WASTE STREAM 9J19 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.....	560.2 m^3
Total future arisings:		0 m^3
Total waste volume:		560.2 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 1.1m3, FED graphite 501.3m3, 22.5MCI m3, FED Fuel Channel Components 26.6m3 and MAC 8.7m3

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.MAC - The source of the waste is miscellaneous activated in-core components.MCI - The source of the waste is redundant contaminated equipment and materials.

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 packaging 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 diameter 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.MAC - The waste consists of thermocouple cables, control rod wires, BCD clips, contact assemblies and thermocouple reeling drums. There are no large items that may require special handling.MCI - The waste consists mainly of redundant pond fuel handling equipment, filters, filter dust bags, general metallic waste and some sludge in 20 litre cans. Items must have a dimension less than 1.3 metres to pass through a bunker loading hole. Wastes may be in polythene or 180 litre drums. No large items have been identified apart from pond skips which have a volume of 1.2 m3 and weigh 350 kg

Physical components (%wt): FED Graphite (89.49%) - Fuel element sleeves (94 wt%), reflector sleeves (6 wt%). Polythene bags and bottles (trace wt%).FED Magnox (0.2%) - Splitter blades (60 wt%), Magnox buttons (40 wt%). By volume, it is assumed there is 95% of solid and 5% powder.FED Fuel Channel Components (4.75%) - Support members (~67% wt), D-bars (~33% wt).MAC (1.55%) - Thermocouple cables (~0.6% wt), thermocouple reeling drums (~99% wt), other items (~0.4% wt).MCI (4.02%) - Percentage breakdown of physical constituents by weight is as follows: filters (~6%), filter dust bags (~82%), sludge (~0.5%), general waste (~7.5%), pond skips (~4%). By volume, the solid and powders (dust and ash) are 17.5 and 82.5% respectively.

Sealed sources: The waste does not contain sealed sources.

Bulk density (t/m^3): ~1.32

Comment on density: Density of waste is calculated from a weighted average of 9J19, 9J24, 9J27, 9J36 & 9J41.

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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%).MAC - The waste consists principally of stainless steel, with other unspecified metals.MCI - The waste consists of metals such as stainless steel, mild steel and aluminium alloys, entrapped graphite dust and other dust and ceramic material. Some sludge and ion exchange resin is also present (~0.5 wt%), this contains organic materials including polymers and cellulose.

Chemical state: Neutral

Chemical form of radionuclides: H-3: The chemical form of tritium has not been determined but may be present as water or as 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 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 (~67wt %) are 150 mm diameter x 200 mm.MAC - No sheet metal present. Largest item has envelope volume of approximately 70 litres (thermocouple reeling drum).MCI - Bunker contains 2 pond skips each with envelope volume of 1.2 m3, 350 kg mass.

	(%wt)	Type(s) / Grade(s) with proportions	% of total C14 activity
Stainless steel	0		
Other ferrous metals	~5.0	The waste contains steel and other ferrous metals.	
Iron			
Aluminium			
Beryllium	<0.01		
Cobalt			
Copper	0		
Lead	0		
Magnox/Magnesium	~0.19	Magnox AL80, which includes 0.8 wt% aluminium as an alloying constituent.	
Nickel			
Titanium			
Uranium			
Zinc	TR		
Zircaloy/Zirconium	~1.6		
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. Halogenated plastics are expected to be present within the MCI proportion of the waste stream. However no detailed information exists. Halogenated rubbers may be present within the MCI proportion of the waste stream but this has not been estimated.

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	(%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	0.02		
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	<0.02		
Inorganic sludges and flocs	NE		
Soil	0		
Brick/Stone/Rubble	0		
Cementitious material	0		
Sand			
Glass/Ceramics	0		
Graphite	89.5		100.0
Desiccants/Catalysts			
Asbestos	0		
Non/low friable			
Moderately friable			
Highly friable			
Free aqueous liquids	TR		
Free non-aqueous liquids	0		
Powder/Ash	~3.3		

Inorganic anions (%wt): None expected at greater than trace concentration in the majority of the waste. The sludge and ion exchange resin within the MCI may contain inorganic anions - exact composition has not been determined.

