WASTE STREAM 9F23 FED Magnox

SITE	Sizewell A
SITE OWNER	Nuclear Decommissioning Authority
WASTE CUSTODIAN	Magnox Limited
WASTE TYPE	LLW
Is the waste subject to Scottish Policy:	No

WASTE VOLUMES

		Reported
Stocks:	At 1.4.2022.....	261.0 m^3
Total future arisings:		0 m^3
Total waste volume:		261.0 m^3

Comment on volumes: The process of de-splittering 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: The waste does not contain sealed sources.

Bulk density (t/m^3): 0.317

Comment on density: Bulk densities of waste in each cell are 0.31 te/m3 (Cell 2), 0.31 te/m3 (Cell 3) and 0.49 te/m3 (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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	(%wt)	Type(s) / Grade(s) with proportions	% of total C14 activity
Stainless steel	0		
Other ferrous metals	0		
Iron			
Aluminium	0		
Beryllium	TR		
Cobalt			
Copper	0		
Lead	0		
Magnox/Magnesium	>99.0	Will consist predominantly of Magnox alloy ZR55. includes 0.5% zirconium	
Nickel			
Titanium			
Uranium			
Zinc	0		
Zircaloy/Zirconium	P		
Other metals	0	No "other" metals present.	

Organics (%wt): There may be organics present in trace quantities. There are no halogenated plastics or rubbers present.

	(%wt)	Type(s) and comment	% of total C14 activity
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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	(%wt)	Type(s) and comment	% of total C14 activity
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.

	(%wt)	Type(s) and comment
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.

	(%wt)	Type(s) and comment
Combustible metals.....	>99.0	
Low flash point liquids.....	0	
Explosive materials.....	0	
Phosphorus.....	0	
Hydrides.....	0	
Biological etc. materials.....	0	
Biodegradable materials.....	0	
Putrescible wastes.....	0	
Non-putrescible wastes.....		

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Corrosive materials.....	0
Pyrophoric materials.....	0
Generating toxic gases.....	0
Reacting with water.....	>99.0
Higher activity particles.....	
Soluble solids as bulk chemical compounds.....	

Hazardous substances / non hazardous pollutants: Toxic metals may be present as impurities incorporated into the Magnox.

	(%wt)	Type(s) and comment
Acrylamide.....		
Benzene.....		
Chlorinated solvents.....		
Formaldehyde.....		
Organometallics.....		
Phenol.....		
Styrene.....		
Tri-butyl phosphate.....		
Other organophosphates.....		
Vinyl chloride.....		
Arsenic.....		
Barium.....		
Boron.....	0	
Boron (in Boral).....		
Boron (non-Boral).....		
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.....		

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Complexing agents (%wt):

	(%wt)	Type(s) and comment
EDTA.....		
DPTA.....		
NTA.....		
Polycarboxylic acids…….		
Other organic complexants.....		
Total complexing agents.....	NE	

Potential for the waste to contain discrete items: Yes. In & of itself not a DI; Will likely contain "rogue" items (HDRIs) that will be (see Nimonic/Others)

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 Recyling / reuse Other / various None	Off-site	100.0

Comment on planned treatments: -

Disposal Routes:

Disposal Route	Stream volume %	Disposal density t/m3
Expected to be consigned to the LLW Repository	100.0	0.32
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		

Classification codes for waste expected to be consigned to a landfill facility: -

Upcoming (2022/23-2024/25) Waste Routing (if expected to change from above):

Disposal Route	Stream volume %		
	2022/23	2023/24	2024/25
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			

Opportunities for alternative disposal routing: -

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Baseline Management Route	Opportunity Management Route	Stream volume (%)	Estimated Date that Opportunity will be realised	Opportunity Confidence	Comment
Disposal at LLWR	Disposal at a Geological Disposal Facility	NE	2023	Low	Baseline position is LLW disposal but this is under threat - under investigation still but risk realisation not looking as likely as Oldbury FED

Waste Packaging for Disposal:

Container	Stream volume %	Waste loading m³	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	19

Other information: Assessment and further modelling of FED characterisation has resulted in a change and, therefore, a review of the current waste strategy is underway. In addition, FED sort and segregation learning from Bradwell and Hinkley Point A is available and provides empirical data to review the current sort and segregation strategy for FED at Oldbury and Sizewell A.

