WASTE STREAM 9J20 Bunker Waste

SITE	Hunterston A
SITE OWNER	Nuclear Decommissioning Authority
WASTE CUSTODIAN	Magnox Limited
WASTE TYPE	ILW
Is the waste subject to Scottish Policy:	Yes

WASTE VOLUMES

		Reported
Stocks:	At 1.4.2022.....	502.0 m^3
Total future arisings:		0 m^3
Total waste volume:		502.0 m^3

Comment on volumes: There will be no future arisings from this stream. The total waste volume is made up of the sum of FED Magnox 0.4 m3, FED graphite 460.3 m3, MCI 16.2 m3, FED Fuel Channel Components 24.7m3 and MAC 0.4 m3

Uncertainty factors on volumes:

Stock (upper):	x 1.2	Arisings (upper)	x
Stock (lower):	x 0.8	Arisings (lower)	x

WASTE SOURCE

FED Graphite: Fuel element debris from the removal of graphite sleeves from discharged fuel elements plus reflector sleeves from each fuel channel.FED Magnox: Fuel element debris, from the removal of Magnox splitters and buttons from discharged fuel elements.FED Fuel Channel Components; The waste consists of components from reactor fuel assemblies.MCI: The source of the waste is redundant contaminated equipment and materials.MAC: The source of the waste is miscellaneous activated in-core components.

PHYSICAL CHARACTERISTICS

General description: FED Graphite: Each fuel channel comprised 10 fuel elements (with associated graphite sleeves) and a disposable bottom reflector graphite sleeve. The fuel element sleeve and the reflector have been removed from the fuel and reduced in size in a cracking unit. The resultant graphite pieces have a maximum size of 300 mm and weight of 5.5 kg. Dust from the cracking operation has been accumulated in polythene bags or bottles. There are no large items that may require special handling.FED Magnox 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 desplittering process involved bailing Magnox into 150 mm bales.FED Fuel Channel Components; Fuel channel components are metallic and consist of one cast iron support member and ten zirconium `D' bars per fuel channel. There are no large items that may require special handling.MCI: The waste consists of filters, filter dust bags, general metallic waste and incinerator ash bags. Items must have a dimension less than 1.3 metres to pass through a bunker loading hole. Wastes may be in polythene bags or 180 litre drums. No large items have been identified.MAC: The waste consists of thermocouple cables, control rod wires, and BCD clips. There are no large items that may require special handling.

Physical components (%wt): FED Graphite (91.69%): Fuel element sleeves (94 wt%), reflector sleeves (6 wt%), polythene bags and bottles (trace wt%).FED Magnox (0.08%): Splitter blades (35 wt%), Magnox buttons (65 wt%). By volume, there is assumed to be 95% of solid and 5% powder.FED Fuel Channel Components (4.92%): Support members (~67% wt), D-bars (~33% wt).MCI (3.23%): Percentage breakdown of physical constituents by weight is as follows: filters (~6%), filter dust bags (~91%), incinerator ash (~1%), general waste (~2%). By volume, the solid and powders (dust and ash) are 8 and 92% respectively.MAC (0.08%): Thermocouple cables (99% wt), control rod wire (1% wt), other items (<0.1% wt).

Sealed sources: The waste does not contain sealed sources.

Bulk density (t/m^3): ~1.34

Comment on density: Mean density of waste calculated assuming a packing efficiency of 1.4 (packing fraction of 0.71). Density may be greater than the given value towards the bottom of the bunker, where the graphite may be crushed.

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CHEMICAL COMPOSITION

General description and components (%wt): FED Graphite: Graphite (~100%), graphite impurities. The waste consists almost entirely of graphite with only trace amounts of activated impurities, fission products, actinide contaminants and metals. Also trace quantities of polythene.FED Magnox; The waste is comprised of (~100%) Magnox AL80 alloy. The Magnox may be contaminated by fission products and actinides. Some corrosion product will be present in the form of magnesium hydroxide (<0.3 wt%).FED Fuel Channel Components: The waste consists of cast iron and zirconium metal. Cast iron (~67%), zirconium (~33%).MCI; The waste consists of metals such as stainless steel, mild steel and aluminium, entrapped graphite dust and other dust and ceramic material. Also a little incinerator ash.MAC: The waste consists principally of stainless steel, with other unspecified metals.