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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 it is difficult to ignite, graphite will eventually burn in air. There is Magnox present which will ignite under certain conditions. Hazardous materials within the MCI have not been fully assessed, however they are only likely to be present in trace quantities.

	(%wt)	Type(s) and comment
Combustible metals	~0.19	
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	0	
Reacting with water	~0.19	
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		

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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.....	

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:	It is not expected that the waste will be tamped or compacted. 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:	-

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Throughput for this stream (m³/y incoming waste): ~100.0

Other information: It is expected that all wastes in the bunker would be encapsulated together excluding any dust.

Likely container type:

Container	Waste packaged (%vol)	Waste loading (m³)	Payload (m³)	Number of packages
3m³ box (round corners)	100.0	2.04	2.9	275

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 encapsuluated in BFS/OPC. PFA/OPC is another matrix that may be adopted.

Conditioned density (t/m³): ~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	1.10E-01	C C 2			Gd 153		8		
Be 10	4.75E-06	C C 2			Ho 163		8		
C 14	7.73E-03	C C 2			Ho 166m	8.89E-08	C C 2		
Na 22		8			Tm 170		8		
Al 26		8			Tm 171		8		
Cl 36	2.74E-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	2.22E-05	C C 2			Pt 193		8		
Mn 53		8			Tl 204		8		
Mn 54		8			Pb 205		8		
Fe 55	4.96E-04	C C 2			Pb 210		8		
Co 60	2.29E-02	C C 2			Bi 208		8		
Ni 59	7.64E-04	C C 2			Bi 210m		8		
Ni 63	6.91E-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	2.48E-04	C C 2			Th 227		8		
Zr 93	4.75E-04	C C 2			Th 228		8		
Nb 91		8			Th 229		8		
Nb 92	9.5E-09	C C 2			Th 230		8		
Nb 93m	4.30E-04	C C 2			Th 232		8		
Nb 94	5.31E-06	C C 2			Th 234	1.47E-08	C C 2		
Mo 93	4.73E-04	C C 2			Pa 231		8		
Tc 97		8			Pa 233	2.01E-09	C C 2		
Tc 99	1.43E-04	C C 2			U 232		8		
Ru 106		8			U 233		8		
Pd 107		8			U 234	1.49E-08	C C 2		
Ag 108m	9.32E-04	C C 2			U 235		8		
Ag 110m		8			U 236	1.95E-09	C C 2		
Cd 109		8			U 238	1.47E-08	C C 2		
Cd 113m	1.67E-05	C C 2			Np 237	2.01E-09	C C 2		
Sn 119m		8			Pu 236		8		
Sn 121m	2.04E-03	C C 2			Pu 238	8.38E-06	C C 2		
Sn 123		8			Pu 239	5.23E-06	C C 2		
Sn 126	1.75E-09	C C 2			Pu 240	9.81E-06	C C 2		
Sb 125	2.08E-07	C C 2			Pu 241	7.79E-05	C C 2		
Sb 126		8			Pu 242	5.01E-09	C C 2		
Te 125m	5.21E-08	C C 2			Am 241	1.73E-05	C C 2		
Te 127m		8			Am 242m	3.89E-08	C C 2		
I 129		8			Am 243	1.45E-08	C C 2		
Cs 134		8			Cm 242	3.21E-08	C C 2		
Cs 135	4.03E-09	C C 2			Cm 243	7.61E-09	C C 2		
Cs 137	2.59E-04	C C 2			Cm 244	9.06E-08	C C 2		
Ba 133	2.71E-07	C C 2			Cm 245		8		
La 137	7.85E-09	C C 2			Cm 246		8		
La 138		8			Cm 248		8		
Ce 144		8			Cf 249		8		
Pm 145	1.20E-04	C C 2			Cf 250		8		
Pm 147	8.72E-09	C C 2			Cf 251		8		
Sm 147		8			Cf 252		8		
Sm 151	8.65E-04	C C 2			Other a				
Eu 152	7.72E-03	C C 2			Other b/g				
Eu 154	3.61E-02	C C 2			**Total a**	**4.09E-05**	**C C 2**	**0**	
Eu 155	6.06E-05	C C 2			**Total b/g**	**2.61E-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