

**WASTE STREAM****6C33/C****NDS Contact Handled ILW**

**SITE** Harwell  
**SITE OWNER** Nuclear Decommissioning Authority

**WASTE CUSTODIAN** Magnox Limited

**WASTE TYPE** ILW

Is the waste subject to Scottish Policy: No

**WASTE VOLUMES**

		Conditioned	Packaged
Stocks:	At 1.4.2022.....	4.2 m <sup>3</sup>	5.1 m <sup>3</sup>
Total future arisings:		0 m <sup>3</sup>	0 m <sup>3</sup>
Total waste volume:		4.2 m <sup>3</sup>	5.1 m <sup>3</sup>
Number of waste packages in stock:	At 1.4.2022.....	9 package(s)	

**Comment on volumes:** This waste has now been encapsulated in to 9 x 500 litre drums This waste stream covers the large NDS sources at Harwell, including RIPPLE sources 1 to 10, the teletherapy sources and the blood irradiator. Volume updated for 2019 RWI to be consistent with FLoC and package loading.

**Uncertainty factors on volumes:**  
 Stock (upper): x 1.1 Arisings (upper) x  
 Stock (lower): x 0.9 Arisings (lower) x

**WASTE SOURCE** RIPPLE (Radio Isotope Powered Prolonged Life Equipment) generators numbers I-X. These were used for the production of Sr90 titanate sources to power navigation buoy lights and radio-direction equipment. Large teletherapy sources and blood irradiator used in the medical sector and collected by the National Disposal Service and latterly Safeguard International.

**PHYSICAL CHARACTERISTICS**

**General description:** RIPPLE (Radio Isotope Powered Prolonged Life Equipment) generators numbers I-X. These were used for the production of Sr90m titanate sources to power navigation buoy lights and radio-direction equipment. Large teletherapy sources and blood irradiator used in the medical sector and collected by the National Disposal Service and latterly Safeguard International. Contains tungsten alloy, mild steel, stainless steel, lead, aluminium, brass, copper, bismuth telluride, polyurethane foam, wood, concrete and Strontium titanate. The waste has been encapsulated using 3:1 PFA/OPC grout with a water/solid ratio of 0.42. Internal overpacks and sacrificial harnesses were used to contain the waste. Waste loaded into 500 litre drums did not contain DU and therefore were directly grouted.

**Physical components (%wt):** Cement/grout encapsulate 50%; Tungsten Alloy 12.5%; Mild Steel 20.3%; Stainless Steel 0.02%; Lead 10.9%; Aluminium 0.47%; Brass 3.1%; Copper 1.1%; Bismuth telluride 0.02%; Foam 0.08%; Wood 0.52%; Polyurethane foam 0.78%; Strontium titanate 0.16%;

**Sealed sources:** The waste contains sealed sources. RIPPLE (Radio Isotope Powered Prolonged Life Equipment) generators numbers I-X. Large teletherapy sources and blood irradiator used in the medical sector .

**Bulk density (t/m<sup>3</sup>):** ~1.75

**Comment on density:** conditioned waste density

**CHEMICAL COMPOSITION**

**General description and components (%wt):** Cement/grout encapsulate 50%; Tungsten Alloy 12.5%; Mild Steel 20.3%; Stainless Steel 0.02%; Lead 10.9%; Aluminium 0.47%; Brass 3.1%; Copper 1.1%; Bismuth telluride 0.02%; Foam 0.08%; Wood 0.52%; Polyurethane foam 0.78%; Strontium titanate 0.16%.

**Chemical state:** Alkali

**Chemical form of radionuclides:** -

**Metals and alloys (%wt):** Metal is present in a large range of thicknesses.

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	(%wt)	Type(s) / Grade(s) with proportions	% of total C14 activity
Stainless steel.....	0.02		
Other ferrous metals.....	20.3	Mild steel	
Iron.....			
Aluminium.....	0.47		
Beryllium.....			
Cobalt.....			
Copper.....	4.2	3.1% as brass	
Lead.....	10.9		
Magnox/Magnesium.....			
Nickel.....			
Titanium.....			
Uranium.....			
Zinc.....			
Zircaloy/Zirconium.....			
Other metals.....	12.7	Other metals = 12.67% and comprise of 12.5% Tungsten Alloy; 0.16% Strontium titanate and 0.02% Bismuth telluride	
Organics (%wt):	-		
	(%wt)	Type(s) and comment	% of total C14 activity
Total cellulosics.....	0.52		
Paper, cotton.....			
Wood.....	0.52		
Halogenated plastics .....	0.78	PVC wrapping	
Total non-halogenated plastics.....	0		
Condensation polymers.....			
Others.....			
Organic ion exchange materials....	0		
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.....	0.08	Polyurethane foam	
Other materials (%wt):	-		