Chemical state: Neutral

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 as 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 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 neptunium content is insignificant.
Pu: The chemical form of plutonium isotopes has not been determined but may be present as plutonium oxides.

Metals and alloys (%wt): FED Graphite: No sheet or bulk metal present in this waste stream.FED Magnox: No bulk metal items present.FED Fuel Channel Components; Support members (~67% wt) are 200 mm length by 150 mm diameter.MCI: No sheet metal is expected.MAC: No sheet metal or bulk metal items present.

	(%wt)	Type(s) / Grade(s) with proportions	% of total C14 activity
Stainless steel	0		
Other ferrous metals	3.4	The waste contains steel and other ferrous metals. Alloying proportions of tin, nickel, niobium and molybdenum may be present.	
Iron			
Aluminium			
Beryllium	<0.01		
Cobalt			
Copper	0		
Lead	0		
Magnox/Magnesium	0.08	Magnox AL80, which includes 0.8 wt% aluminium as an alloying constituent. There will be impurities, generally at trace levels, incorporated in the Magnox.	
Nickel			
Titanium			
Uranium			
Zinc	TR		
Zircaloy/Zirconium	1.6	FED Fuel Channel Components: Zirconium D bars	
Other metals	TR	Only trace amounts of "other" metals may be present.	

Organics (%wt): Trace amounts of polythene will be present in the form of wrappings. Graphite dust was placed in the bunkers using polythene bags or bottles. Filters and waste bags contain organic materials. The relative amounts of organic materials have not been established.

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There are no halogenated plastics or rubbers expected in the majority of the waste. Halogenated plastics and rubbers are expected to be present within the MCI, however no detailed information exists.

	(%wt)	Type(s) and comment	% of total C14 activity
Total cellulosics	0		
Paper, cotton	0		
Wood	0		
Halogenated plastics	NE		
Total non-halogenated plastics	TR		
Condensation polymers	0		
Others	TR		
Organic ion exchange materials	0		
Total rubber	0		
Halogenated rubber	NE		
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): Principally graphite.

	(%wt)	Type(s) and comment	% of total C14 activity
Inorganic ion exchange materials	0		
Inorganic sludges and flocs	0.03		
Soil	0		
Brick/Stone/Rubble	0		
Cementitious material	0		
Sand			
Glass/Ceramics	0		
Graphite	94.6		100.0
Desiccants/Catalysts			
Asbestos	0		
Non/low friable			
Moderately friable			
Highly friable			
Free aqueous liquids	TR		
Free non-aqueous liquids	0		
Powder/Ash	<1.0		

Inorganic anions (%wt): None expected at greater than trace concentration.

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	(%wt)	Type(s) and comment
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: Graphite dust could be hazardous. Whilst graphite is difficult to ignite, it will eventually burn in air. Magnox will ignite under certain conditions.

	(%wt)	Type(s) and comment
Combustible metals	0.08	
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		
Corrosive materials	0	
Pyrophoric materials	0	
Generating toxic gases	NE	
Reacting with water	0.08	
Higher activity particles		
Soluble solids as bulk chemical compounds		

Hazardous substances / non hazardous pollutants: none expected

	(%wt)	Type(s) and comment
Acrylamide		
Benzene		
Chlorinated solvents		
Formaldehyde		
Organometallics		
Phenol		
Styrene		
Tri-butyl phosphate		
Other organophosphates		

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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.....

Complexing agents (%wt): Yes

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

Potential for the waste to contain discrete items: Yes. Fuel Sleeves assumed to be DIs

PACKAGING AND CONDITIONING

Conditioning method:	The waste will be grouted in 3m3 stainless steel boxes.The waste has been containerised and is in the ILW store awaiting conditioning.
Plant Name:	SILWR
Location:	Hunterston A Decommissioning Site
Plant startup date:	-
Total capacity (m^3/y incoming waste):	~500.0
Target start date for packaging this stream:	-
Throughput for this stream (m^3/y incoming waste):	~95.0

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Other information: -

Likely container type:

Container	Waste packaged (%vol)	Waste loading (m^3)	Payload (m^3)	Number of packages
3m^3 box (round corners)	100.0	1.81	2.9	278

Likely container type comment: -

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: Blast Furnace Slag / Ordinary Portland Cement

Other information: The waste is expected to be encapsulated in BFS/OPC. PFA/OPC is another matrix that may be adopted.

