

<b>WASTE STREAM</b>	<b>2C931</b>	<b>LLW Radioactive Sources</b>
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**SITE** Chapelcross

**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.....	< 0.1 m <sup>3</sup>
Future arisings -	1.4.2034 - 31.3.2035.....	< 0.1 m <sup>3</sup>
Total future arisings:		< 0.1 m <sup>3</sup>
Total waste volume:		< 0.1 m <sup>3</sup>

Comment on volumes: Common volume assumption per source of 0.0002m<sup>3</sup> (10cm x 10cm x 2cm). Source register indicates 101 sources in stock and 126 in use to arise in the future.

Uncertainty factors on volumes: Stock (upper): x 1.2 Arisings (upper) x 1.2  
 Stock (lower): x 0.8 Arisings (lower) x 0.8

**WASTE SOURCE** Sealed radioactive sources which were used for applications such as calibration of equipment, instrument testing etc.

**PHYSICAL CHARACTERISTICS**

General description: The sources are made from a mixture of materials including: impregnated fabric, plastic, perspex, metal, resin beads and wood.

Physical components (%vol): -

Sealed sources: The waste contains sealed sources. 101 in stock and 126 to arise in the future.

Bulk density (t/m<sup>3</sup>): ~5

Comment on density: Calculated by dividing waste stream mass by volume from previous WCH - 1MXN-1CHA-0-WCH-0-4201.

**CHEMICAL COMPOSITION**

General description and components (%wt): Metal: 3% (consisting of 50:50 Aluminium and Mild Steel) Concrete / Cementitious material: 93%, Wood: 2%, non-halogenated plastics: 1% and Other: 1% (Others consists of sources in the form of pellets.)

Chemical state: Neutral

Chemical form of radionuclides: -

Metals and alloys (%wt): -

	(%wt)	Type(s) / Grade(s) with proportions	% of total C14 activity
Stainless steel.....			
Other ferrous metals.....	1.5	Mild steel	
Iron.....			
Aluminium.....	1.5		
Beryllium.....			
Cobalt.....			
Copper.....			
Lead.....			
Magnox/Magnesium.....			
Nickel.....			
Titanium.....			

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Uranium.....  
 Zinc.....  
 Zircaloy/Zirconium.....  
 Other metals.....

Organics (%wt): -

	(%wt)	Type(s) and comment	% of total C14 activity
Total cellulose.....	2.0		
Paper, cotton.....			
Wood.....	2.0		
Halogenated plastics .....			
Total non-halogenated plastics.....	1.0		
Condensation polymers.....			
Others.....	1.0		
Organic ion exchange materials....			
Total rubber.....	0		
Halogenated rubber .....			
Non-halogenated rubber.....			
Hydrocarbons.....			
Oil or grease .....			
Fuel.....			
Asphalt/Tarmac (cont.coal tar)...			
Asphalt/Tarmac (no coal tar)....			
Bitumen.....			
Others.....			
Other organics.....			

Other materials (%wt): -

	(%wt)	Type(s) and comment	% of total C14 activity
Inorganic ion exchange materials..			
Inorganic sludges and flocs.....			
Soil.....			
Brick/Stone/Rubble.....			
Cementitious material.....	93.0		
Sand.....			
Glass/Ceramics.....			
Graphite.....			
Desiccants/Catalysts.....			
Asbestos.....	0		
Non/low friable.....			
Moderately friable.....			
Highly friable.....			
Free aqueous liquids.....			

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Free non-aqueous liquids.....

Powder/Ash.....

Inorganic anions (%wt): -

(%wt) Type(s) and comment

Fluoride.....

Chloride.....

Iodide.....

Cyanide.....

Carbonate.....

Nitrate.....

Nitrite.....

Phosphate.....

Sulphate.....

Sulphide.....

Materials of interest for waste acceptance criteria: -

(%wt) Type(s) and comment

Combustible metals.....

Low flash point liquids.....

Explosive materials.....

Phosphorus.....

Hydrides.....

Biological etc. materials.....

Biodegradable materials..... 0

Putrescible wastes.....

Non-putrescible wastes.....

Corrosive materials.....

Pyrophoric materials.....

Generating toxic gases.....

Reacting with water.....

Higher activity particles.....

Soluble solids as bulk chemical compounds.....

Hazardous substances / non hazardous pollutants: -

(%wt) Type(s) and comment

Acrylamide.....

Benzene.....

Chlorinated solvents.....

Formaldehyde.....

Organometallics.....

Phenol.....

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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):

(%wt)      Type(s) and comment

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

Potential for the waste to contain discrete items:      Not yet determined. Subject to DI type assessment (specific clauses within WAC)

**TREATMENT, PACKAGING AND DISPOSAL**

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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:

As much extraneous packaging and shielding will be removed from the sources as possible prior to packaging in a single small container.

**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	5.0

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

**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:**

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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 1/2 Height IP-2 Disposal/Re-usable ISO 2m box (no shielding) 4m box (no shielding) Other	100.0	15.5	< 1

Other information:                      Due to small volume of waste, likely to be co-disposed with other streams.

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

Container voidage:                      -

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:                      -

**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:                      -

Uncertainty:                      -

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:                      Source activities taken from source register and decayed to common reference dates for stocks (2022) and arisings (2034). TBq/m3 calculated using common source volume assumption.

Other information:                      -

**WASTE STREAM 2C931 LLW Radioactive Sources**

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	5.83E-04	BB 2		8	Gd 153		8		8
Be 10		8		8	Ho 163		8		8
C 14	3.03E-04	BB 2	2.24E-06	BB 2	Ho 166m		8		8
Na 22	4.18E-09	BB 2		8	Tm 170		8		8
Al 26		8		8	Tm 171		8		8
Cl 36	1.41E-05	BB 2	5.28E-06	BB 2	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		8		8	Pb 210		8		8
Co 60	2E-06	BB 2	2.46E-05	BB 2	Bi 208		8		8
Ni 59		8		8	Bi 210m		8		8
Ni 63		8		8	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	1.14E-03	BB 2	7.97E-02	BB 2
Kr 85		8		8	Ra 228		8		8
Rb 87		8		8	Ac 227		8		8
Sr 90	5.7E-05	BB 2	1.09E-03	BB 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	9.05E-06	BB 2		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	2.17E-05	BB 2		8	U 232		8		8
Ru 106		8		8	U 233		8		8
Pd 107		8		8	U 234	1.15E-02	BB 2		8
Ag 108m		8		8	U 235	5.37E-04	BB 2		8
Ag 110m		8		8	U 236		8		8
Cd 109		8		8	U 238	1.15E-02	BB 2		8
Cd 113m		8		8	Np 237		8		8
Sn 119m		8		8	Pu 236		8		8
Sn 121m		8		8	Pu 238		8		8
Sn 123		8		8	Pu 239	1.7E-05	BB 2	5.9E-07	BB 2
Sn 126		8		8	Pu 240		8		8
Sb 125		8		8	Pu 241		8		8
Sb 126		8		8	Pu 242		8		8
Te 125m		8		8	Am 241	4.79E-04	BB 2	1.96E-06	BB 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	2.88E-06	BB 2	6.78E-03	BB 2	Cm 244		8		8
Ba 133	7.35E-05	BB 2	1.93E-04	BB 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		8		8	Other b/g				
Eu 154		8		8	<b>Total a</b>	<b>2.52E-02</b>	<b>BB 2</b>	<b>7.97E-02</b>	<b>BB 2</b>
Eu 155		8		8	<b>Total b/g</b>	<b>1.06E-03</b>	<b>BB 2</b>	<b>8.10E-03</b>	<b>BB 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