

<b>WASTE STREAM</b>	<b>9J23</b>	<b>FED Magnox</b>
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**SITE** Hunterston A

**SITE OWNER** Nuclear Decommissioning Authority

**WASTE CUSTODIAN** Magnox Limited

**WASTE TYPE** ILW; SPD1

**WASTE VOLUMES**

Stocks: At 1.4.2013..... 563.7 m<sup>3</sup>

Total future arisings: 0 m<sup>3</sup>

Total waste volume: 563.7 m<sup>3</sup>

Comment on volumes: There will be no future arisings of this stream; the bunker is nominally full.

Uncertainty factors on volumes: Stock (upper): x 1.25 Arisings (upper) x  
 Stock (lower): x 0.75 Arisings (lower) x

**WASTE SOURCE** Fuel element debris, from the removal of Magnox splitters and buttons from discharged fuel elements.

**PHYSICAL CHARACTERISTICS**

General description: The waste consists of splitters and buttons from discharged fuel elements. Each fuel element comprises a Magnox can with 4 splitter blades. These blades are sheared off. Each piece of Magnox is generally small (75 mm long) with an average mass of 0.1125 kg which includes a percentage of the braces (i.e. mass of Magnox per fuel element is 0.45 kg). Magnox buttons (one per element) each weigh 1.7g. No items require special handling. During initial station operation the desplitting process involved baling Magnox into 150 mm diameter bales.

Physical components (%wt): Splitter blades (99.9 wt%), Magnox buttons (<0.1 wt%). By volume, there is 95% of solid and 5% powder.

Bulk density (t/m<sup>3</sup>): 0.25

Comment on density: Mean bulk density is 0.25 t/m<sup>3</sup>. This assumes a packing fraction of 1/7 (= 0.143).

**CHEMICAL COMPOSITION**

General description and components (%wt): The waste is comprised of (~100%) Magnox AL80 alloy. The Magnox may be contaminated by fission products and actinides. Some corrosion product, magnesium hydroxide, may be present (<0.3 wt %).

Chemical state: The waste is neutral but will act as a reducing agent.

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 chemical form of selenium has not been determined.  
 Tc-99: The chemical form of technetium has not been determined.  
 Ra: 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): The waste is Magnox AL80 which includes 0.8% wt aluminium as an alloying constituent. There will be impurities, generally at trace levels, incorporated in the Magnox. No bulk metal items present.

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.....	>99.0	Monel.....	0
Zircaloy.....	0	Uranium.....	
Brass.....	0	Beryllium.....	<0.03
		Other metals (below).....	0

Other metals: No "other" metals have been identified.

<b>WASTE STREAM</b>	<b>9J23</b>	<b>FED Magnox</b>
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Inorganic anions (%wt): None expected 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 certain conditions.

Combustible metals.....	>99.0	Strong oxidising agents.....	0
Low flash point liquids.....	0	Pyrophoric materials.....	0
Explosive materials.....	0	Generating toxic gases.....	0
Phosphorus.....	0	Reacting with water.....	>99.0
Hydrides.....	0	Asbestos.....	0
Putrescible wastes.....	0	Free aqueous liquids.....	TR
Biological etc. materials.....	0	Free non-aqueous liquids.....	0
Powder.....	TR		

Asbestos types and proportions: -

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

Complexing agents..... TR

Organics (%wt): There are no organic materials present.

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): Traces of graphite may be present.

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

### PACKAGING AND CONDITIONING

Conditioning method: The solid will be encapsulated in a 3m3 box. It is not expected that the waste will be tamped or compacted. Any powdered waste is expected to be encapsulated separately and packaged in 3m3 Drum.

Plant Name: SILWR for solid waste, WILWREP (Wet ILW Retrieval and Encapsulation Plant) for any powdered waste.

Location: Hunterston A Decommissioning Site

Plant startup date: 2012

Total capacity (m<sup>3</sup>/y incoming waste): ~500.0

<b>WASTE STREAM</b>	<b>9J23</b>	<b>FED Magnox</b>
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Target start date for packaging this stream: 2012

Throughput for this stream (m<sup>3</sup>/y incoming waste): ~113.0

Other information: All solid wastes in the bunker would be encapsulated together in a BFS/OPC matrix and packaged in 3m<sup>3</sup> Stainless Steel Box. There is no intention to first supercompact the waste. Any powdered waste is expected to be encapsulated separately in a 9:1 BFS/OPC matrix and would be packaged in 3m<sup>3</sup> Drum.

Likely container type:	Container	Waste packaged (%vol)	Waste loading (m <sup>3</sup> )	Payload (m <sup>3</sup> )	Container displacement volume (m <sup>3</sup> )
	3m <sup>3</sup> box (round corners)	100.0	2.93	2.65	3.273

Likely container type comment: The loading assumes that the waste will revert to a similar volume as the original volume in the vault. It is not expected that the waste will be tamped or compacted.