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	(%wt)	Type(s) and comment	% of total C14 activity
Inorganic ion exchange materials..			
Inorganic sludges and flocs.....			
Soil.....			
Brick/Stone/Rubble.....			
Cementitious material.....	50.0		
Sand.....			
Glass/Ceramics.....			
Graphite.....			
Desiccants/Catalysts.....			
Asbestos.....	0		
Non/low friable.....			
Moderately friable.....			
Highly friable.....			
Free aqueous liquids.....			
Free non-aqueous liquids.....			
Powder/Ash.....			

Inorganic anions (%wt):            Carbonate has been used to stabilise reactive metals. Other chemicals may be present in trace quantities but are not expected- hence recorded as zero.

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

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.....		

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Corrosive materials.....  
 Pyrophoric materials.....  
 Generating toxic gases.....  
 Reacting with water..... TR  
 Higher activity particles.....  
 Soluble solids as bulk chemical  
 compounds.....

Hazardous substances /      The waste contains traces of solvents and pharmaceutical compounds  
 non hazardous pollutants:

	(%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.....		

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Complexing agents (%wt): No

(%wt) Type(s) and comment

EDTA.....  
DPTA.....  
NTA.....  
Polycarboxylic acids.....  
Other organic complexants.....  
Total complexing agents..... 0

Potential for the waste to contain discrete items: Yes. Grouted drums are considered DI

**PACKAGING AND CONDITIONING**

Container type:	Container	Waste packaged (%vol)	Waste loading (m <sup>3</sup> )	Payload (m <sup>3</sup> )	Number of packages
	500 l drum (basket for waste)	~100.0	~0.47	0.47	9

Container type comment: The physical geometry of the items in the 500 litre drums did not lend themselves for loading of more than one unit per drums and hence the low loading volume per drum.

Range in container waste volume: Waste loaded into 500 litre drums did not contain DU and therefore were directly grouted. The physical geometry of the items in the 500 litre drums did not lend themselves for loading of more than one unit per drums and hence the low loading volume per drum.

Other information on containers: Stainless Steel 316L

Conditioned density (t/m<sup>3</sup>): 1.75

Conditioned density comment: The density is assumed to be consistent with that stated in the FLoC submission.

Other information on conditioning: -

**RADIOACTIVITY**

Source: Sealed sources inside units.

Uncertainty: Data taken from FLoC and Waste Product Specification. It should be noted that whilst this waste stream has been encapsulated the specific activity of the waste remains the same as it was pre-encapsulation. This is due to the fact that the radioactivity is contained in the sealed source and does not become distributed throughout the grout formulation i.e. it is not homogenously mixed into the grout.

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: Data taken from FLoC and Waste Product Specification. It should be noted that whilst this waste stream has been encapsulated the specific activity of the waste remains the same as it was pre-encapsulation. This is due to the fact that the radioactivity is contained in the sealed source and does not become distributed throughout the grout formulation i.e. it is not homogenously mixed into the grout.

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			Gd 153		8		
Be 10		8			Ho 163		8		
C 14		8			Ho 166m		8		
Na 22		8			Tm 170		8		
Al 26		8			Tm 171		8		
Cl 36		8			Lu 174		8		
Ar 39		8			Lu 176		8		
Ar 42		8			Hf 178n		8		
K 40		8			Hf 182		8		
Ca 41		8			Pt 193		8		
Mn 53		8			Tl 204		8		
Mn 54		8			Pb 205		8		
Fe 55		8			Pb 210		8		
Co 60	6.63E+00	BB 2			Bi 208		8		
Ni 59		8			Bi 210m		8		
Ni 63		8			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	9.09E+01	BB 2			Th 227		8		
Zr 93		8			Th 228		8		
Nb 91		8			Th 229		8		
Nb 92		8			Th 230	1.24E-08	BB 2		
Nb 93m		8			Th 232		8		
Nb 94		8			Th 234	2.69E-04	BB 2		
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	1.5E-04	BB 2		
Ag 108m		8			U 235	7.13E-06	BB 2		
Ag 110m		8			U 236		8		
Cd 109		8			U 238	2.69E-04	BB 2		
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	4.63E+00	BB 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		8			Other a				
Eu 152		8			Other b/g				
Eu 154		8			<b>Total a</b>	<b>4.26E-04</b>	<b>BB 2</b>		<b>0</b>
Eu 155		8			<b>Total b/g</b>	<b>1.02E+02</b>	<b>BB 2</b>		<b>0</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