WASTE STREAM 9J22 Bunker Waste

SITE	Hunterston A
SITE OWNER	Nuclear Decommissioning Authority
WASTE CUSTODIAN	Magnox Limited
WASTE TYPE	ILW

WASTE VOLUMES

		Reported
Stocks:	At 1.4.2019.....	109.4 m³
Total future arisings:		0 m³
Total waste volume:		109.4 m³

Comment on volumes: There will be no future arisings from this stream. The waste is containerised but not yet conditioned. The total waste volume is made up of the sum of FED graphite 86.9m3, MCI 17.1 m3, FED Fuel Channel Components 5.2 m3 and MAC 0.2m3.

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.MCI: The source of the waste is redundant contaminated equipment and materials.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.

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.MCI: The waste consists mainly of filters and filter dust bags, with a little general waste. There are a few drums of ceramic rings from the precipitator process vessel. Items must have a dimension less than 1.3 metres to pass through a bunker loading hole. Waste may be in polythene bags or 180 litre drums. No large items have been identified.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 and control rod wires. There are no large items that may require special handling.

Physical components (%wt): FED Graphite (79.43%): Fuel element sleeves (94 wt%), reflector sleeves (6 wt%). Polythene bags and bottles (trace wt%).MCI (15.63%): Percentage breakdown of physical constituents by weight is as follows: filters (~43%), filter dust bags (~54%), other general waste (~3%). By volume, the solid and dusts are 46 and 54% respectively.FED Fuel Channel Components (4.75%): Support members (66% wt), D-bars (34% wt).MAC (0.18%): Thermocouple cables (~98% wt), control rod wire (~2% wt).

Sealed sources: -

Bulk density (t/m³): ~1.19

Comment on density: Mean density of the waste is calculated assuming a packing factor of 1.4 (packing fraction = 0.71).

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. Trace quantities of polythene.MCI: The waste consists of metals such as steel and aluminium, entrapped graphite dust and other dust and ceramic material.FED Fuel Channel Components: The waste consists of cast iron and zirconium metal. Cast iron (~66%), zirconium (~34%).MAC: The waste consists principally of stainless steel, with other unspecified metals.

WASTE STREAM 9J22 Bunker Waste

Chemical state:	Neutral
Chemical form of radionuclides:	H-3: The chemical form of tritium has not been assessed but will probably be present as surface contamination C-14: Carbon 14 will be present as graphite. Cl-36: The chemical form of chlorine 36 has not been determined but will probably be present as 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: The 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.MCI: No sheet metal is expected.FED Fuel Channel Components: Support members (~66% wt) 200 mm length by diameter 150 mm.MAC: No sheet metal or bulk metal items present.

Stainless steel	0	
Other ferrous metals	~4.1	MAC: The waste contains steel and other metals. Alloying proportions of tin, nickel, niobium and molybdenum may be present.
Iron		
Aluminium	~0.31	
Beryllium	<0.01	
Cobalt		
Copper	0	
Lead	0	
Magnox/Magnesium	TR	
Nickel		
Titanium		
Uranium		
Zinc	0	
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. There are no halogenated plastics or rubbers present in the majority of the waste. Halogenated plastics and rubbers are expected to be present within the MCI, however no detailed information exists.

Total cellulosics	0.10
Paper, cotton	0.10
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

WASTE STREAM 9J22 Bunker Waste

	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.	
	Inorganic ion exchange materials.	0
	Inorganic sludges and flocs	0.16
	Soil	0
	Brick/Stone/Rubble	0
	Cementitious material	0
	Sand	
	Glass/Ceramics	0
	Graphite	93.5
	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.	
	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 may be traces of Magnox present.	

WASTE STREAM 9J22 Bunker Waste

Combustible metals	TR
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	TR
Active particles	
Soluble solids as bulk chemical compounds	

Hazardous substances / non hazardous pollutants: None expected.

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): Yes

EDTA.....

DPTA.....

NTA.....

Polycarboxylic acids……

Other organic complexants.....

Total complexing agents..... TR

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. The number of packages below is forecast number, actual number of packages held is shown as number of packages in stock.

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): ~17.4

Other information: The current proposal is to process the waste during Care and Maintenance Preparation. All wastes in the bunker will be encapsulated together, but possibly excluding any dusts.