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

Other information on containers: The 3m<sup>3</sup> box is expected to be made from stainless steel.

Likely conditioning matrix: BFS/OPC

Other information: -

Conditioned density (t/m<sup>3</sup>): ~2.0

Conditioned density comment: The density of the conditioned waste will probably be about 2 t/m<sup>3</sup>.

Other information on conditioning: The proposed method has changed from dissolution to encapsulation in BFS/OPC, in a 3m<sup>3</sup> box. The wastes in the bunker will probably be encapsulated together, but possibly excluding any ash and dusts. The waste is a mixture of waste streams 9J18, 9J23, 9J26, 9J35 and 9J40. Any of the Magnox waste that has degraded from metal to powder will be encapsulated in a 3m<sup>3</sup> drum with a conditioning factor of about 3.

## RADIOACTIVITY

Source: Predominantly activation products with possible contamination by fission products and actinides.

Accuracy: The values quoted are indicative of 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: Activities have been estimated from activation calculations with assumptions for contamination.

Other information: Other beta/gamma nuclides (in TBq/m<sup>3</sup>) in stocks are : Al26 (2E-5).

Nuclide	Average specific activity, TBq/m <sup>3</sup>				Nuclide	Average specific activity, TBq/m <sup>3</sup>			
	Waste at 1.4.2013	Bands and Code	Future arisings	Bands and Code		Waste at 1.4.2013	Bands and Code	Future arisings	Bands and Code
H 3	2.53E-02	CC 2			Ho 163		8		
Be 10	1E-07	CC 2			Ho 166m		8		
C 14	1E-04	CC 2			Tm 170		8		
Cl 36	2E-05	CC 2			Tm 171		8		
Ar 39		8			Lu 174		8		
Ar 42		8			Lu 176		8		
K 40		8			Hf 178n		8		
Ca 41	<2E-05	C 3			Hf 182		8		
Mn 53		8			Pt 193		8		
Mn 54		8			Tl 204		8		
Fe 55	9.26E-05	CC 2			Pb 205		8		
Co 60	<6.74E-04	C 3			Pb 210		8		
Ni 59	2E-05	CC 2			Bi 208		8		
Ni 63	1.96E-03	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	6.52E-04	CC 2			Ac 227		8		
Zr 93	4E-08	CC 2			Th 227		8		
Nb 91		8			Th 228		8		
Nb 92		8			Th 229		8		
Nb 93m	4.77E-09	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	2E-07	CC 2			Pa 233	4.03E-09	CC 2		
Ru 106		8			U 232		8		
Pd 107		8			U 233		8		
Ag 108m	2.99E-06	CC 2			U 234	6.01E-08	CC 2		
Ag 110m		8			U 235	2E-09	CC 2		
Cd 109		8			U 236	5E-09	CC 2		
Cd 113m	<5.18E-05	C 3			U 238	7E-08	CC 2		
Sn 119m		8			Np 237	4.03E-09	CC 2		
Sn 121m	<1.92E-04	C 3			Pu 236		8		
Sn 123		8			Pu 238	8.79E-06	CC 2		
Sn 126	3.04E-09	CC 2			Pu 239	2E-05	CC 2		
Sb 125	1.87E-06	CC 2			Pu 240	2E-05	CC 2		
Sb 126		8			Pu 241	2.6E-04	CC 2		
Te 125m	1.98E-06	CC 2			Pu 242	6E-09	CC 2		
Te 127m		8			Am 241	3.12E-05	CC 2		
I 129		8			Am 242m	3.94E-08	CC 2		
Cs 134	1.46E-08	CC 2			Am 243	8E-09	CC 2		
Cs 135	6E-09	CC 2			Cm 242	3.22E-08	CC 2		
Cs 137	6.53E-04	CC 2			Cm 243	6.53E-09	CC 2		
Ba 133	<4.1E-05	C 3			Cm 244	3.57E-08	CC 2		
La 137	<4E-06	C 3			Cm 245		8		
La 138		8			Cm 246		8		
Ce 144		8			Cm 248		8		
Pm 145		8			Cf 249		8		
Pm 147	<1.81E-04	C 3			Cf 250		8		
Sm 147		8			Cf 251		8		
Sm 151	1.95E-06	CC 2			Cf 252		8		
Eu 152	2.57E-08	CC 2			Other a				
Eu 154	1.57E-06	CC 2			Other b/g	2E-05	CC 2		
Eu 155	3.29E-07	CC 2			<b>Total a</b>	<b>8.02E-05</b>	<b>CC 2</b>		
Gd 153		8			<b>Total b/g</b>	<b>3.03E-02</b>	<b>CC 2</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 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