

WASTE STREAM	9B317	Concrete (Reactor and Non-Reactor) LLW
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SITE Bradwell
SITE OWNER Nuclear Decommissioning Authority

WASTE CUSTODIAN Magnox Limited

WASTE TYPE LLW

Is the waste subject to Scottish Policy: No

WASTE VOLUMES

		Reported
Stocks:	At 1.4.2022.....	0 m ³
Future arisings -	1.4.2087 - 31.3.2090.....	30244.0 m ³
Total future arisings:		30244.0 m ³
Total waste volume:		30244.0 m ³

Comment on volumes: It has been assumed that the whole of the bioshield will be knocked down and disposed of as LLW. There will be no segregation of waste. Final Dismantling & 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 Concrete wastes from dismantling of reactors and associated plant.

PHYSICAL CHARACTERISTICS

General description: A wide variety of concrete and reinforced concrete items (reinforcing steel is described in waste stream 9B315).
 Physical components (%vol): Concrete and reinforced concrete. 98% from the bioshield.
 Sealed sources: The waste does not contain sealed sources.
 Bulk density (t/m³): ~1.4
 Comment on density: The density is of the waste as cut for packaging. The density is the effective density for packaging assuming 20% of the concrete is in blocks and 80% is rubble.

CHEMICAL COMPOSITION

General description and components (%wt): Concrete (100%). Some of the concrete might include iron shot.
 Chemical state: Alkali
 Chemical form of radionuclides: H-3: The tritium is incorporated in the concrete.
 C-14: The carbon 14 is incorporated in the concrete.
 Cl-36: The chlorine 36 is incorporated in the concrete.
 Metals and alloys (%wt): There is no sheet metal or bulk metal in this waste stream.

	(%wt)	Type(s) / Grade(s) with proportions	% of total C14 activity
Stainless steel.....	0		
Other ferrous metals.....	NE	Some of the concrete may incorporate iron shot.	
Iron.....			
Aluminium.....	0		
Beryllium.....	0		
Cobalt.....			
Copper.....	0		
Lead.....	0		
Magnox/Magnesium.....	0		

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Nickel.....
Titanium.....
Uranium.....
Zinc..... 0
Zircaloy/Zirconium..... 0
Other metals..... NE

Reinforcing steel is described in waste stream 9B315. Some of the concrete may include iron shot; otherwise only trace quantities of metals are expected.

Organics (%wt): -

	(%wt)	Type(s) and comment	% of total C14 activity
Total cellulose.....	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): There might be traces of graphite.

	(%wt)	Type(s) and comment	% of total C14 activity
Inorganic ion exchange materials..	0		
Inorganic sludges and flocs.....	0		
Soil.....	0		
Brick/Stone/Rubble.....	0		
Cementitious material.....	100.0		100.0
Sand.....			
Glass/Ceramics.....	0		
Graphite.....	TR		
Desiccants/Catalysts.....			
Asbestos.....	0		

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Non/low friable.....
 Moderately friable.....
 Highly friable.....
 Free aqueous liquids..... 0
 Free non-aqueous liquids..... 0
 Powder/Ash..... 0

Inorganic anions (%wt): Principal anions will be silicates and aluminates in various anionic forms. Carbonates could be up to 20% if limestone used as an aggregate.

	(%wt)	Type(s) and comment
Fluoride.....	<1.0	
Chloride.....	<1.0	
Iodide.....	<1.0	
Cyanide.....	0	
Carbonate.....	<2.0	
Nitrate.....	<1.0	
Nitrite.....	<1.0	
Phosphate.....	<1.0	
Sulphate.....	~2.0	
Sulphide.....	<1.0	

Materials of interest for waste acceptance criteria: No materials likely to pose a fire or other non-radiological hazard have been identified.

	(%wt)	Type(s) and comment
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	
Higher activity particles.....		
Soluble solids as bulk chemical compounds.....		

Hazardous substances / non hazardous pollutants: None expected

	(%wt)	Type(s) and comment
Acrylamide.....		
Benzene.....		

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- Chlorinated solvents.....
- Formaldehyde.....
- Organometallics.....
- Phenol.....
- Styrene.....
- Tri-butyl phosphate.....
- Other organophosphates.....
- Vinyl chloride.....
- Arsenic.....
- Barium.....
- Boron.....
 - 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): No

(%wt) Type(s) and comment

- EDTA.....
- DPTA.....
- NTA.....
- Polycarboxylic acids.....
- Other organic complexants.....
- Total complexing agents.....

Potential for the waste to contain discrete items: Yes. Large Concrete Items (LCIs) may be DIs; drummed (ungrouned)/"rubbleised" wastes assumed NOT DIs

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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 Recycling / reuse Other / various None		100.0

Comment on planned treatments:

-

Disposal Routes:

Disposal Route	Stream volume %	Disposal density t/m3
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	1.4

Classification codes for waste expected to be consigned to a landfill facility: 17 01 01

Upcoming (2022/23-2024/25) Waste Routing (if expected to change from above):

Disposal Route	Stream volume %		
	2022/23	2023/24	2024/25
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			

Opportunities for alternative disposal routing: -

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

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

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Container	Stream volume %	Waste loading m ³	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: -

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

Source: Activation of the concrete and impurities.

Uncertainty: The values quoted were derived by calculation from available material specifications and are indicative of the activities that are expected. The majority of uncertainty is in the impurity levels.

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: The specific activities were estimated from neutron activation calculations of the material and its impurities.

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/m ³				Nuclide	Mean radioactivity, TBq/m ³			
	Waste at 1.4.2022	Bands and Code	Future arisings	Bands and Code		Waste at 1.4.2022	Bands and Code	Future arisings	Bands and Code
H 3			3.6E-05	CC 2	Gd 153				8
Be 10				8	Ho 163				8
C 14			7.09E-07	CC 2	Ho 166m		5.36E-09	CC	2
Na 22				8	Tm 170				8
Al 26				8	Tm 171				8
Cl 36			3.88E-07	CC 2	Lu 174				8
Ar 39				8	Lu 176				8
Ar 42				8	Hf 178n				8
K 40				8	Hf 182				8
Ca 41			7.4E-06	CC 2	Pt 193				8
Mn 53				8	Tl 204				8
Mn 54				8	Pb 205				8
Fe 55				8	Pb 210				8
Co 60			1.88E-09	CC 2	Bi 208				8
Ni 59			8.6E-09	CC 2	Bi 210m				8
Ni 63			4.94E-07	CC 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				8	Th 232				8
Nb 94			5E-09	CC 2	Th 234				8
Mo 93				8	Pa 231				8
Tc 97				8	Pa 233				8
Tc 99				8	U 232				8
Ru 106				8	U 233				8
Pd 107				8	U 234				8
Ag 108m			5.29E-09	CC 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				8	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			4.27E-07	CC 2	Other a				
Eu 152			3.59E-06	CC 2	Other b/g				
Eu 154			1.8E-08	CC 2	Total a	0		0	
Eu 155				8	Total b/g	0		4.91E-05	CC 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