

<b>WASTE STREAM</b>	<b>9A920</b>	<b>Reactor LLW</b>
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**SITE** Berkeley  
**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.....	~0.4 m <sup>3</sup>
Future arisings -	1.4.2022 - 31.3.2036.....	5.0 m <sup>3</sup>
Total future arisings:		5.0 m <sup>3</sup>
Total waste volume:		5.4 m <sup>3</sup>
Comment on volumes:	Assumed approx. 0.4m <sup>3</sup> arising per year for 14 years until C&M entry Volumes include an estimate of secondary wastes (from reactor safe store inspection and maintenance).	
Uncertainty factors on volumes:	Stock (upper): x 1.1	Arisings (upper) x 1.2
	Stock (lower): x 0.9	Arisings (lower) x 0.8

**WASTE SOURCE** 9A920 currently consists of soft and hard trash resulting from safestore preparations, as well as on going inspections and maintenance of the reactor buildings. this waste includes steel work, cables, rubble, wood, where such work has been carried out, as well as secondary wastes (eg: used PPE, plastic sheeting etc.) Some of the waste is likely to be contaminated by asbestos(<1% wt) from past use of this substance in lagging and other building materials.

**PHYSICAL CHARACTERISTICS**

General description: Hard and soft trash and redundant equipment.  
 Physical components (%wt): Metal: 45%, Concrete 15%, Cellulosic 10%, Plastic / rubber 20% and wood 10%  
 Sealed sources: The waste does not contain sealed sources.  
 Bulk density (t/m<sup>3</sup>): ~0.85  
 Comment on density: WCH mass divided by volume

**CHEMICAL COMPOSITION**

General description and components (%wt): Metal: 45%, Concrete 15%, Cellulosic 10%, Plastic / rubber 20% and wood 10%  
 Chemical state: Neutral  
 Chemical form of radionuclides: H-3: Most tritium is expected to be present as water but some may be in the form of other inorganic compounds or as organic compounds.  
 C-14: Chemical form of carbon 14 has not been determined but may be graphite.  
 Cl-36: Chemical form of chlorine 36 has not been determined.  
 U: Chemical form of uranium isotopes has not been determined but may be uranium oxides.  
 Pu: Chemical form of plutonium isotopes has not been determined but may be plutonium oxides.  
 Metals and alloys (%wt): Steel brackets, cable tray conduit and ducting, frames handrails, piping and boxes. Some items will have to be cut for packaging.

	(%wt)	Type(s) / Grade(s) with proportions	% of total C14 activity
Stainless steel.....	NE		
Other ferrous metals.....	45.0	Miscellaneous steelwork (e.g. cable trays, pipes, handrails)	
Iron.....			
Aluminium.....	TR		
Beryllium.....	0		

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Cobalt.....		
Copper.....	TR	
Lead.....	0	
Magnox/Magnesium.....	0	
Nickel.....		
Titanium.....		
Uranium.....		
Zinc.....	0	
Zircaloy/Zirconium.....	0	
Other metals.....	NE	The waste may include a small volume of palladium.

Organics (%wt):                      The waste may contain cellulose and cloth as secondary waste, halogenated plastic may be present as PVC and non-halogenated plastic as polythene.

	(%wt)	Type(s) and comment	% of total C14 activity
Total cellulosics.....	20.0		
Paper, cotton.....	10.0		
Wood.....	10.0		
Halogenated plastics .....	NE	Halogenated plastic may be present as PVC.	
Total non-halogenated plastics.....	10.0		
Condensation polymers.....	0		
Others.....	10.0	.Polythene	
Organic ion exchange materials....	0		
Total rubber.....	10.0		
Halogenated rubber .....	0		
Non-halogenated rubber.....	10.0		
Hydrocarbons.....			
Oil or grease .....			
Fuel.....			
Asphalt/Tarmac (cont.coal tar)...			
Asphalt/Tarmac (no coal tar).....			
Bitumen.....			
Others.....			
Other organics.....	NE		

Other materials (%wt):                      -

	(%wt)	Type(s) and comment	% of total C14 activity
Inorganic ion exchange materials..	NE		
Inorganic sludges and flocs.....	NE		
Soil.....	NE		
Brick/Stone/Rubble.....	15.0		
Cementitious material.....	NE		
Sand.....			
Glass/Ceramics.....	NE		

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Graphite.....	NE	
Desiccants/Catalysts.....		
Asbestos.....	~0.01	
Non/low friable.....	0	
Moderately friable.....	0	
Highly friable.....	~0.01	As dust in gutter debris. A mixture of Amosite and Chrysotile
Free aqueous liquids.....	0	
Free non-aqueous liquids.....	0	
Powder/Ash.....	0	

Inorganic anions (%wt):           No significant anion content is expected in the waste.

