WASTE STREAM 9A312 Miscellaneous Metal (Reactor) ILW

SITE Berkeley

SITE OWNER Nuclear Decommissioning Authority

WASTE CUSTODIAN Magnox Limited

WASTE TYPE ILW

WASTE VOLUMES

		Reported
Stocks:	At 1.4.2019.....	0 m³
Future arisings -	1.4.2074 - 31.3.2077.....	52.0 m³
Total future arisings:		52.0 m³
Total waste volume:		52.0 m³

Comment on volumes: Waste arisings are assumed to occur at a uniform rate over 3 years. Final Dismantling & Site Clearance is assumed to commence in 2070 with reactor dismantling commencing in 2074 and lasting for 3 years. The volumes and radioactivity have been calculated for 85 years after reactor shutdown, i.e. 2074.

Uncertainty factors on volumes:

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

WASTE SOURCE A variety of miscellaneous metallic wastes resulting from reactor dismantling.

PHYSICAL CHARACTERISTICS

General description: Reactor components including channel sleeves, control rods, tie rods, zirconium pins, CGO thermocouples, core thermocouples and thermocouple ducts. Waste can be packaged in standard ILW containers.

Physical components (%wt): Boron Steel control rods (~10%wt), channel sleeves (~60% wt), zirconium pins (~6% wt) NiloK tie rods (~24%).

Sealed sources: -

Bulk density (t/m³): ~1.4

Comment on density: The density is of the waste as cut for packaging.

CHEMICAL COMPOSITION

General description and components (%wt): Boron steel (10%wt), Magnox alloy (~60% wt), zirconium (~6%), NiloK steel (~24%wt), alumel (<0.1% wt) and chromel (<0.1%wt).

Chemical state: Neutral

Chemical form of radionuclides: C-14: The carbon 14 is incorporated in the metal. There may also be some contamination as graphite.
Cl-36: The chlorine 36 is incorporated in the metal.

Metals and alloys (%wt): All of the waste will have been cut to fit a standard 4m ILW container.

Stainless steel.....	0	
Other ferrous metals.....	~34.0	All of the waste included in this waste stream is from a wide range of miscellaneous metals
Iron.....		
Aluminium.....	0	
Beryllium.....	TR	
Cobalt.....		
Copper.....	0	
Lead.....	0	
Magnox/Magnesium.....	~60.0	
Nickel.....		
Titanium.....		
Uranium.....		

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	Zinc	0	
	Zircaloy/Zirconium	~6.0	
	Other metals	TR	Chromel and alumel are present at <0.1% wt.
Organics (%wt):	None expected. There are no halogenated plastics or rubbers present.		
	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	0	
Other materials (%wt):	Some graphite dust may be associated with reactor materials.		
	Inorganic ion exchange materials.	0	
	Inorganic sludges and flocs	0	
	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	0	
	Free non-aqueous liquids	0	
	Powder/Ash	0	
Inorganic anions (%wt):	The waste may include traces of chloride.		

Fluoride	0
Chloride	TR
Iodide	0
Cyanide	0
Carbonate	0
Nitrate	0
Nitrite	0
Phosphate	0
Sulphate	0
Sulphide	0

Materials of interest for waste acceptance criteria: Magnox will ignite under appropriate conditions.

Combustible metals	~60.0
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	~60.0
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	

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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):

EDTA.....

DPTA.....

NTA.....

Polycarboxylic acids……

Other organic complexants.....

Total complexing agents..... TR

PACKAGING AND CONDITIONING

Conditioning method:	The waste is not expected to be supercompacted. It will be placed in baskets in the waste packages followed by encapsulation with BFS/OPC.
Plant Name:	None
Location:	Berkeley Site
Plant startup date:	2074
Total capacity (m^3/y incoming waste):	~5000.0
Target start date for packaging this stream:	2074
Throughput for this stream (m^3/y incoming waste):	~13.0
Other information:	It is currently intended that these wastes will be grouted.

