WASTE STREAM	9B318	Miscellaneous Metals and Materials (Reactor and Non-Reactor) LLW

SITE Bradwell

SITE OWNER Nuclear Decommissioning Authority

WASTE CUSTODIAN Magnox Limited

WASTE TYPE LLW

WASTE VOLUMES

		Reported
Stocks:	At 1.4.2019.....	0 m³
Future arisings -	1.4.2087 - 31.3.2090.....	626.0 m³
Total future arisings:		626.0 m³
Total waste volume:		626.0 m³

Comment on volumes: Final Site Clearance is assumed to commence in 2083 with reactor dismantling commencing in 2087 and lasting for three years. Volumes and radioactivity have been calculated for 85 years after reactor shutdown, i.e. 2087.

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 materials from plant dismantling, including thermocouple and insulation materials.

PHYSICAL CHARACTERISTICS

General description: A variety of materials including Nimonic restraint bars, steel alloy Wigner probes, thermocouple metals and insulation materials.

Physical components (%vol): A variety of constituents including metallic items from the reactor (<0.1%), insulating materials (~85%), temporary active drains (~7%) and vacuum clean and washdown area items (~8%).

Sealed sources: -

Bulk density (t/m³): ~1

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

CHEMICAL COMPOSITION

General description and components (%wt): A variety of materials including insulation materials and metals. Materials will include special steels, zirconium and magnesium oxide.

Chemical state: Neutral

Chemical form of radionuclides: H-3: The chemical form of tritium has not been assessed.
C-14: The chemical form of carbon 14 has not been assessed but may be graphite.
Cl-36: The chemical form of chlorine 36 has not been assessed.

Metals and alloys (%wt): Items will have been cut for packaging. An assessment of item dimensions has not been made.

Stainless steel.....	
Other ferrous metals.....	
Iron.....	
Aluminium.....	NE
Beryllium.....	0
Cobalt.....	
Copper.....	NE
Lead.....	NE
Magnox/Magnesium.....	NE
Nickel.....	
Titanium.....	
Uranium.....	

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	Zinc	NE	
	Zircaloy/Zirconium	NE	Zirconium will be present.
	Other metals	NE	Non-ferrous metals have not been estimated.
Organics (%wt):	Plastics may be present. Halogenated rubbers are not expected. Halogenated plastics have not been estimated.		
	Total cellulosics	0	
	Paper, cotton	0	
	Wood	0	
	Halogenated plastics	NE	
	Total non-halogenated plastics	NE	
	Condensation polymers	NE	
	Others	NE	
	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):	There might be traces of graphite.		
	Inorganic ion exchange materials.	0	
	Inorganic sludges and flocs	8.0	vacuum clean and washdown area items
	Soil	0	
	Brick/Stone/Rubble	0	
	Cementitious material	7.0	temporary active drains
	Sand		
	Glass/Ceramics	85.0	MMMF (Man Made Mineral Fibre) insulation materials
	Graphite	TR	
	Desiccants/Catalysts		
	Asbestos		
	Non/low friable		
	Moderately friable		
	Highly friable		
	Free aqueous liquids	0	
	Free non-aqueous liquids	0	
	Powder/Ash	0	
Inorganic anions (%wt):	-		

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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: The presence or absence of asbestos has yet to be confirmed.

Combustible metals	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	0
Active particles	
Soluble solids as bulk chemical compounds	

Hazardous substances / non hazardous pollutants: -

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):

EDTA.....

DPTA.....

NTA.....

Polycarboxylic acids……

Other organic complexants.....

Total complexing agents..... TR

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		100.0

Comment on planned treatments: -

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Disposal Routes:

Disposal Route	Stream volume %
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	100.0

Upcoming (2019/20-2021/22) Waste Routing (if expected to change from above):

Disposal Route	Stream volume %		
	2019/20	2020/21	2021/22
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			

Waste Packaging for Disposal: (Not applicable to this waste stream)

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			

Other information: -

Waste Planned for Disposal at the LLW Repository: (Not applicable to this waste stream)

Container voidage: -

Waste Characterisation Form (WCH): -

Waste consigned for disposal to LLWR in year of generation: -

Potential for the waste to contain discrete items: -

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

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Source:	Activation of the materials and impurities. There may be some contamination.
Uncertainty:	Only very approximate estimates have been made of the total specific activities. The activities quoted are those at the time of Final Dismantling & Site Clearance.
Definition of total alpha and total beta/gamma:	All alpha emitter activities are insignificant. An estimate of beta/gamma activity is provided for individual nuclide activities.
Measurement of radioactivities:	The specific activities of the reactor material were estimated from neutron activation calculations of the reactor material and its impurities, but this is only a small component of the total volume (<0.1%). The specific activity of the thermal insulation (85 % by volume) has been assumed to be the same as at Trawsfynydd.
Other information:	The activities quoted are those at 85 years after reactor shutdown, i.e. in 2087. There may be some contamination by Cs137.

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Nuclide	Mean radioactivity, TBq/m³				Nuclide	Mean radioactivity, TBq/m³			
	Waste at 1.4.2019	Bands and Code	Future arisings	Bands and Code		Waste at 1.4.2019	Bands and Code	Future arisings	Bands and Code
H 3			3.78E-05	C C 2	Gd 153				8
Be 10				8	Ho 163				8
C 14			7.3E-05	C C 2	Ho 166m				8
Na 22				8	Tm 170				8
Al 26				8	Tm 171				8
Cl 36			1.27E-06	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			1.54E-05	C C 2	Pt 193				8
Mn 53				8	Tl 204				8
Mn 54				8	Pb 205				8
Fe 55				8	Pb 210				8
Co 60			6.21E-08	C C 2	Bi 208				8
Ni 59			1.16E-09	C C 2	Bi 210m				8
Ni 63			2.79E-05	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				8	Th 230				8
Nb 93m				6	Th 232				8
Nb 94			1.57E-09	C C 2	Th 234				8
Mo 93			1.28E-08	C C 2	Pa 231				8
Tc 97				8	Pa 233				8
Tc 99				6	U 232				8
Ru 106				8	U 233				8
Pd 107				8	U 234				8
Ag 108m				6	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			5.82E-08	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			2.74E-08	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				8	Cf 250				8
Pm 147				8	Cf 251				8
Sm 147				8	Cf 252				8
Sm 151			1.93E-06	C C 2	Other a				
Eu 152			1.15E-05	C C 2	Other b/g				
Eu 154			1.92E-07	C C 2	**Total a**	**0**		**0**	
Eu 155				8	**Total b/g**	**0**		**1.69E-04**	**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