, PACKAGING AND DISPOSAL**

Planned on-site / off-site treatment(s):

Treatment	On-site / Off site	Stream volume %
Low force compaction Supercompaction (HFC) Incineration Solidification Decontamination Metal treatment Size reduction Decay storage Recycling / reuse Other / various None	Off-site	100.0

Comment on planned treatments:

-

**Disposal Routes:**

Disposal Route	Stream volume %
Expected to be consigned to the LLW Repository Expected to be consigned to a Landfill Facility Expected to be consigned to an On-Site Disposal Facility Expected to be consigned to an Incineration Facility Expected to be consigned to a Metal Treatment Facility Expected to be consigned as Out of Scope Expected to be recycled / reused Disposal route not known	100.0

**Upcoming (2019/20-2021/22) Waste Routing (if expected to change from above):**

Disposal Route	Stream volume %		
	2019/20	2020/21	2021/22
Expected to be consigned to the LLW Repository Expected to be consigned to a Landfill Facility Expected to be consigned to an On-Site Disposal Facility Expected to be consigned to an Incineration Facility Expected to be consigned to a Metal Treatment Facility Expected to be consigned as Out of Scope Expected to be recycled / reused Disposal route not known			

**Waste Packaging for Disposal:**

Container	Stream volume %	Waste loading m <sup>3</sup>	Number of packages
1/3 Height IP-1 ISO 2/3 Height IP-2 ISO 1/2 Height WAMAC IP-2 ISO 1/2 Height IP-2 Disposal/Re-usable ISO 2m box (no shielding) 4m box (no shielding) Other	100.0	~14.4	20

Other information:

-

**Waste Planned for Disposal at the LLW Repository:**

Container voidage:

-

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Waste Characterisation Form (WCH):

The waste meets the LLWR's Waste Acceptance Criteria (WAC).  
The waste does not have a current WCH.

Waste consigned for disposal to LLWR in year of generation:

No. Waste generated during operation of the station and stored on-site in cells.

Potential for the waste to contain discrete items:

-

**Non-Containerised Waste for In-Vault Grouting:** (Not applicable to this waste stream)

Stream volume (%):

-

Waste stream variation:

-

Bounding cuboidal volume:

Inaccessible voidage:

-

Other information:

-

**RADIOACTIVITY**

Source:

The source of the waste is the removal of splitters and lugs from fuel elements 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.

Uncertainty:

The values quoted are indicative of activities that might be expected. Specific activity is from sampling of the waste at the top of the cells and is a function of Station operating history.

Definition of total alpha and total beta/gamma:

The sum of the listed alpha and beta/gamma radionuclides do not include any 'other alpha' or 'other beta/gamma' radionuclides.

Measurement of radioactivities:

Values were derived from analysis of samples retrieved from the top of the cells.

Other information:

The activity estimates make no allowance for any Nimonic springs (9F43) or zirconium in the top end fittings but the resulting average activities would be likely to lie within the uncertainties associated with the average activity of Magnox.

**WASTE STREAM**

**9F23**

**FED Magnox**

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	4.61E-04	AA 1			Gd 153		8		
Be 10		8			Ho 163		8		
C 14	3.69E-05	AA 1			Ho 166m		8		
Na 22		8			Tm 170		8		
Al 26		8			Tm 171		8		
Cl 36	1.39E-05	AA 1			Lu 174		8		
Ar 39		8			Lu 176		8		
Ar 42		8			Hf 178n	2.29E-06	AA 1		
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	1.66E-05	AA 1			Pb 210		8		
Co 60	7.28E-05	AA 1			Bi 208		8		
Ni 59		8			Bi 210m		8		
Ni 63	5.48E-04	AA 1			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	9.27E-06	AA 1			Th 227		8		
Zr 93		8			Th 228		8		
Nb 91		8			Th 229		8		
Nb 92		8			Th 230		8		
Nb 93m		8			Th 232		8		
Nb 94		8			Th 234	1.82E-08	CC 2		
Mo 93		8			Pa 231		8		
Tc 97		8			Pa 233		8		
Tc 99		8			U 232		8		
Ru 106		8			U 233		8		
Pd 107		8			U 234	4.56E-08	AA 1		
Ag 108m	1.34E-06	AA 1			U 235		8		
Ag 110m		8			U 236	1.01E-09	AA 1		
Cd 109		8			U 238	1.82E-08	AA 1		
Cd 113m		8			Np 237		8		
Sn 119m		8			Pu 236		8		
Sn 121m		8			Pu 238	2.88E-07	AA 1		
Sn 123		8			Pu 239	3.54E-07	AA 1		
Sn 126		8			Pu 240	4.65E-07	AA 1		
Sb 125	5.84E-08	AA 1			Pu 241	1.37E-05	AA 1		
Sb 126		8			Pu 242	4.76E-09	AA 1		
Te 125m	1.46E-08	CC 2			Am 241	1.46E-06	AA 1		
Te 127m		8			Am 242m		8		
I 129		8			Am 243		8		
Cs 134		8			Cm 242		8		
Cs 135		8			Cm 243	1.38E-09	AA 1		
Cs 137	1.48E-05	AA 1			Cm 244	1.52E-08	AA 1		
Ba 133	8.07E-07	AA 1			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	1.84E-07	AA 1			Cf 251		8		
Sm 147		8			Cf 252		8		
Sm 151	1.8E-06	AA 1			Other a				
Eu 152		8			Other b/g				
Eu 154	1.67E-06	AA 1			<b>Total a</b>	<b>2.65E-06</b>	<b>AA 1</b>	<b>0</b>	
Eu 155	3.15E-07	AA 1			<b>Total b/g</b>	<b>1.20E-03</b>	<b>AA 1</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