Conditioned density (t/m^3): ~2.0

Conditioned density comment: The density of the conditioned waste will probably be about 2 t/m3.

Other information on conditioning: The current proposal is to retrieve and condition wastes held in the SAWB Bunkers during Care and Maintenance Preparation.

Opportunities for alternative disposal routing: -

Baseline Management Route	Opportunity Management Route	Stream volume (%)	Estimated Date that Opportunity will be realised	Opportunity Confidence	Comment
-	-	-	-	-	-

RADIOACTIVITY

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

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: Activities have been estimated from activation calculations with assumptions for contamination.

Other information: -

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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	9.99E-02	C C 2			Gd 153		8		
Be 10	4.92E-06	C C 2			Ho 163		8		
C 14	7.67E-03	C C 2			Ho 166m	9.11E-06	C C 2		
Na 22		8			Tm 170		8		
Al 26		8			Tm 171		8		
Cl 36	2.76E-04	C C 2			Lu 174		8		
Ar 39		8			Lu 176		8		
Ar 42		8			Hf 178n		8		
K 40		8			Hf 182		8		
Ca 41	2.28E-05	C C 2			Pt 193		8		
Mn 53		8			Tl 204		8		
Mn 54		8			Pb 205		8		
Fe 55	2.43E-03	C C 2			Pb 210		8		
Co 60	7.23E-02	C C 2			Bi 208		8		
Ni 59	1.8E-04	C C 2			Bi 210m		8		
Ni 63	3.46E-02	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	2.14E-04	C C 2			Th 227		8		
Zr 93	4.92E-04	C C 2			Th 228		8		
Nb 91		8			Th 229		8		
Nb 92	9.84E-09	C C 2			Th 230		8		
Nb 93m	4.46E-04	C C 2			Th 232		8		
Nb 94	4.88E-06	C C 2			Th 234	1.27E-08	C C 2		
Mo 93	4.90E-04	C C 2			Pa 231		8		
Tc 97		8			Pa 233	1.64E-09	C C 2		
Tc 99	1.48E-04	C C 2			U 232		8		
Ru 106		8			U 233		8		
Pd 107		8			U 234	1.24E-08	C C 2		
Ag 108m	9.66E-05	C C 2			U 235		8		
Ag 110m		8			U 236	1.64E-09	C C 2		
Cd 109		8			U 238	1.27E-08	C C 2		
Cd 113m	5.56E-05	C C 2			Np 237	1.64E-09	C C 2		
Sn 119m		8			Pu 236		8		
Sn 121m	2.11E-03	C C 2			Pu 238	6.93E-06	C C 2		
Sn 123		8			Pu 239	4.41E-06	C C 2		
Sn 126	1.41E-09	C C 2			Pu 240	8.21E-06	C C 2		
Sb 125	9.59E-07	C C 2			Pu 241	7.43E-05	C C 2		
Sb 126		8			Pu 242	4.22E-09	C C 2		
Te 125m	2.40E-07	C C 2			Am 241	1.43E-05	C C 2		
Te 127m		8			Am 242m	3.85E-08	C C 2		
I 129		8			Am 243	1.21E-08	C C 2		
Cs 134		8			Cm 242	3.17E-08	C C 2		
Cs 135	3.23E-09	C C 2			Cm 243	9.23E-09	C C 2		
Cs 137	2.23E-04	C C 2			Cm 244	9.62E-08	C C 2		
Ba 133	8.50E-07	C C 2			Cm 245		8		
La 137	3.19E-09	C C 2			Cm 246		8		
La 138		8			Cm 248		8		
Ce 144		8			Cf 249		8		
Pm 145	1.25E-04	C C 2			Cf 250		8		
Pm 147	2.23E-08	C C 2			Cf 251		8		
Sm 147		8			Cf 252		8		
Sm 151	9.04E-04	C C 2			Other a				
Eu 152	8.09E-03	C C 2			Other b/g				
Eu 154	3.75E-02	C C 2			**Total a**	**3.40E-05**	**C C 2**	**0**	
Eu 155	2.69E-04	C C 2			**Total b/g**	**2.69E-01**	**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