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

Materials of interest for waste acceptance criteria:           Asbestos may be present.

	(%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.....	0	
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.....		

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Hazardous substances /  
non hazardous pollutants:

Some of the waste is likely to be contaminated by asbestos(<1% wt) from past use of this substance in lagging and other building materials.

	(%wt)	Type(s) and comment
Acrylamide.....		
Benzene.....		
Chlorinated solvents.....		
Formaldehyde.....		
Organometallics.....		
Phenol.....		
Styrene.....		
Tri-butyl phosphate.....		
Other organophosphates.....		
Vinyl chloride.....		
Arsenic.....		
Barium.....		
Boron.....	0	
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.....	0	

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Potential for the waste to contain discrete items:

Not yet determined. Large Metal Items (LMIs)/"substantial" thickness items considered "durable" assumed DIs; Stainless items assumed DIs Large Concrete Items (LCIs) may be DIs; drummed (ungrouted)/"rubbleised" wastes assumed not DIs

**TREATMENT, PACKAGING AND DISPOSAL**

Planned on-site / off-site treatment(s):

Treatment	On-site / Off site	Stream volume %
Low force compaction	On-site	34.3
Supercompaction (HFC)	Off-site	34.3
Incineration	Off-site	~34.3
Solidification		
Decontamination		
Metal treatment	Off-site	~24.0
Size reduction		
Decay storage		
Recycling / reuse		
Other / various		
None		~7.5

Comment on planned treatments:

34.25% expected to be consigned to incineration, 24% to metallic treatment, 5% of waste is expected to be consigned to Landfill as VLLW, 34.25% to Supercompaction and 2.5% direct to LLWR

**Disposal Routes:**

Disposal Route	Stream volume %	Disposal density t/m3
Expected to be consigned to the LLW Repository	36.8	0.85
Expected to be consigned to a Landfill Facility	5.0	0.85
Expected to be consigned to an On-Site Disposal Facility		
Expected to be consigned to an Incineration Facility	34.3	0.40
Expected to be consigned to a Metal Treatment Facility	24.0	1.4
Expected to be consigned as Out of Scope		
Expected to be recycled / reused		
Disposal route not known		

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

17 04 05, 17 05 03\*/04, 17 06 01\*, 20 01 01, 17 02 01, 17 02 03

**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
-	-	-	-	-	-

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**Waste Packaging for Disposal:**

Container	Stream volume %	Waste loading m <sup>3</sup>	Number of packages
1/3 Height IP-1 ISO			
2/3 Height IP-2 ISO			
1/2 Height WAMAC IP-2 ISO	~34.3	~43.2	< 1
1/2 Height IP-2 Disposal/Re-usable ISO	~2.5	~10	< 1
2m box (no shielding)			
4m box (no shielding)			
Other			

Other information:                      It is likely that this waste will be placed in containers with other LLW. 43.2m<sup>3</sup> loading volume for the WAMAC container is calculated based on the fact that you can low force compact two times the normal volume of waste into a 200 litre/0.2m<sup>3</sup> drum (400 litres/0.4m<sup>3</sup>), you can then fit 36 drums (14.4m<sup>3</sup>) into a ½ height ISO, each drum can be super-compacted to a 1/3 of its original volume so therefore we can get 3 x the amount of un-compacted drums into the final disposal container (43.2m<sup>3</sup>).

**Waste Planned for Disposal at the LLW Repository:**

Container voidage:                      No significant inaccessible voidage is expected.

Waste Characterisation Form (WCH):                      The waste meets the LLWR's Waste Acceptance Criteria (WAC). The waste does not have a current WCH.

Waste consigned for disposal to LLWR in year of generation:                      No. Maximum holding period 1 year. The timing of consignments is under review.

**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:                                      Activity is mainly from materials contaminated by activation products.