Likely container type:

Container	Waste packaged (%vol)	Waste loading (m^3)	Payload (m^3)	Number of packages
3m^3 box (round corners)	100.0	1.825	2.7	60

Likely container type comment: 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 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 product 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. The waste will be conditioned with waste from the same bunker amalgamated under this stream but formerly known as 9J30, 9J39 and 9J44

(possibly apart from any dust - 9J62).

Opportunities for alternative disposal routing:

Treatment	Stream volume (%)	Comment
-	-	-

RADIOACTIVITY

Source:	Predominantly activation products 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:	-

WASTE STREAM 9J22 Bunker Waste

Nuclide	Mean radioactivity, TBq/m³ Waste at 1.4.2019	Bands and Code	Future arisings	Bands and Code	Nuclide	Mean radioactivity, TBq/m³ Waste at 1.4.2019	Bands and Code	Future arisings	Bands and Code
H 3	2.43E-01	C C 2			Gd 153		8		
Be 10	4.75E-06	C C 2			Ho 163		8		
C 14	7.17E-03	C C 2			Ho 166m	7.90E-06	C C 2		
Na 22		8			Tm 170		8		
Al 26		8			Tm 171		8		
Cl 36	3.66E-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	2.02E-05	C C 2			Pt 193		8		
Mn 53		8			Tl 204		8		
Mn 54		8			Pb 205		8		
Fe 55	4.50E-02	C C 2			Pb 210		8		
Co 60	2.95E-01	C C 2			Bi 208		8		
Ni 59	2.16E-04	C C 2			Bi 210m		8		
Ni 63	3.82E-02	C C 2			Po 210		8		
Zn 65		8			Ra 223		8		
Se 79	1.89E-09	C C 2			Ra 225		8		
Kr 81		8			Ra 226		8		
Kr 85		8			Ra 228		8		
Rb 87		8			Ac 227		8		
Sr 90	2.57E-03	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	9.51E-09	C C 2			Th 230		8		
Nb 93m	3.70E-04	C C 2			Th 232		8		
Nb 94	4.67E-06	C C 2			Th 234	4.93E-08	C C 2		
Mo 93	4.75E-04	C C 2			Pa 231		8		
Tc 97		8			Pa 233	6.65E-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	5.02E-08	C C 2		
Ag 108m	9.42E-05	C C 2			U 235		8		
Ag 110m		8			U 236	6.59E-09	C C 2		
Cd 109		8			U 238	4.93E-08	C C 2		
Cd 113m	9.28E-05	C C 2			Np 237	6.65E-09	C C 2		
Sn 119m		8			Pu 236		8		
Sn 121m	2.54E-03	C C 2			Pu 238	3.01E-05	C C 2		
Sn 123		8			Pu 239	1.67E-05	C C 2		
Sn 126		8			Pu 240	3.29E-05	C C 2		
Sb 125	1.97E-05	C C 2			Pu 241	3.77E-04	C C 2		
Sb 126		8			Pu 242	1.66E-08	C C 2		
Te 125m	4.93E-06	C C 2			Am 241	4.08E-05	C C 2		
Te 127m		8			Am 242m	1.61E-07	C C 2		
I 129		8			Am 243	4.93E-08	C C 2		
Cs 134	4.60E-08	C C 2			Cm 242	1.33E-07	C C 2		
Cs 135	1.56E-08	C C 2			Cm 243	4.04E-08	C C 2		
Cs 137	2.60E-03	C C 2			Cm 244	4.64E-07	C C 2		
Ba 133	8.79E-07	C C 2			Cm 245		8		
La 137		8			Cm 246		8		
La 138		8			Cm 248		8		
Ce 144		8			Cf 249		8		
Pm 145	1.70E-04	C C 2			Cf 250		8		
Pm 147	1.37E-06	C C 2			Cf 251		8		
Sm 147		8			Cf 252		8		
Sm 151	9.04E-04	C C 2			Other a				
Eu 152	1.51E-02	C C 2			Other b/g				
Eu 154	9.19E-02	C C 2			**Total a**	**1.21E-04**	**C C 2**	**0**	
Eu 155	9.31E-04	C C 2			**Total b/g**	**7.47E-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