Likely container type:

Container	Waste packaged (%vol)	Waste loading (m^3)	Payload (m^3)	Number of packages
4m box (300mm concrete shielding)	100.0	6.94	8.1	8

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Likely container type comment:	The waste is assumed to be in baskets in the waste package so the occupied volume in the package is greater than the original waste volume. Container choice may be influenced by Transport Regulations at the time of Final Site Clearance.
Range in container waste volume:	Not yet determined.
Other information on containers:	The container material is expected to be stainless steel.
Likely conditioning matrix:	Blast Furnace Slag / Ordinary Portland Cement
Other information:	-
Conditioned density (t/m³):	~3.0
Conditioned density comment:	The conditioned waste density assumes the waste will be encapsulated.
Other information on conditioning:	The waste will be in baskets placed in the waste packages. Baskets of different Final Dismantling & Site Clearance ILW wastes may be in the same waste package. As encapsulation is now intended the matrix is likely to be BFS/OPC and the density of the conditioned waste product will be about 3 t/m3.
Opportunities for alternative disposal routing:	No

Treatment	Stream volume (%)	Comment
-	-	-

RADIOACTIVITY

Source:	Activation of the metals and impurities.
Uncertainty:	The values quoted were derived by calculation from available material specifications and are indicative of the activities that are expected. The major source of uncertainty is the impurity levels.
Definition of total alpha and total beta/gamma:	Total beta/gamma is defined as the sum of the listed activities of all nuclides other than alpha emitters. All alpha emitter activities are insignificant.
Measurement of radioactivities:	The specific activities were estimated from neutron activation calculations of the materials and the expected impurities.
Other information:	The activities quoted are those at 85 years after reactor shutdown, i.e. in 2074.

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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				8	Gd 153				8
Be 10				8	Ho 163				8
C 14			2.28E-02	C C 2	Ho 166m				8
Na 22				8	Tm 170				8
Al 26			3E-07	C C 2	Tm 171				8
Cl 36			1.12E-03	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			7.36E-05	C C 2	Pt 193				8
Mn 53				8	Tl 204				8
Mn 54				8	Pb 205				8
Fe 55			2.91E-09	C C 2	Pb 210				8
Co 60			1.74E-02	C C 2	Bi 208				8
Ni 59			8.32E-02	C C 2	Bi 210m				8
Ni 63			5.78E+00	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				8	Th 227				8
Zr 93				8	Th 228				8
Nb 91				8	Th 229				8
Nb 92			5.12E-09	C C 2	Th 230				8
Nb 93m				6	Th 232				8
Nb 94			8.33E-03	C C 2	Th 234				8
Mo 93			3.64E-04	C C 2	Pa 231				8
Tc 97				8	Pa 233				8
Tc 99			7.09E-05	C C 2	U 232				8
Ru 106				8	U 233				8
Pd 107				8	U 234				8
Ag 108m			7.83E-06	C C 2	U 235				8
Ag 110m				8	U 236				8
Cd 109				8	U 238				8
Cd 113m				8	Np 237				8
Sn 119m				8	Pu 236				8
Sn 121m			2.2E-03	C C 2	Pu 238				8
Sn 123				8	Pu 239				8
Sn 126				8	Pu 240				8
Sb 125				8	Pu 241				8
Sb 126				8	Pu 242				8
Te 125m				8	Am 241				8
Te 127m				8	Am 242m				8
I 129				8	Am 243				8
Cs 134				8	Cm 242				8
Cs 135				8	Cm 243				8
Cs 137				6	Cm 244				8
Ba 133				8	Cm 245				8
La 137				8	Cm 246				8
La 138				8	Cm 248				8
Ce 144				8	Cf 249				8
Pm 145				8	Cf 250				8
Pm 147				8	Cf 251				8
Sm 147				8	Cf 252				8
Sm 151				8	Other a				
Eu 152			1.38E-03	C C 2	Other b/g				C C 2
Eu 154			9.78E-05	C C 2	**Total a**	**0**		**0**	
Eu 155			3.93E-07	C C 2	**Total b/g**	**0**		**5.92E+00**	**C C 2**

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