

WASTE STREAM	9B319	Secondary Wastes 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.....	1038.0 m ³
Total future arisings:		1038.0 m ³
Total waste volume:		1038.0 m ³
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 Wastes arising from contamination control procedures during plant dismantling.

PHYSICAL CHARACTERISTICS

General description: A variety of combustible and non combustible materials. No large items are expected.
 Physical components (%vol): Metallic pipe and other items (~50% vol), plastic pipework, sheet and other items (~10% vol), rubber gloves and other items (~5% vol), clothing (~5% vol), wood (~5% vol), encapsulated sludge (~5% vol), air filters (~5% vol), combustible material (e.g. paper sheet) (~15-20 % vol). Percentages of constituents are very uncertain.
 Sealed sources: The waste does not contain sealed sources.
 Bulk density (t/m³): ~1
 Comment on density: The density is likely to lie between 0.5 and 1.5 t/m³.

CHEMICAL COMPOSITION

General description and components (%wt): The waste is expected to include cloth (~5%vol), plastics (~15%vol), paper (~15%vol), wood (~5%vol), rubber (~5%vol), encapsulated sludge (~5%vol) and metals (~50%vol). Percentages of constituents are very uncertain.
 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.
 Cl-36: The chemical form of chlorine 36 has not been assessed.
 Metals and alloys (%wt): Items will have been cut for packaging but an assessment of item dimensions has not been made. Metal thicknesses will probably be typically 1-3 mm.

	(%wt)	Type(s) / Grade(s) with proportions	% of total C14 activity
Stainless steel.....	<<1.0		
Other ferrous metals.....	~50.0	Apart from steels only small quantities of metals and alloys are expected.	
Iron.....			
Aluminium.....	<<1.0		
Beryllium.....	0		
Cobalt.....			
Copper.....	<<1.0		
Lead.....	0		

WASTE STREAM	9B319	Secondary Wastes LLW
---------------------	--------------	-----------------------------

Magnox/Magnesium.....	0
Nickel.....	
Titanium.....	
Uranium.....	
Zinc.....	0
Zircaloy/Zirconium.....	0
Other metals.....	<<1.0

Organics (%wt): A wide variety of materials may be present.

	(%wt)	Type(s) and comment	% of total C14 activity
Total cellulosics.....	~25.0		
Paper, cotton.....	~20.0		
Wood.....	~5.0		
Halogenated plastics	7.5		
Total non-halogenated plastics.....	7.5		
Condensation polymers.....	3.8		
Others.....	3.8		
Organic ion exchange materials....	0		
Total rubber.....	~5.0		
Halogenated rubber	<2.5		
Non-halogenated rubber.....	<2.5		
Hydrocarbons.....			
Oil or grease			
Fuel.....			
Asphalt/Tarmac (cont.coal tar)...			
Asphalt/Tarmac (no coal tar)....			
Bitumen.....			
Others.....			
Other organics.....	TR		

Other materials (%wt): Graphite may be present in at least trace quantities. Sludges will be encapsulated.

	(%wt)	Type(s) and comment	% of total C14 activity
Inorganic ion exchange materials..	0		
Inorganic sludges and flocs.....			
Soil.....	TR		
Brick/Stone/Rubble.....	TR		
Cementitious material.....	~5.0	encapsulated sludge	
Sand.....			
Glass/Ceramics.....	0		
Graphite.....	TR		
Desiccants/Catalysts.....			
Asbestos.....	0		
Non/low friable.....			

WASTE STREAM	9B319	Secondary Wastes LLW
---------------------	--------------	-----------------------------

Moderately friable.....

Highly friable.....

Free aqueous liquids..... 0

Free non-aqueous liquids..... 0

Powder/Ash..... 0

Inorganic anions (%wt): Not fully assessed.

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

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.....		
Chlorinated solvents.....		

WASTE STREAM	9B319	Secondary Wastes LLW
---------------------	--------------	-----------------------------

- 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): 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. Large Metal Items (LMIs)/"substantial" thickness items considered "durable" assumed DIs. NB If recycled then DI Limits n/a

TREATMENT, PACKAGING AND DISPOSAL

WASTE STREAM 9B319 Secondary Wastes LLW

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	1.0

Classification codes for waste expected to be consigned to a landfill facility: 17 04 05, 17 02 01, 17 02 03, 20 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)

WASTE STREAM 9B319 Secondary Wastes LLW

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: Contamination by activation products from the reactor structure.

Uncertainty: Only very approximate estimates have been made of the specific activities. The activities quoted are those at the time of Final Dismantling & Site Clearance (85 years after Station shutdown).

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 activity has been calculated from the weighted average of all the other Bradwell ILW and LLW streams assuming a total specific activity for the beta/gamma component.

Other information: The activities quoted are those at the time of Final Dismantling & Site Clearance (85 years after station shutdown, i.e. 2087).

WASTE STREAM 9B319 Secondary Wastes LLW

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			8.86E-07	CC 2	Gd 153				8
Be 10				8	Ho 163				8
C 14			2.42E-05	CC 2	Ho 166m				8
Na 22				8	Tm 170				8
Al 26				8	Tm 171				8
Cl 36			5.97E-08	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-08	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			1.73E-08	CC 2	Bi 208				8
Ni 59			1.08E-06	CC 2	Bi 210m				8
Ni 63			7.36E-05	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				6	Th 232				8
Nb 94			1.04E-08	CC 2	Th 234				8
Mo 93			1.64E-08	CC 2	Pa 231				8
Tc 97				8	Pa 233				8
Tc 99			3.11E-09	CC 2	U 232				8
Ru 106				8	U 233				8
Pd 107				8	U 234				8
Ag 108m			3.07E-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			4.5E-08	CC 2	Pu 238				6
Sn 123				8	Pu 239				6
Sn 126				8	Pu 240				6
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			2.9E-09	CC 2	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			1.17E-09	CC 2	Other a				
Eu 152			8.46E-09	CC 2	Other b/g				
Eu 154				8	Total a	0			0
Eu 155				8	Total b/g	0			1E-04 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