Waste Planned for Disposal at the LLW Repository:

Container voidage: -

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.

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: 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: Data taken from M/EF/SZA/EAN/0036/20 Issue 2 July 2021

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.

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Nuclide	Mean radioactivity, TBq/m³ Waste at 1.4.2022	Bands and Code	Future arisings	Bands and Code	Nuclide	Mean radioactivity, TBq/m³ Waste at 1.4.2022	Bands and Code	Future arisings	Bands and Code
H 3	3.66E-03	C C 2			Gd 153		8		
Be 10	8.69E-08	C C 2			Ho 163	1.09E-08	C C 2		
C 14	1.43E-04	C C 2			Ho 166m	2.06E-07	C C 2		
Na 22		8			Tm 170		8		
Al 26	1.25E-09	C C 2			Tm 171		8		
Cl 36	1.65E-05	C C 2			Lu 174		8		
Ar 39	2.25E-08	C C 2			Lu 176		8		
Ar 42		8			Hf 178n		8		
K 40		8			Hf 182		8		
Ca 41	1.38E-07	C C 2			Pt 193		8		
Mn 53		8			Tl 204	2.45E-06	C C 2		
Mn 54		8			Pb 205		8		
Fe 55	8.16E-06	C C 2			Pb 210		8		
Co 60	3.41E-05	C C 2			Bi 208		8		
Ni 59	8.24E-06	C C 2			Bi 210m		8		
Ni 63	8.54E-04	C C 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	1.64E-05	C C 2			Th 227		8		
Zr 93	6.83E-06	C C 2			Th 228	2.09E-08	8		
Nb 91		8			Th 229		8		
Nb 92		8			Th 230		8		
Nb 93m	9.32E-06	C C 2			Th 232		8		
Nb 94	6.72E-07	C C 2			Th 234	1.95E-08	8		
Mo 93	8.89E-08	C C 2			Pa 231		8		
Tc 97		8			Pa 233		8		
Tc 99	3.97E-08	C C 2			U 232	3.11E-08	C C 2		
Ru 106		8			U 233	6.84E-08	C C 2		
Pd 107		8			U 234	6.20E-08	C C 2		
Ag 108m	1.47E-06	C C 2			U 235		8		
Ag 110m		8			U 236	1.32E-09	C C 2		
Cd 109		8			U 238	1.95E-08	C C 2		
Cd 113m	5.75E-05	C C 2			Np 237		8		
Sn 119m		8			Pu 236		8		
Sn 121m	7.71E-07	C C 2			Pu 238	4.58E-07	C C 2		
Sn 123		8			Pu 239	4.29E-07	C C 2		
Sn 126		8			Pu 240	5.07E-07	C C 2		
Sb 125	2.67E-08	C C 2			Pu 241	1.42E-05	C C 2		
Sb 126		8			Pu 242	5.20E-09	C C 2		
Te 125m	6.68E-09	8			Am 241	2.43E-06	C C 2		
Te 127m		8			Am 242m		8		
I 129		8			Am 243		8		
Cs 134	3.35E-09	C C 2			Cm 242		8		
Cs 135		8			Cm 243	2.24E-09	C C 2		
Cs 137	2.23E-05	C C 2			Cm 244	2.65E-08	C C 2		
Ba 133	1.83E-06	C C 2			Cm 245		8		
La 137	1.38E-09	C C 2			Cm 246		8		
La 138		8			Cm 248		8		
Ce 144		8			Cf 249		8		
Pm 145	9.11E-08	C C 2			Cf 250		8		
Pm 147	6.67E-08	C C 2			Cf 251		8		
Sm 147		8			Cf 252		8		
Sm 151	6.20E-06	C C 2			Other a				
Eu 152	1.11E-07	C C 2			Other b/g				
Eu 154	1.67E-06	C C 2			**Total a**	**4.06E-06**	**C C 2**	**0**	
Eu 155	1.49E-06	C C 2			**Total b/g**	**4.87E-03**	**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