Uncertainty:                                Specific activity is a function of Station operating history. The values quoted are indicative of the activities that would 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:                      The specific activities have been estimated from waste stream fingerprint data 1MXN-1BNL-0-WCH-0-3917 v1.2 decayed by 9 years from 2013 to 2022

Other information:                      -

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Nuclide	Mean radioactivity, TBq/m <sup>3</sup>				Nuclide	Mean radioactivity, TBq/m <sup>3</sup>			
	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	8.82E-05	CC 1	8.82E-05	CC 1	Gd 153		8		8
Be 10		8		8	Ho 163		8		8
C 14	4.89E-05	CC 1	4.89E-05	CC 1	Ho 166m		8		8
Na 22		8		8	Tm 170		8		8
Al 26		8		8	Tm 171		8		8
Cl 36	1.39E-05	CC 1	1.39E-05	CC 1	Lu 174		8		8
Ar 39		8		8	Lu 176		8		8
Ar 42		8		8	Hf 178n		8		8
K 40		8		8	Hf 182		8		8
Ca 41		8		8	Pt 193		8		8
Mn 53		8		8	Tl 204		8		8
Mn 54		8		8	Pb 205		8		8
Fe 55	3.39E-07	CC 2	3.39E-07	CC 2	Pb 210		8		8
Co 60	5.54E-06	CC 2	5.54E-06	CC 2	Bi 208		8		8
Ni 59		8		8	Bi 210m		8		8
Ni 63	1.07E-05	CC 2	1.07E-05	CC 2	Po 210		8		8
Zn 65		8		8	Ra 223		8		8
Se 79		8		8	Ra 225		8		8
Kr 81		8		8	Ra 226		8		8
Kr 85		8		8	Ra 228		8		8
Rb 87		8		8	Ac 227		8		8
Sr 90	2.97E-07	CC 2	2.97E-07	CC 2	Th 227		8		8
Zr 93		8		8	Th 228		8		8
Nb 91		8		8	Th 229		8		8
Nb 92		8		8	Th 230		8		8
Nb 93m		8		8	Th 232		8		8
Nb 94		8		8	Th 234		8		8
Mo 93		8		8	Pa 231		8		8
Tc 97		8		8	Pa 233		8		8
Tc 99		8		8	U 232		8		8
Ru 106		8		8	U 233		8		8
Pd 107		8		8	U 234		8		8
Ag 108m		8		8	U 235		8		8
Ag 110m		8		8	U 236		8		8
Cd 109		8		8	U 238		8		8
Cd 113m		8		8	Np 237		8		8
Sn 119m		8		8	Pu 236		8		8
Sn 121m		8		8	Pu 238	3.41E-09	CC 2	3.41E-09	CC 2
Sn 123		8		8	Pu 239	6.25E-09	CC 2	6.25E-09	CC 2
Sn 126		8		8	Pu 240	1.25E-08	CC 2	1.25E-08	CC 2
Sb 125		8		8	Pu 241	5.27E-08	CC 2	5.27E-08	CC 2
Sb 126		8		8	Pu 242		8		8
Te 125m		8		8	Am 241	1.33E-08	CC 2	1.33E-08	CC 2
Te 127m		8		8	Am 242m		8		8
I 129		8		8	Am 243		8		8
Cs 134		8		8	Cm 242		8		8
Cs 135		8		8	Cm 243		8		8
Cs 137	4.42E-07	CC 2	4.42E-07	CC 2	Cm 244		8		8
Ba 133	3.46E-08	CC 2	3.46E-08	CC 2	Cm 245		8		8
La 137		8		8	Cm 246		8		8
La 138		8		8	Cm 248		8		8
Ce 144		8		8	Cf 249		8		8
Pm 145		8		8	Cf 250		8		8
Pm 147		8		8	Cf 251		8		8
Sm 147		8		8	Cf 252		8		8
Sm 151		8		8	Other a				
Eu 152	6.7E-08	CC 2	6.7E-08	CC 2	Other b/g				
Eu 154	5.44E-08	CC 2	5.44E-08	CC 2	<b>Total a</b>	<b>3.55E-08</b>	<b>CC 2</b>	<b>3.55E-08</b>	<b>CC 2</b>
Eu 155	3.45E-09	CC 2	3.45E-09	CC 2	<b>Total b/g</b>	<b>1.69E-04</b>	<b>CC 2</b>	<b>1.69E-04</b>	<b>CC 2</b>

**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